

AN INTEGRATED PERSUASIVE DESIGN
FRAMEWORK BASED ON MAQASID AL-SHARI'AH
FOR MUNICIPAL SOLID WASTE DISPOSAL

BY

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the Degree of Doctor of Philosophy in Computer Science
and Information Technology

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ABSTRACT

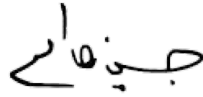
Effective Municipal Solid Waste (MSW) disposal is crucial for environmental sustainability and public health. As waste is segregated at source, the success of the Malaysian waste management practices such as reduce, reuse and recycle largely depends on the active participation of households. However, most Malaysians are unaware of the significance of appropriate cleaning and waste disposal, and their role as *Khalifah* to care for and preserve the environment. Within the domain of sustainable Human-Computer Interaction (HCI), persuasive technology (PT) has emerged as a promising approach to encourage green practices. In order to assist designers in designing persuasive application, Persuasive System Design (PSD), a framework described the process of designing and evaluating a persuasive system was introduced. The framework also enlisted four categories of persuasive design principles such as primary task support, dialogue support, system credibility support and social support. However, one of the major limitations of the framework is lack of spiritual and religious values that could influence and guide human behavior. As Malaysia is a Muslim-majority country and is largely influenced by religious values, we believe that integrating *Maqasid al-Shari'ah* can enhance the persuasive power of technology-driven interventions *Maqasid al-Shari'ah* refers to the higher objectives of Islamic law, providing a value-based approach to influencing behavior through ethical, social, and environmental principles. By integrating persuasive design strategies with these principles, the framework encourages responsible waste disposal behaviors among individuals and communities. Therefore, this study presents the development of an integrated persuasive design framework that integrates PSD principles with *Maqasid al-Shari'ah* to promote environmentally friendly waste disposal behaviors. The research begins by investigating community awareness of MSW disposal based on *Maqasid al-Shari'ah* and identifying barriers to sustainable waste management practices. Afterwards, end-users' perspectives on effective persuasive design principles based on the Persuasive System Design (PSD) framework were identified through in-depth interviews. Additionally, the principles guiding sustainable waste management practices within the framework of *Maqasid al-Shari'ah* were examined using qualitative content analysis and an inductive approach. The output has been used to propose a new integrated framework, which was later validated by expert review using Fuzzy Delphi Analysis. Based on the validated framework, a persuasive application *Tahara* was designed and evaluated through a case study involving eleven Malaysians. This finding proves that the persuasive application designed and developed based on PSD approach integrated with *Maqasid al-Shari'ah*, is effective and successfully motivating desired behaviour change among Malaysian. This study provides valuable insights for policymakers, designers, and environmental agencies in developing culturally and religiously aligned persuasive interventions for sustainable waste management.

ملخص البحث

يُعتبر التخلص الفعال من النفايات الصلبة البلدية أمراً بالغ الأهمية لاستدامة البيئة والصحة العامة. في ماليزيا، حيث يُعد فصل النفايات من المصدر أساسياً للممارسات الناجحة مثل التقليل، وإعادة الاستخدام، وإعادة التدوير، فإن المشاركة الفعالة من الأسر تُعتبر ضرورية. ومع ذلك، فإن العديد من الماليزيين لا نهجا تقدم تكنولوجيا الإقناع يدركون أهمية التخلص الصحيح من النفايات ودورهم كحُماة للبيئة. ولكن في مجال تفاعل الإنسان والحاسوب المستخدم فعلاً لتشجيع تغيير السلوك. عملية تصميم الأنظمة المقلعة، ويتضمن أربع فئات رئيسية: دعم الحوار يحدد إطار هي عدم مراعاته للقيم الروحية والدينية، التي يمكن أن تؤثر بشكل كبير على السلوك البشري. وبما ماليزيا دولة ذات أغلبية مسلمة وتتأثر بشكل كبير بالمبادئ الإسلامية، فإننا نقترح أن دمج مقاصد الشريعة الإسلامية (الإهداف العليا للشريعة الإسلامية) يمكن أن يعزز القوة الإقناعية للتدخلات المعتمدة على التكنولوجيا. بتركز مقاصد الشريعة الإسلامية على المبادئ الأخلاقية والبيئة. مما يوفر نهجاً قائماً على القيم يؤثر في السلوك ومقاصد الشريعة الإسلامية لتعزيز سلوكيات التخلص المستخدم يقدم هذا البحث إطار تصميم متكامل يجمع بين مبادئ تصميم الخدمة العامة النفايات يبدأ البحث بالتحقيق في وعي المجتمع بشأن التخلص من النفايات الصلبة البلدية في سياق مقاصد الشريعة الإسلامية ويحدد العوائق التي تواجه ممارسات إدارة النفايات المستخدمة. تم إجراء مقابلات لجمع وجهات نظر المستخدمين حول المبادئ الفعالة لتصميم الأنظمة المقلعة استناداً إلى إطار عمل حدد. بالإضافة إلى ذلك تم استخدام التحليل النوعي للمحتوى ومنهج استقرائي لفحص المبادئ التي توجه ممارسات إدارة النفايات المستخدمة ضمن إطار مقاصد الشريعة الإسلامية. استناداً إلى النتائج، تم اقتراح إطار عمل متكامل وتم التحقق من صحته من خلال مراجعته الخبراء باستخدام نهج مدمج مع مقاصد الشريعة الإسلامية، فعال في تحفيز التغيير السلوكي المطلوب بين الماليزيين. توفر هذه الدراسة لصانعي السياسات والمصممين والوكالات البيئة لتطوير تدخلات مقنعة تتوافق ثقافياً ودينياً مع إدارة النفايات المستخدمة.

APPROVAL PAGE

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DECLARATION

I hereby declare that this dissertation is the result of my own investigations, except where otherwise stated. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at IIUM or other institutions.

Zohora Azmin Shompa

Signature 

Date 28/04/2025



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This thesis is dedicated to my respected parents, husband and children

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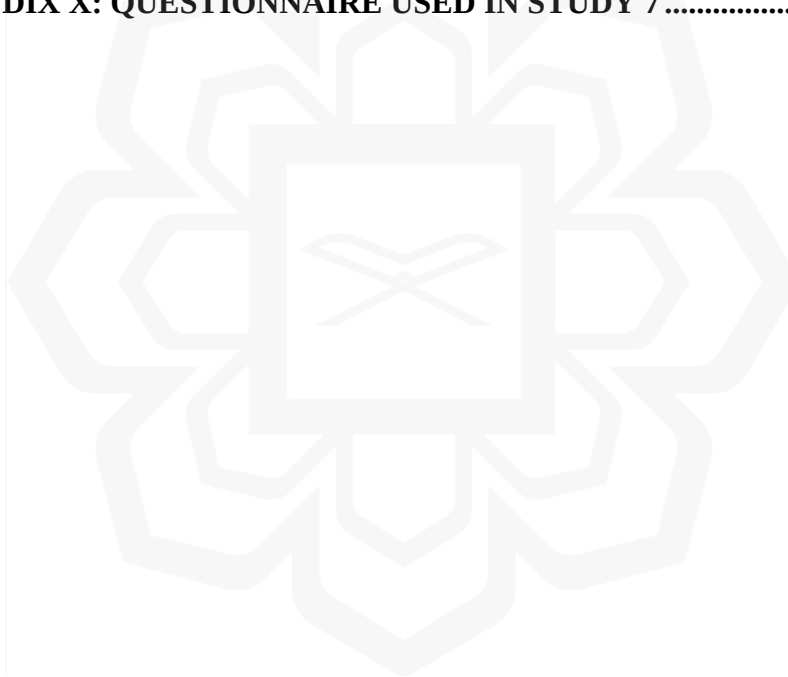
TABLE OF CONTENTS

Abstract	ii
Abstract in Arabic	iii
Approval Page.....	iv
Declaration	v
Copyright	vi
Dedication	vii
Acknowledgements	viii
List of Tables	xiii
List of Figures	xvi
List of Abbreviation	xxi
 CHAPTER ONE:INTRODUCTION	 1
1.1 Background of the Study.....	1
1.2 Problem Statement	5
1.2.1 Shariah-Based Waste Awareness	5
1.2.2 Persuasive System Design Framework (PSD)	6
1.3 Research Questions	8
1.4 Research Objectives	9
1.5 Research Scope and Assumptions.....	10
1.6 Significance of the Study	11
1.7 Conceptual Framework of the Study.....	12
1.8 Definition of Terms	14
1.9 Organization of Thesis	15
 CHAPTER TWO:LITERATURE REVIEW	 19
2.0 Introduction	19
2.1 Municipal Solid Waste (MSW) Management in Malaysia	19
2.1.1 Definition of Municipal Solid Waste (MSW).....	19
2.1.2 MSW Generation and Composition	20
2.1.3 Municipal Solid Waste (MSW) Disposal.....	24
2.1.4 Current Implementation of 3RS (Reduce, Reuse and Recycle).....	28
2.2 Persuasive Technology	30
2.2.1 Definition of Persuasion.....	30
2.2.2 Definition of Persuasive Technology	31
2.2.3 Classification of Persuasive Technology	32
2.3 Theories and Framework.....	42
2.3.1 Fogg Behavioral Model (FBM)	42
2.3.2 Fogg's Eight-Step Design Process Framework	44
2.3.3 The Behavior Change Wheel (BCW) Framework	47
2.3.4 Context-aware, Personalized, Persuasive (CPP) Framework	49
2.3.5 Persuasive System Design (PSD) Model	51
2.4 Mapping the Principles in Waste Management Intervention	72
2.5 Environmental Ethics in Waste Management	77
2.6 Application of Maqasid al-Shari'ah in Sustainable Waste Management.	79
2.6.1 Definition of Maqasid al-Shari'ah	78
2.6.2 Constituents of Maqasid al-Shari'ah in Sustainable Waste Management.....	80

2.6.3 The Role of the Maqasid al-Shari'ah in Waste Disposal	82
2.6.4 Waste Disposal in Persuasive Technology and Maqasid al-Shari'ah Perspective	89
2.7 Chapter Summary	91
CHAPTER THREE: METHODOLOGY.....	92
3.1 Introduction	92
3.2 Research Design.....	92
3.3 Research Phases	93
3.3.1 Phase I: Problem Identification.....	94
3.3.2 Phase II: Identifying Key Design Principles.....	96
3.3.3 Phase III: Framework Development	98
3.3.4 Phase IV: Prototype Development	101
3.3.4 Phase V: Evaluation	102
3.4 Chapter Summary	103
CHAPTER FOUR : DESIGN AND DEVELOPMENT	105
4.1 Introduction	105
4.2 Problem Identification	106
4.2.1 Study 1: Investigating Urban Community Awareness Based on Maqasid al-Shariah	107
4.2.1.1 Model and Hypothesis	109
4.2.1.2 Study Design.....	109
4.2.1.3 Recruitment Procedure	110
4.2.1.4 Instrument Development	110
4.2.1.5 Instrument Validation	111
4.2.1.6 Pilot Study	112
4.2.1.7 Data Screening.....	113
4.2.1.8 Reliability Test	115
4.2.1.9 Data Analysis.....	116
4.2.1.10 Results and Discussion	117
4.2.1.11 Summary of Study 1	129
4.2.2 Study 2: Identify the Barrier of Adopting Green Practices.....	129
4.2.2.1 Study Design.....	131
4.2.2.2 Participants Recruitment.....	131
4.2.2.3 Instrument Development	132
4.2.2.4 Data Collection Procedures	133
4.2.2.5 Data Coding and Analysis	133
4.2.2.6 Results	134
4.2.2.7 Discussion.....	143
4.2.2.8 Summary of Study 2	145
4.3 Identifying Key Design Principles	146
4.3.1 Study 3: Identify End-User's Perspectives on the Persuasive Behavior Change Principles Based on Persuasive System Design (PSD) Model	146
4.3.1.1 Results and Discussion	147
4.3.1.2 Summary of Study 3	159
4.3.2 Study 4: Identify the Principles of Waste Management Practices Within Maqasid Al-Shari'ah Framework.....	161
4.3.2.1 Results and Discussion	161

4.3.2.2 Summary of Study 4	174
4.4 Framework Development	174
4.4.1 Study 5: Initial Persuasive Design Framework of Waste Management Practices Based on Maqasid al-Shariah	175
4.4.1.1 Fuzzy Delphi Method	176
4.4.1.2 Expert Selection and Invitation	177
4.4.1.3 Conduct of Fuzzy Delphi Method (Round 1).....	179
4.4.1.4 Data Collection	180
4.4.1.5 Data Analysis.....	180
4.4.1.6 Results	181
4.4.1.7 Discussion.....	185
4.4.1.8 Summary of Study 5	195
4.4.2 Revised Study 4: Investigate the Principles of Waste Management Practices within the Framework of Maqasid Al-Shari'ah	195
4.4.2.1 Developing A Conceptual Framework for Implementing Maqasid al-Shari'ah in Sustainable Waste Management Practices	196
4.4.2.2 Methods	198
4.4.2.3 Maqasid al-Shari'ah and Sustainable Waste Management Practices: Proposed Conceptual Framework	200
4.4.3 Study 6: Determination of Persuasive Principles of Waste Management Framework Based on Maqasid Al-Shari'ah.....	225
4.4.3.1 Revised Persuasive Design Framework	225
4.4.3.2 Design Principles Integrated with Maqasid al-Shariah ...	226
4.4.3.3 Conduct of Fuzzy Delphi Method (Round 2).....	241
4.4.3.3.1 Expert Invitation	241
4.4.3.3.2 Questionnaire for Experts	242
4.4.3.3.3 Results	243
4.4.3.4 Discussions	244
4.4.3.5 Summary of Study 6	252
4.5 Tahara Application	252
4.5.1 The High-Fidelity Tahara Application.....	252
4.5.2 The Persuasive Features of <i>Tahara</i> Application.....	254
4.5.3 Summary	272
CHAPTER FIVE : EVALUATION	274
5.1 Introduction	274
5.2 Study 7: The Case Study	274
5.2.1 Study Design	274
5.2.2 Study Participants	275
5.2.3 Procedures	276
5.2.4 The Pilot Study.....	278
5.2.5 Data Analysis	279
5.2.6 Results	280
5.2.7 Summary of Study 7	291
CHAPTER SIX:CONCLUSION	293
6.1 Introduction	293
6.2 Summary of the Study.....	293
6.3 Research Contribution.....	300

6.4 Research Limitations and Future Research Directions	305
6.5 Conclusion.....	307
REFERENCES	310
APPENDIX I:QUESTIONNAIRE USED IN STUDY 1	332
APPENDIX II: INTERVIEW USED IN STUDY 2	340
APPENDIX III: INTERVIEW IN STUDY 3	343
APPENDIX IV: INTERVIEW IN STUDY 4	357
APPENDIX V: EXPERT REVIEW (ROUND I) USED IN STUDY 5	359
APPENDIX VI: EXPERT REVIEW (ROUND II) USED IN STUDY 6	387
APPENDIX VII: DETAILED SCREENSHOTS OF MEDIUM-FIDELITY PROTOTYPE TAHARA	400
APPENDIX VIII: DETAILED SCREENSHOTS OF HIGH-FIDELITY PROTOTYPE TAHARA	405
APPENDIX IX: CONSENT FORM USED IN STUDY 7	411
APPENDIX X: QUESTIONNAIRE USED IN STUDY 7	412



LIST OF TABLES

Table 2.1	MSW generation Data in Malaysia	22
Table 2.1	Generation of MSW in major urban areas in Peninsular Malaysia	22
Table 2.3	MSW Composition in Malaysia	23
Table 2.4	Solid Waste Management Policies and Plans Transformation in Malaysia	29
Table 2.5	Classification of intent in Persuasive Technology	32
Table 2.6	Persuasive Strategies when Functioning as a Tool	33
Table 2.7	Simulation Strategies for Persuasive Technology (Fogg, 2003)	35
Table 2.8	Types of Social Cues (Fogg, 2003)	36
Table 2.9	Primary Task Support	59
Table 2.10	Dialogue Support	63
Table 2.11	System Credibility Support	66
Table 2.12	Social Support Category	69
Table 2.13	Relevant Works on Persuasive Waste Management Interventions	76
Table 3.1	Summary of Study Design, Sampling, Data Collection and Analysis Method, and Number of Participants Involved in This Research	103
Table 4.1	Scale for questionnaire validation	111
Table 4.2	Results of Pilot Study	112
Table 4.3	The Skewness and Kurtosis of Each Item	114
Table 4.4	Reliability of the Questionnaires for Community Residents	116
Table 4.5	Scale for Level of Awareness	117
Table 4.6	Demographic Profile of The Respondents	118
Table 4.7	Solid Waste Disposal Practices	121
Table 4.8	Level of Awareness of the Respondents on Solid Waste Disposal Based on Maqasid al-Shariah	123
Table 4.9	Respondents' Behavioral Intention Towards Waste Disposal	125
Table 4.10	Pearson's Bivariate Correlations Between Latent Factors	126
Table 4.11	Regression Analysis Results	126

Table 4.12	Summary of Hypothesis Results	128
Table 4.13	Overview of Socio-Ecological Factors	130
Table 4.14	The Demographics of the Participants	134
Table 4.15	Identified Barrier of Applying Green Practices of MSW Disposal Based on Socio-Ecological Factors	135
Table 4.16	Scale For Interpretation	147
Table 4.17	One User's Perceptions of Persuasive Design Principles in Waste Management Application	149
Table 4.18	Participants' Excerpts Based on Maqasid al-Shariah	161
Table 4.19	Experts Demographic Information	178
Table 4.20	Scale For Experts' Rating	179
Table 4.21	Interpretation of 5 Likert Scale to Fuzzy Delphi Scale	180
Table 4.22	Findings of Expert Consensus on Persuasive Components for Waste Management Application	182
Table 4.23	Items Are Sorted by Priority	183
Table 4.24	Findings of Expert Consensus on Persuasive Component for Waste Management Application Based on Maqasid al-Shariah	185
Table 4.25	Principles of Maqasid al-Shari'ah into Various Sub-Dimensions, Indicators, and Principles Related to Sustainable Waste Management Practices.	201
Table 4.26	Religiosity of Waste Management Practices Based on Maqasid al-Shariah	206
Table 4.27	Healthcare And Wellbeing for Waste Management Practices Based on Maqasid al-Shariah	211
Table 4.28	Useful Knowledge for Waste Management Practices Based on Maqasid al-Shariah	215
Table 4.29	Family Wellbeing for Waste Management Practices Based on Maqasid al-Shariah	218
Table 4.30	Wealth Management for Waste Management Practices Based on Maqasid al-Shariah	222
Table 4.31	Experts Demographic Information	242
Table 4.32	Findings of Expert Consensus on for Waste Management Interface Design	243

Table 4.33	Summary of Findings from Study 1 Until Study 6	251
Table 4.34	Persuasive Design Principles Implemented in <i>Tahara</i> Application	253
Table 5.1	The Demographics of the Participants	280



LIST OF FIGURES

Figure 1.1	Mapping Research Gap, Questions, Objectives, and Methods	10
Figure 1.2	Proposed Conceptual Framework on Integrated Persuasive- Maqasid MSW Disposal	14
Figure 1.3	Thesis Organization	18
Figure 2.1	Malaysian Population and GDP From 1960 To 2018	21
Figure 2.2	Municipal Solid Waste Flow	24
Figure 2.3	The Functional Triad	33
Figure 2.4	<i>Takacycle: Easy Waste Collection App</i> (Self-Monitoring)	34
Figure 2.5	<i>Play Recycle! App</i> (Environment Simulations)	36
Figure 2.6	Attractive Physical Cues Applied in a System to Make Decision	37
Figure 2.7	<i>Emoticon-Bin</i> Uses Psychological Cues to Persuade User	38
Figure 2.8	Example of Language Cues Praise (Left) And Reminder (Right) Applied in Waste Management App	39
Figure 2.9	<i>Apache.Org</i> Applied Reciprocity Strategy to Persuade Users to Donate	40
Figure 2.10	Example of Authority Strategy Implemented in <i>iclean Selangor</i> App	41
Figure 2.11	A Behaviour Model for Persuasive Design by Fogg (2009b)	43
Figure 2.12	8-step Design Process for Persuasive Technology by Fogg (2009c)	46
Figure 2.13	The Behavior Change Wheel Framework, adapted from Michie et al. (2011)	48
Figure 2.14	The CPP framework, adapted from Prost et al. (2013)	50
Figure 2.15	The Persuasive Systems Design Framework (Oinas- Kukkonen and Harjumaa, 2009)	51
Figure 2.16	Analysis of Persuasion Context	55
Figure 2.17	Example of Reduction Principle Applied in <i>irecycle</i> App (Left) And Tailoring Principle Applied in <i>Whitby Waste Buddy</i> App (Right)	61

Figure 2.18	Example of Self-Monitoring Principle and Simulation Principle Applied in <i>Takacycle</i> App	62
Figure 2.19	Example of Personalization Principle (Left) And Rehearsal (Right) Principle Applied in Garbage and Waste Sorting App	63
Figure 2.20	Reminder Principle in <i>Garbageday - Waste Reminders</i> App (Left) and Rewards Principles Applied in The <i>Takacycle</i> App (Right)	65
Figure 2.21	Example of Praise Principle Applied in <i>Sort-Your-Waste</i> Application	65
Figure 2.22	Authority Principle Applied in <i>i-Clean Selangor</i> App and Third-Party Endorsement Principle Applied <i>i-Kitar</i> App	68
Figure 2.23	Verifiability Principles Applied in <i>irecycle</i> App	68
Figure 2.24	Social Comparison and Competition Principle in <i>Takacycle</i> App.	71
Figure 2.25	<i>Gone-For-Good</i> App That Utilize the Cooperation Principle (Right), And <i>Recycle Mate</i> Utilize the Normative Influence Principle (Left)	72
Figure 3.1	Flow Chart of The Basic Procedures in Implementing a Multiphase Design	93
Figure 3.2	Research Phase of the Study	94
Figure 3.3	Persuasive Design Framework Validation using Fuzzy Delphi Technique	99
Figure 4.1	Methodological triangulation approach to design and develop persuasive WM application	106
Figure 4.2	The Model for Awareness of Waste Management Practices Based on the Maqasid al-Shari'ah	108
Figure 4.3	Box Plot Representation of the Multivariate Outlier	114
Figure 4.4	Means of Persuasiveness for Each Persuasive Strategy	148
Figure 4.5	Identified Principles from Maqasid al-Shariah	163
Figure 4.6	Interface Designs of <i>Taqwa</i> in Waste Management App	167
Figure 4.7	Interface Designs of <i>Tazkiyah</i> in The Waste Management App	170
Figure 4.8	Interface Designs of <i>Hikmah</i> in The Waste Management App	173

Figure 4.9	Proposed Persuasive Design Framework for Waste Management Application Based on Maqasid al-Shariah	176
Figure 4.10	Yusuf Al Qardawi View on Environment and Maqasid Al-Sharaih	197
Figure 4.11	The Framework of the Principles of Maqasid al-Shari'ah into Various Sub-Dimensions, Indicators, and Principles Related to Sustainable Waste Management Practices.	204
Figure 4.12	Religiosity of Waste Management Practices Based on Maqasid al-Shariah	205
Figure 4.13	Healthcare And Wellbeing for Waste Management Practices Based on Maqasid al-Shariah	210
Figure 4.14	Useful Knowledge for Waste Management Practices Based on Maqasid al-Shariah	214
Figure 4.15	Family Wellbeing for Waste Management Practices Based on Maqasid al-Shariah	217
Figure 4.16	Wealth Management for Waste Management Practices Based on Maqasid al-Shariah	221
Figure 4.17	Revised Persuasive Design Framework of Waste Management Application Based on Maqasid al-Shariah	226
Figure 4.18	Prototype Displays Garbage Collection Schedule (<i>reduction</i>)	228
Figure 4.19	Prototype Provides Series of Actions (<i>tunnelling</i>)	229
Figure 4.20	Prototype Provides Schedule Based on User Home Address (<i>tailoring</i>)	230
Figure 4.21	Prototype Provides Personalized Content and Services (<i>personalization</i>)	231
Figure 4.22	Prototype Displays User- Performance (<i>self-monitoring</i>) and Contribution (<i>simulation</i>)	233
Figure 4.23	Prototype Displays Recycle Rewards (<i>reward</i>)	235
Figure 4.24	Prototype Displays Reminder from Quran and Sunnah and Provides Notification (<i>reminder</i>)	237
Figure 4.25	Prototype Provides Suggestion About Waste Management (<i>suggestion</i>)	238
Figure 4.26	Prototype Displays <i>Liking</i> Feature	239

Figure 4.27	Prototype Displays Complaint Feature (<i>authority</i>)	240
Figure 4.28	Prototype Provides the Address and Contact Information (<i>verifiability</i>)	241
Figure 4.29	Tahara Prototype Displays Welcome Messages (<i>liking</i>)	256
Figure 4.30	Tahara Prototype Displays Color-Coding Garbage Collection Schedule Based on User Home Address (<i>tailoring (left), reduction and hifz al-din, nafs, nasl, aql, and mal (right)</i>)	257
Figure 4.31	Tahara Prototype Displays the Recycle Page	258
Figure 4.32	Tahara Prototype Displays the Request to Pick Up Recyclable Waste	259
Figure 4.33	Tahara Prototype Displays the Collection History	260
Figure 4.34	Tahara Prototype Displays Nearest Waste Drop Off Locations (<i>reduction and hifz al-din, nafs, nasl, aql, and mal (right) and verification (left)</i>)	261
Figure 4.35	Tahara Prototype Displays User's Performance (<i>Self-Monitoring and Hifz Al-Din</i>) and Contribution of Waste Being Recycled on the Environment (<i>simulation and hifz al-nafs</i>)	262
Figure 4.36	Tahara Prototype Displays Complaint Towards Any Mismanagement or Problem (<i>authority</i>)	263
Figure 4.37	Tahara Prototype Rewards After Disposing Recyclable Waste (<i>rewards</i>)	264
Figure 4.38	Tahara Prototype Provides Suggestion About Sustainability, Health, And Wellbeing, As Well As How to Live a Cleaner, Greener Lifestyle (<i>Suggestion</i>)	265
Figure 4.39	Tahara Prototype Displays Dashboard Screen and Category of Principles of Waste Management Practices from Maqasid al-Shari'ah ((<i>Tunnelling, And Hifz Al-Din, Nafs, Aql, Nasl, and Mal</i>)	267
Figure 4.40	Tahara Prototype Displays Current Practices to Improve On (<i>Tunnelling, And Hifz Al-Din, Nafs, Aql, Nasl, And Mal</i>)	268

Figure 4.41	<i>Tahara</i> Prototype Guides and Reminds User Based on Quran and Sunnah of Managing Waste (<i>Tunnelling, Reminder, And Hifz Al-Din, Nafs, Aql, Nasl, And Mal</i>)	269
Figure 4.42	<i>Tahara</i> Prototype Displays Individual Progress of Managing Waste from Shariah Perspective (<i>Self-Monitoring and Hifz Al-Din</i>)	270
Figure 4.43	<i>Tahara</i> Prototype Reminds User About Their Task of Managing Waste from Shariah Perspective (<i>Reminder and Hifz Al-Din</i>)	271
Figure 4.44	<i>Tahara</i> Prototype Allow User to Choose the Language (<i>Personalization</i>)	272
Figure 5.1	Participants' Smartphone Usage Level	281
Figure 5.2	Types of Waste Produced by Participants	281
Figure 5.3	Methods of Disposing Waste by Participants	282
Figure 5.4	Difficulties of Managing Waste by Participants	283
Figure 5.5	Participants' Usage Bin for Different Type of Waste	283
Figure 5.6	Participants' Usage Waste Management App	284
Figure 5.7	Average Rate of System Design	286
Figure 5.8	Likert-Scale Graph of System Design	286
Figure 6.1	Research Phase of the Study	294
Figure 6.2	The Framework of the Principles of Maqasid al-Shari'ah into Various Sub-Dimensions, Indicators, and Principles Related to Sustainable Waste Management Practices.	303

LIST OF ABBREVIATION

3RS	Reduce, Reuse and Recycle
CMC	Computer-Mediated Communication
EPA	Environmental Protection Agency
FBM	Fogg Behaviour Model
FDM	Fuzzy Delphi Method
HCI	Human-Computer Interaction
KDEBWM	KDEB Waste Management Sdn Bhd
MSW	Municipal Solid Waste
PSD	Persuasive System Design
PT	Persuasive Technology
SSI	Separation at Source Initiative
SWCorp	Solid Waste Management and Public Cleanliness Corporation
UI	User interface
USE	Usefulness, Satisfaction, and Ease of Use
WM	Waste Management

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Municipal solid waste (MSW) is commonly known as garbage or trash, consists of nonhazardous disposable materials generated from residential, commercial, and institutional facilities, rather than hazardous wastes generated by industrial facilities and construction sites (United States Environmental Protection Agency, 2016). The U.S Environmental Protection Agency (EPA) states that materials such as industrial, hazardous, or construction and demolition waste are not classified as MSW, although these materials are most likely disposed of in municipal landfills.

With the rapid progression of globalization, industrialization, and socio-economic development, there has been a significant increase in waste generation worldwide (Yiougo et al., 2013; Ferronato et al., 2019). As urbanization and economic growth accelerate, higher consumption rates contribute to an ever-increasing volume of waste, posing a challenge to municipal authorities responsible for managing public health and sanitation (Ray and Rahaman, 2016; Nor Faiza et al., 2019; Singh, 2020; Lenkiewicz, 2021). Currently, 2.01 billion metric tons of MSW is generated annually worldwide, and this is expected to increase to about 3.40 billion metric tons by 2050 (Kaza et al., 2018).

The improper disposal of municipal solid waste (MSW) leads to significant environmental pollution and poses serious social challenges, affecting public health, ecosystems, and overall quality of life. Therefore, safe disposal of waste has become a necessity all over the world. Malaysia is one of the developing countries in Southeast Asia experiencing the same fate. Many studies have been conducted by various researchers in Malaysia that rapid urbanization, economic and population growth, and changing lifestyles are the main factors contributing to the increasing generation of MSW in Malaysian municipalities (Manaf et al., 2009; Johari et al., 2014; Hoornweg et al., 2015; Rahman et al., 2020). The World Bank has stated that solid waste is one

of the major environmental problems in Malaysia (Hamid et al., 2011). With the high rate of economic growth in the past few decades in Malaysia, the population has grown from 28.6 million in 2010 to 32.7 million in 2020 and the population is projected to increase to 41.5 million by 2040. The main waste generator is the urban population which constitutes approximately 78.4% of the total population in 2020. Considering these rapid economic and population growths are together, Malaysia is generating more wastes compared to any previous point of time in history (Alam and Siwar, 2015; Chu Mei, 2019). According to the Malaysian government (SWCorp), the amount of municipal solid waste generated is steadily increasing. It was documented at 38,563 tons per day in 2015 to 44,888 tons per day in 2018. According to projections, Malaysians are expected to generate about 51,655 tons of waste per day in 2025 (Chin et al., 2020).

Currently, there are three main methods to disposed MSW in Malaysia which are through landfills, recycle and compost (Pariatamby, 2017). However, Malaysia is still very dependent on landfills or open dumps for final disposal of waste (Devadoss et al., 2021). In 2016, Malaysia disposed 81.5% of the waste in landfills and open dumps, while the recycling rate is only 17.5% and composting is only 1% (Pariatamby, 2017). This low recycling rate among the public increased the volume of solid waste generation that sends to landfill year after year.

Households are the predominant source of MSW generation in Malaysia, accounting for 44.5% of total waste, with food waste comprising approximately 50% of household waste (Moh & Manaf, 2017; Ismail et al., 2020). This excessive waste production leads to landfill overflow, with 80% of landfills expected to shut down due to reaching full capacity (Yong et al., 2020). Sanitary landfill was introduced as an initiative to reduce the negative impact of landfills to the environment. However, sanitary landfills are very expensive to operate and maintain, so any additional sanitary landfill will inevitably lead to an increase in government spending on waste management, which currently bears 61% of the total budget for solid waste management and public cleanup (Ministry of Housing and Local Government, 2015).

Therefore, the most cost-effective solution to deal with these problems is to minimize the solid waste generation and participation of household-level waste

segregation. The Malaysian government has implemented various environmental protection programs to promote the 3R principles (reduce, reuse, and recycle). However, research suggests that public awareness and participation remain low due to wrong attitudes and a lack of understanding of recycling's purpose (Zainu & Songip, 2017; Yoke et al., 2019). A survey conducted by SWCorp (2012) found that 89% of respondents were aware of recycling programs, but only 68.8% intended to practice them. More recent studies indicate that only 34% of respondents actively engage in recycling, despite numerous public campaigns (Abdullah et al., 2017).

The main aspect of handling these challenging could be lies by increasing awareness from the perspective of Shariah. A better result could be achieved by raising awareness of Islamic teachings on environmental protection rather than seeking general awareness to solve an environmental protection problem (McKay et al., 2013). According to Zabidi et al., (2021), the responsible behavior to protect the environment can be demonstrated through the religious values. However, this responsible behavior towards the environmental is gradually being eroded because the lack of obligation of Islamic values related to environmental care based on Quran and Sunnah (Abd Rahman, 2020; Ibrahim, 2010). Therefore, it is best to approach this study to raise awareness of the importance of appropriate waste disposal practices from the perspective of *Maqasid al-Shari'ah* in order to protect the environment while generating waste.

Maqasid Al-Shari'ah is defined as the higher goals of the legislator (Al-Raysuni, 2005). It is based on the Holy Qur'an and the Sunnah of Prophet Muhammad (SAW), which are the guidelines for all religious actions. In the context of MSW disposal, the Shariah will shape the people's behavior to protect the environment and make them aware of the importance of adopting environmentally friendly practices from the five principles of *Maqasid al-Shari'ah* namely to protect our faith, life, intellect, lineage, and property. It has been proven that *Maqasid al-Shari'ah* contributes greatly to modern society in various fields such as global warming, environmental crisis, health, family relations, socio-economic affairs, citizens' duties, decision-making structures, laws of war and peace, international relations, and preservation and protection of a healthy environment (Deuraseh, 2012).

In this context of protecting environment, technology could be developed to promote conservation and discourage behaviors that threaten our environment and human health. In recent years, the study of Human-Computer Interaction (HCI) has played a significant role in everyday life in the development of interactive systems that can motivate or persuade people to change their thinking, attitudes, and behavior. One of the widely used frameworks for designing behavior change intervention is Persuasive Technology, which broadly defined as “*technology that is designed to motivate people to change or shape their attitudes or behaviors without using coercion or deception*” (Oinas-Kukkonen and Harjumaa, 2009). In order to facilitate designer and developers to develop application, Oinas-kukkonen and Harjumaa (2009) had further introduced Persuasive System Design (PSD) Framework that offers systematic ways of understanding and analyzing the persuasion context (the intent, the event and strategy) which is very critical for successful behaviour change intervention. Further, the PSD model also enlisted 28 persuasive design principles that were categorized into four categories which are a) primary task support, b) dialogue support, c) system credibility support, and d) social support. Recent studies have demonstrated the effectiveness of the PSD framework in various domains such as health, education, and energy conservation (Orji and Moffatt, 2018), e-commerce (Nkwo et al., 2018), education (Abdullahi et al., 2018), and energy conservation (Bockle et al., 2020). Fewer works have been done in developing persuasive technologies (PTs) to support sustainable waste management behaviors (Bremer, C.,2018; Nkwo, M.,2019; Nkwo et al., 2020). However, the most apparent problem with this persuasive technology is that they have completely ignored the influence of religious values on human behavior.

Therefore, in order to improve or change the behavior towards waste disposal, this study suggests a framework that integrates *Maqasid al-Shari'ah* with persuasive technology to encourage towards green practices (reduce, reuse, recycle) of waste disposal among the urban community in Malaysia. By incorporating Islamic values into persuasive system design, the proposed framework aims to enhance user motivation and engagement, ultimately encouraging sustainable MSW disposal behaviors.

1.2 PROBLEM STATEMENT

1.2.1 Shariah-Based Waste Awareness

Municipal solid waste (MSW) disposal remains a critical issue, especially in Muslim-majority countries where environmental responsibility is deeply influenced by religious and ethical values. Despite Islam's emphasis on environmental conservation, many Islamic nations continue to face inefficient waste management practices, leading to serious environmental and public health concerns. In Malaysia, where Islam is the main religion, the integration of Shariah principles in waste management practices has been gaining attention. Malaysia has developed various environmental policies, such as the Separation at Source Initiative (SSI) (2016), which promotes sustainable waste management. However, the awareness and application of Shariah-based waste management among the public remain limited. Many Muslims in Malaysia are not fully aware of the Islamic obligations regarding waste management. A study by Nasir and Yaacob (2022) found that while Islamic teachings provide detailed ethical principles on environmental stewardship, there is a noticeable indifference among many Malaysian Muslims towards environmental issues. The study emphasizes the need for greater awareness and integration of Islamic environmental ethics into daily practices. Another study by Omar et al. (2018) discusses how modernization and economic growth have overshadowed some aspects of Islamic teachings, leading to inefficient waste management practices among Muslim communities. The paper underscores the importance of understanding and applying Islamic guidance from the Qur'an and Sunnah to address waste management challenges.

Islamic values that are related to environmental conservation need to be translated into environmental conservation behavior. However, this responsible behavior toward environmental conservation is increasingly getting eroded because of spiritual malaise, and the failure to recognize their responsibility toward God-given resources (Jalloh, Dahalan, and Khalid, 2022, Abd Rahman and Jalil, 2021). While Islamic teachings measure prevention, preservation, and conservation before environmental destruction occurs, these values are not effectively translated into sustainable waste management behaviors. The erosion of Islamic environmental ethics, along with a lack of appreciation for Qur'anic and Sunnah based environmental

principles, has contributed to increasing environmental degradation. In Malaysia, the majority of the people are Muslims, and the attitudes and behaviors of Muslims are largely influenced by their religious values. However, their level of awareness of waste management and environmental sustainability from *Maqasid al-Shariah's* perspective has not been explored. Therefore, there is a need to investigate the awareness on the importance of appropriate Municipal Solid Waste disposal based on *Maqasid al-Shariah* develop an approach that influences Islamic principles to enhance persuasive interventions in waste management.

1.2.2 Persuasive System Design Framework (PSD)

In the field of sustainable HCI, the Persuasive Systems Design (PSD) framework has been applied to design persuasive technologies to promote sustainable behavior (Agnisarman, Madathil, and Stanley, (2018; Nkwo, M., Suruliraj, Orji, and Ugah, 2020; Adaji, and Adisa, 2022). Promoting environmental sustainability in waste management has only recently started to the forefront. Exploring this untapped potential is a unique opportunity to achieve the policy goals of the Separation at Source Initiative (SSI) in Malaysia. However, the main problem with this existing PSD framework is that it may not work for the Muslim majority of the Malaysian population.

First, the most pressing problem is that the framework is highly generic – it is lack of cultural and spiritual specificity. The framework does not specify which behavior change strategies are most effective for influencing user intentions and behavior toward environmentally friendly practices. A systematic review by Aldenaini et al., (2020) analyzed persuasive technology adoption in different cultural settings, concluding that both cultural and religious sensitivity are key to designing effective behavior change technologies. A study by Nkwo et al., (2021) systematically evaluated 148 sustainable waste management application, identifying commonly employed persuasive strategies such as reduction, personalization, real-world feel, surface credibility, reminders, and self-monitoring. The study highlighted the importance of tailoring these strategies to align with users' cultural contexts to improve app effectiveness. Research has shown that different types of users are motivated to

different persuasive strategies (Orji, Mandryk, and Vassileva, 2014; Noorbehbahani, and Zarein, 2018; Muhammad Abdullahi, Orji, and Oyibo, 2018; Oyebo, et al., 2021). Therefore, to enhance effectiveness, it is crucial to identify and evaluate specific persuasive strategies that strengthen persuasive components and support sustainable waste management goals (Lehto and Oinas-Kukkonen, 2011; Daud, Sahari, and Muda, 2013). In other words, it is a matter of figuring out how to design an effective and persuasive framework that will capture users' interest or encourage them to adopt 3R practices on an ongoing basis.

Second, the PSD framework primarily focused on western communities, raises doubts about its effectiveness in influencing behaviour change in the Malaysian context. Research by Kolodziej-Smith et al., (2013) examined how cultural differences affect the reception and resistance to persuasive design principles. Furthermore, a study by Lu, Chen, and Epstein, (2021) examined how cultural norms influence persuasive design. The research highlighted cultural differences significantly impact the effectiveness of persuasive strategies, suggesting that a one-size-fits-all approach, as seen in the PSD framework, may not be universally effective. The authors advocate for incorporating cultural considerations into persuasive system design to improve user engagement and behavior change outcomes. Therefore, the effectiveness of persuasive systems largely depends on based on user characteristics, and the integration of cultural differences and appropriate design strategies (Nkwo, 2019; Orji, Tondello, and Nacke, 2018; van Velsen et al., 2019).

Third, the framework has entirely ignored the influence of spiritual and religious values on human behavior, which may limit their effectiveness in such societies. Spiritual and religious values can have a significant role in shaping their beliefs, ethics, and behaviors. Studies (Schuman et al., 2018; Chuvieco, Tucker & Grim, 2016) highlight that religious belief is a strong motivation of the environmental concern, as religions providing a cosmology that defines role of the human being toward the environment. Balazadeh (2023) emphasized the importance of integrating religious values when designing products or services that tailor to specific cultures. Therefore, in the context of waste disposal, 61.3% of the population practices Islam in Malaysia, Islamic values play a crucial role in influencing their behavior. In a study by Alkandari et al. (2022), the authors explored how Islamic values can guide the development of

persuasive health applications for Muslim populations, showing that integrating religious values enhances user acceptance and engagement.

In light of the aforementioned discussion, this study intends to fill the gaps by addressing the need for a more culturally, religiously, and spiritually sensitive design approach. By incorporating these factors into persuasive design, we believed that this study would increase persuasion in promoting environmentally friendly waste management practices, ultimately leading to more effective and enduring behavior change among Malaysian community. As a first step towards contributing to the research, this study focuses on how to develop an integrated mobile persuasive behavior change framework by: (1) identification of persuasive principles that is most effective to encourage green practices of MSW Disposal among Malaysian community (2) identification principles of religious values on human behavior based on *Maqasid al-Shariah*. The outcome of this research will be beneficial to raise the awareness of the Malaysian community on the importance of municipal waste disposal based on *Maqasid al-Shari'ah* and ultimately reduce the risks to health and environment caused by improper waste disposal. Therefore, it become a necessary to develop a new persuasive framework based on *Maqasid al-Sharaih*.

1.3 RESEARCH QUESTIONS

Based on the problem described in section 1.2, we are interested in understanding how we can design a mobile persuasive system that integrates Shariah law to motivate Malaysian people to change their attitude and behavior towards waste disposal, and care more for the environment. Therefore, the following three (3) research questions are investigated in this study:

RQ1: What are the levels of awareness of urban community on the importance of disposing municipal solid waste based on *Maqasid al-Shariah*?

RQ2: Which persuasive principles could encourage behavioral change towards green practices (reduce, reuse, recycle) of municipal solid waste disposal?

- a) What are the persuasive design principles that encourage green practices of MSW disposal based on Persuasive System Design (PSD) framework?
- b) What are the principles of *Maqasid al-Shari'ah* encourage green practices of MSW Disposal?

RQ3: How persuasive application designed based on the integrated framework able to encourage people to apply green practices for municipal solid waste disposal?

1.4 RESEARCH OBJECTIVES

The main objective of this study is to develop a persuasive design framework that incorporates *Maqasid al-Shariah* to encourage and promote proper municipal solid waste disposal practices among Malaysian people. Accordingly, the objectives of this research include:

RO1: To investigate urban community awareness on the importance of appropriate municipal solid waste disposal based on *Maqasid al-Shariah*.

RO2: To identify persuasive design principles that could encourage behavioural change towards green practices of municipal solid waste disposal.

- a) Identify effective persuasive design principles to encourage green practices of MSW Disposal based on the Persuasive System Design (PSD) model.
- b) Identify the principles of waste management practices within *Maqasid al-Shari'ah* framework namely protection of faith, life, intellect, lineage, and wealth.

RO3: To propose a new integrated persuasive design framework that incorporates *Maqasid al-Shariah* for promoting proper waste disposal behaviors.

RO4: To evaluate the effectiveness of proposed framework in encouraging environmentally friendly behaviors among Malaysian through the design of persuasive application prototype.

The following Figure 1.1 visualized the relationship between the research gap, questions, objectives, and methods of this thesis.

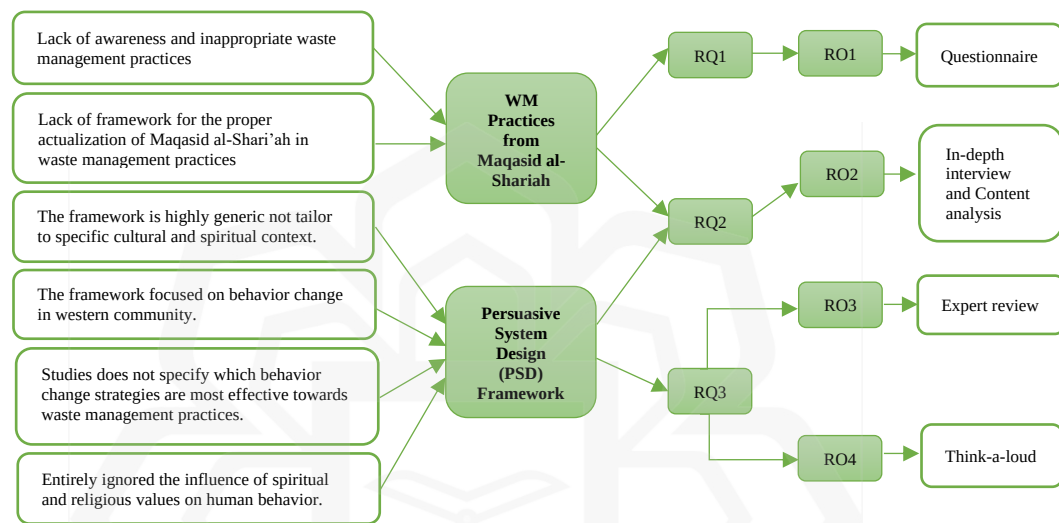


Figure 1.1: Mapping Research Gap, Questions, Objectives, and Methods

1.5 RESEARCH SCOPE AND ASSUMPTIONS

The research conducted in this doctoral thesis is presented by the following scope and assumptions:

a) The target user: The target user of this study is the urban community living in Klang Valley, Malaysia. The reason for choosing Klang Valley is that it is an urban conurbation in West Malaysia comprising the federal capital city of Kuala Lumpur and its suburbs with the adjoining towns and municipalities of Petaling, Klang, Gombak, Hulu Langat, Sepang, Kuala Langat, Kuala Selangor, Sebak Bernam and Hulu Selangor in the state of Selangor. According to the Malaysian Department of Statistics, urbanization in the Klang Valley has increased rapidly in recent decades. From the literature, Selangor and Kuala Lumpur are experiencing rapid urbanization

resulting in high waste generation with people migrating from different areas for various reasons including socio-economic needs, study, work, business, and lifestyle. As Malaysia is on its way to becoming a developed country, the total population in the Klang Valley continues to increase dramatically, so massive waste generation is expected in the future. In 2010, the amount of waste generated in Klang Valley and Selangor was approximately 6000 metric tons per day (Choon, Tan and Chong, 2017). A survey conducted by Rafia and Muhammad (2011) revealed that households are not aware of the benefits of recycling and waste segregation and the number of households willing to separate their waste is low in Kuala Lumpur. A recent study by Choon, Tan and Chong (2017) looks at the awareness and behavior towards waste minimization, waste separation, reuse, and recycling in Klang Valley. The result shows that most of the respondents indicated that they lack knowledge to practice waste separation. 60% of the residents do not separate their household waste in their daily life while about 45.7% of the respondents do not practice waste minimization and therefore dispose mixed waste which is problematic.

b) The target behaviour: Increase public awareness on environmentally friendly practices from a Shariah perspective. In this way, the potential of people to participate in 3Rs activities will be improved and the amount of waste generation and disposal in the country will be reduced and managed.

c) The approach: Persuasive System Design (PSD) model and Maqasid al-Shariah

1.6 SIGNIFICANCE OF THE STUDY

This study is designed to examine new ways of persuading the people of Klang Valley, Malaysia to change their behavior towards waste disposal in order to adopt green practices and protect the environment. As stated in section 1.1, the problem of the community is that they have low awareness of adopting green practices. Half of the waste in Malaysia is not disposed safely and leading to a waste crisis. Our product consumption and irresponsible waste management are directly contributing to climate change, which is warming the air and causing a catastrophic greenhouse effect. Currently, the solution to waste management is landfill, which in turn has a negative

impact on our environment. The decomposition of waste produces large amounts of methane gas and CO₂. Many of these negative impacts could be improved if Malaysians changed their behavior. Hence, this study is proposed that *Maqasid al-Shari'ah* will be integrated into a mobile persuasive system to motivate them to adopt environmentally friendly practices in their actual behavior. It is expected that the residents of the said locality will raise awareness of the importance of proper waste management based on *Maqasid al-Shari'ah* (the objectives of Islamic law) in the urban community. In this way, they will better understand how to behave properly in waste disposal in order to protect the environment and achieve prosperity in this world and the next.

In addition, this study will also help to achieve the Sustainable Development Goals (SDG) target that emphasizes the importance of responsible consumption and production in achieving economic growth and sustainable development. Efficient sustainable management of natural resources and reduction of waste generation through reduction, recycling and reuse are the main objectives to achieve this goal.

In addition, this study also aims to help the Malaysian government to promote a more effective way of waste management by encouraging the method of reduction, reuse and recycling and ultimately reduce the landfills. The adoption of environmentally friendly practices is essential for a sustainable waste management system.

1.7 CONCEPTUAL FRAMEWORK OF THE STUDY

Figure 1.2 illustrates the conceptual framework of the study and explores new ways to persuade the Malaysian community to change their attitude and behavior to adopt green practices (3Rs) from the perspective of persuasive technology and *Maqasid al-Shariah*. As a first step, *Maqasid al-Shari'ah* will raise the awareness of the urban community on waste disposal behaviors and practices according to the five essential objectives of Shari'ah as described by Imam al-Ghazali (d. 505 AH /1111 AD), namely the protection of faith, life, intellect, lineage, and wealth. The literature supports this framework in which *Maqasid al-Shari'ah* raises awareness of the importance of

municipal solid waste disposal by including important elements such as moral obligation as a *khalifa* towards waste management, health, and safety behavioral practices, acquiring knowledge about the 3Rs, awareness of adopting the 3Rs for the future generation and moderate food consumption. *Maqasid al-Shari'ah* will shape behavior for appropriate waste disposal to ensure that all activities are in line with Shari'ah objectives. Therefore, *Maqasid al-Shari'ah* will be integrated with persuasive technology to motivate Malaysian citizens to adopt green practices in their actual behavior. In the next step, the design of the sustainable waste disposal prototype to uncover the persuasive behavior change strategies is based on the four categories of Persuasive Design Strategies as described by Oinas-Kukkonen and Harjumaa (2008). These strategies will be used with a mobile application to change the behavior of the end users through persuasion without using any kind of coercion or deception to adopt green practices. We choose this framework because it is the most commonly used model for reviewing persuasive systems to identify strategies that effectively help users achieve desired tasks and target behaviors. Therefore, designing a persuasive technology product based on Shariah perspective can certainly help designers to develop very efficient systems that promote the Islamic community and benefit the end users. Accordingly, it is very important to conclude that persuasive technology with mobile apps combined with Shariah perspective can provide new and amazing ways of interaction to a wide audience and encourage them to become more aware of the waste management problems.

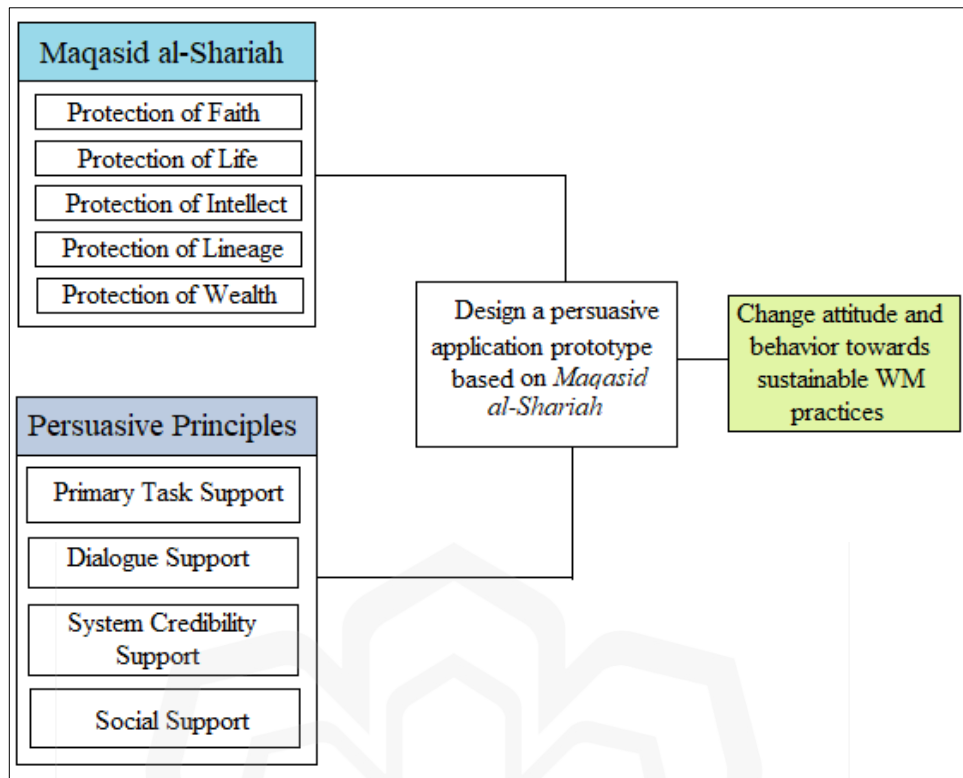


Figure 1.2: Proposed Conceptual Framework on Integrated Persuasive-Maqasid MSW Disposal

1.8 DEFINITION OF TERMS

Persuasive technology: Persuasive technologies are interactive computing system that persuade users to accomplish desired behaviors without coercion or deception (Oinas-Kukkonen and Harjumaa, 2009). The development of mobile technologies has created opportunities for users to learn new behaviours, and complete specific activities which motivated researchers and designers to develop interventions that address a variety of environmental sustainability issues (Pathmanathan, 2011; Nkwo and Orji, 2020). In the context of this study, persuasive technology will address a waste management issue by persuading Malaysian community to better waste management practices.

Persuasive Design Framework: The Persuasive Systems Design (PSD) Framework is a conceptual model used to design, develop and evaluate persuasive systems that

aim to change users' attitudes or behaviors without coercion. The PSD framework was introduced by Harri Oinas-Kukkonen and Marja Harjumaa in 2009.

Municipal Solid Waste (MSW): Municipal Solid Waste (MSW) generally referred to as “trash” or “garbage,” that is collected from households, commercial establishments, institutions, and other sources within a municipality. It typically includes everyday items such as food scraps, newspapers, plastics, paper, glass, metal, and other non-hazardous materials discarded as trash.

Municipal Solid Waste (MSW) Disposal: Municipal Solid Waste (MSW) disposal refers to the procedures and techniques used to manage and eliminate waste produced by households, businesses, and institutions. The goal of MSW disposal is to reduce negative effects on the environment and promote sustainable waste management practices. The most common solid waste disposal methods are recycling, composting, incineration, and landfilling (Farraji et al., 2020).

Maqasid al-Shari'ah: *Maqasid al-Shari'ah* can be defined as the higher objectives of the Legislator (Al-Raysuni, 2005). According to Abu Hamid al-Ghazali, (1413 AH, p. 174) *Maqasid al-Shari'ah* is the attainment of good and benefits for mankind which is intended by the Lawgiver to protect their religion (dīn), life (nafs), intellect ('aql), progeny (nasl), and wealth (mal). *Maqasid al-Shari'ah* provides the guideline and awareness towards all human acts based on the Quran and Sunnah of the prophet. In the context of the study, *Maqasid al-Shariah* plays an important role in guiding human behavior and increase the awareness of managing waste management practices based on Shariah.

1.9 ORGANIZATION OF THE THESIS

The structure of this doctoral thesis is organized as follows:

Chapter 1 introduced the context of the research as well as the objective of this study. It also described the significance of the study. Finally, it described the conceptual

framework of the study followed by the definition of the terms and organization of the thesis.

Chapter 2 contains reviews of relevant literature which include: 1) Municipal Solid Waste (MSW) management in Malaysia, 2) definitions and description of the Persuasive Technology and theories and framework. Reviews of mapping principles in waste management intervention and the examination of closely related works will be discussed in the chapter. Further, 3) environmental ethics in waste management, and 4) the application of *Maqasid al-Shari'ah* in sustainable waste management will be presented at the end of the chapter.

Chapter 3 presents the research design, and research phases specifically describe the methodology and the procedures of seven studies conducted to design and develop persuasive application aiming to encourage sustainable waste management practices among Malaysian residents.

Chapter 4 describes and discusses the six studies conducted to design and develop persuasive application aiming to encourage waste management practices. The first study (Study 1) investigated the urban community awareness to adopt sustainable waste disposal practices based on *Maqasid al-Shariah*. The subsequent five studies were conducted to design, develop, and evaluate the framework.

First, the study identified the specific issue of adopting green practices that hinder the target behavior (Study 2). Afterwards, two studies were conducted to identify the persuasive key design principles which are: a) an in-depth interview was carried out to identify the persuasive behavioral change strategies based on PSD model (Study 3); and a qualitative content analysis method and an inductive approach has been used to outline the constituent elements of *Maqasid al-Shari'ah* in sustainable waste management practices (Study 4).

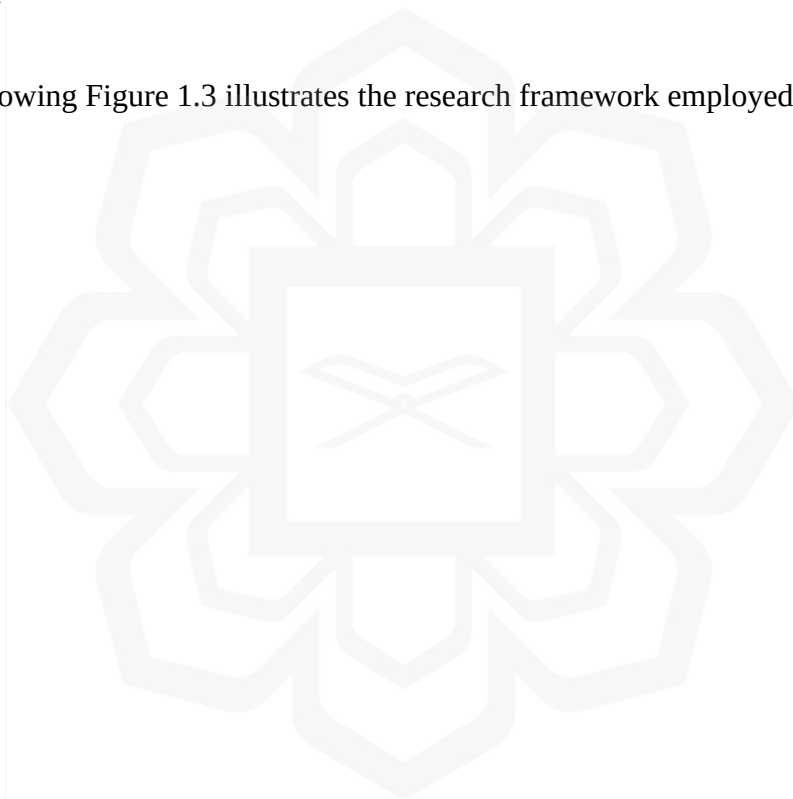
In next phase, two studies were conducted to validate the necessary persuasive components through Fuzzy Delphi technique. An expert review was conducted to validate initial framework (Study 5) and revised framework was validated to determine the persuasive principles of waste management framework based on

Maqasid al- Shari'ah that will encourage sustainable waste management practices among Malaysian households (Study 6). The outcome of this study developed the persuasive prototype named *Tahara*.

Chapter 5 described the evaluation of *Tahara* application. Study 7, a case study was conducted to evaluate the effectiveness of the application at encouraging sustainable waste management practices for Malaysian households.

Chapter 6 concludes this thesis by highlighting its contributions and implications as well as potential future works in the area.

The following Figure 1.3 illustrates the research framework employed in this thesis.



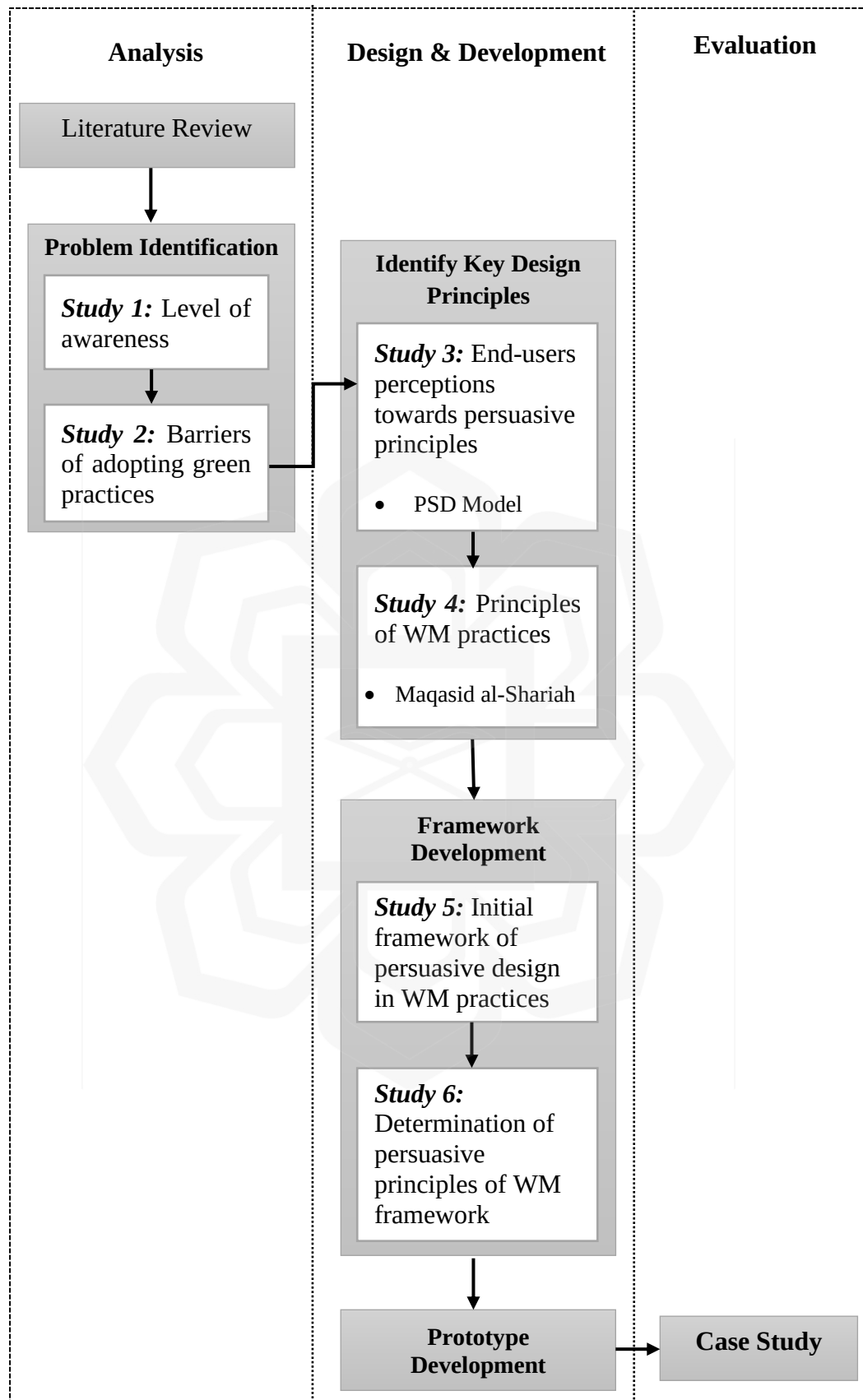


Figure 1.3: Thesis Organization

CHAPTER TWO

LITERATURE REVIEW

2.0 INTRODUCTION

This chapter presents into a section and discuss the key concepts and existing literature related to the theme of the study. This chapter begins with explaining the literature on MSW management including definition of Municipal solid waste (MSW) management, MSW generation and composition, MSW disposal methods and current implication of 3Rs in Malaysia.

Then the study continues discussion the research domain of persuasive technology, the Fogg's framework of Persuasive Technology "Functional Triad". Due to the limitation of Functional Triad, Oinas-kukkonen and Harjumaa (2009) modified the Fogg's functional triad and developed a more specific Persuasive Systems Design (PSD) framework in order to assist researchers and designers in the design, development and evaluation of persuasive system, and existing persuasive application on waste management. In addition, this study also reviews persuasive principles in waste management intervention with research gap of the study.

Last, this chapter ends with this environmental ethics in waste management, the role of five essential elements of *Maqasid al-Shari'ah* such as religion, life, lineage, intellect and property in waste disposal issues and discussed why do we need to integrate the persuasive technology and *Maqasid al- Shari'ah* in MSW disposal.

2.1 MUNICIPAL SOLID WASTE (MSW) MANAGEMENT IN MALAYSIA

2.1.1 Definition of Municipal Solid Waste (MSW)

Municipal Solid Waste (MSW) generally referred to as "trash" or "garbage," is a collection of waste materials that comprises nondurable items (e.g., newspapers, plastic plates, and cups), durable items (e.g., tires, furniture), containers and packaging

(e.g., milk cartons, plastic wrap), and other waste materials (e.g., yard waste, food). Common household waste, as well as office waste, and retail waste are all included in this category of waste, but excludes industrial, hazardous, and construction waste (Center for Sustainable Systems, 2023). As defined by Abbasi (2018), MSW is heterogeneous, basically non-hazardous, biodegradable, or non-biodegradable, carbonaceous or non-carbonaceous, and reusable or unusable solid waste generated from households and commercial establishments.

2.1.2 MSW Generation and Composition

The current global generation of municipal solid waste (MSW) is about 2.01 billion metric tons per year. It is estimated that this number will increase to about 3.40 billion metric tons by 2050 (Kaza et al., 2018). The generation of municipal waste is directly related to rapid population growth, urbanization, and huge consumption of packaged products as a result of rising living standards. The increase in waste generation poses a great challenge for the controlled and sustainable disposal of waste.

Waste generation in Malaysia has been steadily increasing along with population and gross domestic product (GDP) (Figure 2.1), making the management of municipal waste increasingly important (Devadoss et al., 2021). Statistics on demographics shows that the Malaysian population has increased by 40% in 20 years, from 23 million people in 2000 to about 32.7 million people in 2020. MSW generation increased by more than 90% every 10 years with the growing population in Malaysia (Moh and Manaf, 2017). Urbanization is largely responsible for this as the country's urban dwellers (accounting for 65% of the total population) are the largest contributors to waste generation. Waste from households is one of the major sources of MSW generation in Malaysia (65%), followed by commercial and institutional waste (28%) and industrial waste (7%) (Tang et al., 2019). In Malaysia, with an urban population of 14.43 million people, approximately 22,000 tons of municipal solid waste (MSW) is generated every day. As the total urban population is expected to increase to 27.2 million by 2025, the total MSW generated will also double to 51,655 tons per day (World Bank, 2012). Table 2.1 shows the data on municipal waste generation in Malaysia from 2012 to 2025.

In per capita terms, there was a relatively large increase in daily waste generated per capita in 0.8 kg/capita/day in 2005 to 1.7 kg/capita/day in 2016 (SWCorp, 2017), and is subject to be increased by 2024 to 2.23 kg/capita/day in large cities such as Kuala Lumpur (Malakahmad et al., 2017). Meanwhile, the daily average solid waste generated in rural area is from 0.5 kg to 0.8 kg per person while the daily average of solid waste generated at urban area is around 1.9 kg per person (Kadir & Abidin, 2016). The daily waste generation rate per capita in Malaysia is higher than many neighboring Asian countries such as Myanmar, Vietnam, Laos, Indonesia, and Philippines. Table 2.2 shows annual waste generation in Peninsular Malaysia by each state since 1998 until 2020. Among all major urban areas in Peninsular Malaysia, Selangor recorded the highest MSW generation at 1,950 tones, far leading other urban areas. Johor ranked the second; only 1785 tons followed by Kuala Lumpur, third, 1322 tons (Khairuddin et al., 2015). This figure is estimated to keep increasing as the urbanization process continuous in Malaysia.

Therefore, this increasing rate of waste generation indicate that the practices of reduce, reuse, and recycle is still low. The government has launched various campaigns and programs with the aim to create awareness on the 3Rs (reduce, reuse and recycle) but end up with failure due to insufficient public response. However, public awareness on recycling programs increased slightly (SWCorp, 2012, Abdullah et al., 2017).

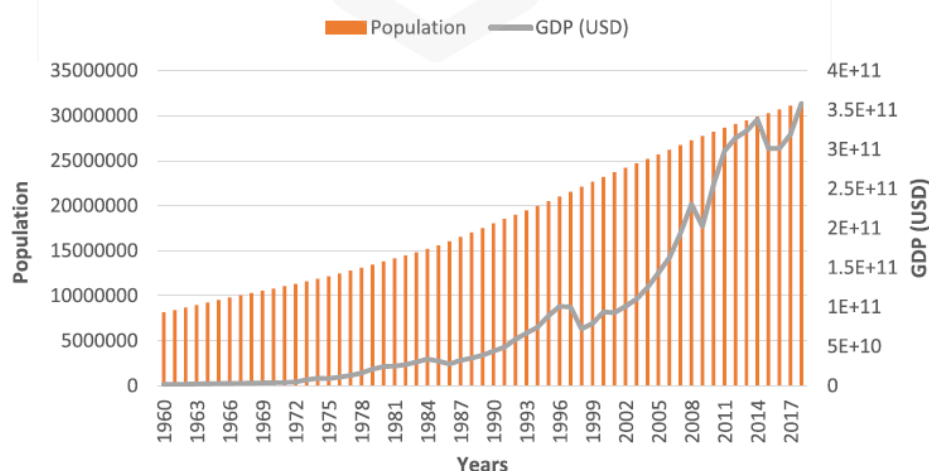


Figure 2.1: Malaysian Population and GDP from 1960 to 2018 (Source: Devadoss et al., 2021)

Table 2.1: MSW Generation Data in Malaysia

Year	MSW Generation (tons / day)
2012	33,150
2013	33,747
2014	34,355
2015	38,563
2016	40,566
2017	42,672
2018	44,888
2019	47,218
2020	49,670
2025	51,655

(Source: SWM lab report, 2015; World Bank, 2012; Noor Azlina, 2018)

Table 2.2: Generation of MSW in major urban areas in Peninsular Malaysia (in thousands of tons)

State	1998	1999	2000	2010	2015	2020
Kuala Lumpur	1,058	1,070	1,082	1,202	1,262	1,322
Selangor	1,169	1,204	1,240	1,595	1,773	1,950
Pahang	202	206	210	250	270	290
Kelantan	123	126	120	87	72	42
Terengganu	119	122	125	155	170	185
Negeri Sembilan	267	278	291	411	471	531
Melaka	208	216	225	310	353	395
Johor	927	956	1,005	1,395	1,590	1,785
Perlis	28	28	29	34	36	39
Kedah	569	569	631	941	1,096	1,251
Penang	611	611	648	833	925	1,018
Perak	719	719	763	983	1,093	1,021
Total	6,000	6,105	6,369	8,196	9,111	9,820

Forecasting based on (1998-2010) average increase rate of 2.14%.

Like municipal waste generation, the composition of municipal waste has changed and become more complex due to many factors such as urbanization, economic development, cultural norms, geographical location, energy sources and climate (Slagstad and Brattebø, 2013; Zorpas et al., 2015). Based on the

characterization of municipal waste, the largest part of the national waste composition is organic waste, especially food waste, which constitutes about 50%, followed by plastics, paper, metal, and glass. This condition is quite similar in most developing countries, as organic waste accounts for the largest share of household waste compared to developed countries (World Bank, 1999a).

Table 2.3 shows the composition of MSW in Malaysia from 1975 to 2020. Food waste has always been the major component of MSW in Malaysia and still is today. In 1975, the proportion of food waste was 56.3% and has decreased to 44.5% in 2020. On the other hand, plastics accounted for 2.5% in 1975 and increased to 24% in 2020. The largest variation in waste composition is disposable diapers, which account for nearly 12.1%. In the last decade, the number of diapers generated daily has increased by more than 400% due to their cheaper and easier availability in the market. Moreover, the generation of paper waste fluctuates over the years. This change in the composition and characteristics of solid waste reflects the changes in the lifestyle of the Malaysian population over this period.

Table 2.3: MSW Composition in Malaysia

Physical composition	Type of solid waste	1975	2020
Organic	Food	56.3	45
Inorganic	Paper	7	8.2
	Plastic	2.5	13.2
	Textile	1.3	3.1
	Glass	2.5	3.3
	Diapers	5.06	12.1
Others	Others	17.9	9.5

*Source: KPKT and JPSPN, 2013; Agamuthu et al., 2009; SWCorp, 2017; Chan et al., 2022.

2.1.3 Municipal Solid Waste (MSW) Disposal

2.1.3.1 Concept of Waste Disposal

Waste disposal is the final functional element in the Solid Waste Management (SWM) system. Generally, they are considered as unwanted products or substances that are deposited in landfills for the purpose of final burial, destruction, or deposition for future recycling (Guangyu, 2009). The goal of waste disposal is to isolate solid waste and its effects on the environment from the biosphere and to protect humans and the environment from infection by hazardous constituents in solid waste. Moreover, disposal means *"any action that may lead to resource recovery, recycling, reclamation, direct reuse or alternative uses"* (Basel Convention, 2018). The most common solid waste disposal methods are recycling, composting, incineration, and landfilling (Farraji et al., 2020).

2.1.3.2 MSW Disposal in Malaysia

Currently, Malaysia has three methods of disposing of municipal waste, namely landfill, recycling, and composting. However, Malaysia is still very dependent on landfills for the final disposal of almost all types of waste (Malakahmad et al. 2017). According to Agamuthu (2017), 81.5% of national waste was disposed of in landfills, 17.5% was recycled and 1% was composted in 2015 as shown in Figure 2.2. However, it should be noted that the national recycling rate may not be accurate as recycling activities in Malaysia are not regulated, resulting in the lack of proper data collection.

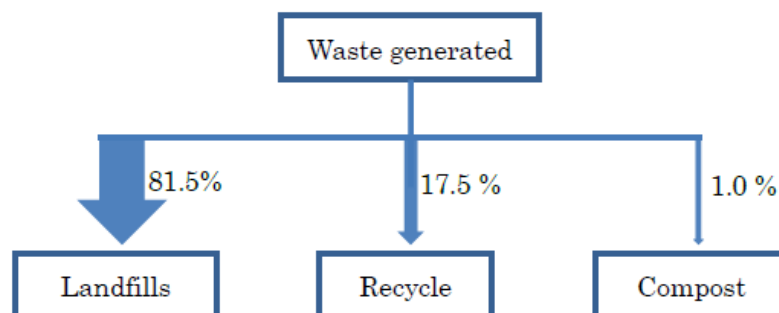


Figure 2.2: Municipal Solid Waste Flow (Source: Pariatamby, 2017)

Landfills

Landfilling is the most widely used method of MSW disposal in the world because of the simplest, cheapest, and low-technical requirement (Feng et al., 2018; Hakami, 2016). The primary purpose of landfill is isolating the waste from the community by reducing its volume and rendering them stable and hygienic. Landfill can be a potential source of pollution if not designed and operated properly. It is found that improper waste disposal led to serious problem such as social and ecological problems like water, groundwater, soil, air, and noise pollution. Other problems such as floods and diseases are increased. However, Malaysia relies heavily on open dumping and landfills for the final disposal of waste and cause serious environmental and social threats (Abd Manaf et al., 2009). A total of 89% of the collected MSW are being dumped to these landfill sites, where only 1% of the total incoming MSW receive proper treatment (MHLG, 2015). Currently, 80% of the existing landfills almost reached full capacity and are expected to be shut down by 2030 and new sites are hard to construct because of land scarcity. There are 300 landfills nationwide. Among all, 157 are operating landfill sites and 13 are operating sanitary landfill sites. The difference between the sanitary landfill and open dump site is that in dump there is no effort to separate the waste from the underlying soil and where the hole extends to below the groundwater level, waste is dumped directly into the groundwater (Vallero and Blight, 2019). In contrast, a sanitary landfill is a modern engineered facility waste disposal method consisting of bottom liners, leachate collection and removal systems, and final covers. Therefore, it is clear that 92% of operating and non-operating solid waste disposal sites are unmanaged.

The National Solid Waste Management Department recognized that the continued usage of landfills is not sustainable in the long run. The urgency to move away from landfill is fueled by the lack of areas for new landfills in major urban cities and the release of greenhouse gases from open dumpsites. Carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O) are the three major greenhouse gases produced from open dump sites. The combination of methane gas and other gases at landfills is very harmful to human health and could potentially lead to the prevalence of health respiratory illnesses such as bronchitis, and asthma attacks (Abas, 2018).

Besides that, the maintenance and operation cost of landfill is very expensive. According to Department of Statistics (2017), the main two types of expenditure for environmental protection were environmental protection expenditure by activity with a value of RM1.67 billion (65.4%) and waste management RM0.78 billion (29.6%). Disposal of municipal solid waste with toxic and hazardous gases continues to be a costly affair with about two-thirds of the local councils' total collected annual assessment fees being spent to manage waste (Teo, 2016). Cost to be borne by the federal Government also continues to increase due to the opening of new areas of landfills. Meanwhile, Malaysia's waste recycling rate unfortunately remains way below the average levels.

Reduce, Reuse and Recycle (3Rs)

Reducing waste, reusing, and recycling resources and products are known as "3Rs" of solid waste management. The concept of 3Rs has been brought in as the most applicable approach that reduces the amount of solid waste generation dumped in the landfill, conserve natural resources, boost economic activities, conserve landfill space and energy as well as save land and money. The rising of municipal solid waste in Malaysia is due to its non-segregation and lack of recycling efforts. Some people in Malaysia are still left behind in terms of knowledge about recycling, advantages of recycling and awareness about the purpose of recycling. It is estimated that, around 65% of the MSW is the recyclable products that end up in landfills in one day (Rahman et al., 2020). According to the SWCorp (2017) the recyclable materials in waste stream was 7,980 tons/day while waste generated rate was 38,000 tons/day in 2016. Therefore, it shows that there was very little recycling done as compared to the generated of waste by Malaysians.

However, Malaysian government aims to achieve the national waste recycling rate about 22% by 2020. Although the Malaysia's recycling rate has exceeded the target that is 28.1% in 2019 and increase 3.5% as compared to 24.6% in 2018 but this rate is still far below world leader Germany where the rate is 56% and in Asia region South Korea recorded recycling rate is 53.7% and Singapore is 34.0 % respectively.

Malaysia will move from open-disposal sites based to recovery and recycling if more practices of 3Rs are emphasized. In addition, the efficiency of recycling program could divert 20% of municipal solid waste and extended the life of disposal sites if the community supports the recycling program (MHLG, 2008; Latifah et al, 2009; Chua et al, 2011; Ogboo et al, 2014).

Composting

Composting of organic waste is one of the most suitable approaches for treating biodegradable waste composition (Ilham, 2017). It is recognized as the sustainable food waste disposal method instead of incineration or landfill which poses detrimental effects to the environment. There are many amazing benefits of composting. For example, the resulting compost reduce the volume of municipal solid waste, ensures environmental sustainability, food security, plant disease control, pollution prevention, reduce greenhouse gases emissions, improve agricultural productivity and organic matter content of the soil, increase life span of landfill and reducing land use (Awasthi et al., 2017, Uyizeye et al., 2017, Luo et al., 2017, Pane et al., 2019).

In some country, home composting is considered among the most preferred municipal waste management practices as it reduces the cost of carrying waste to landfill. The purpose of this is to reduce significant amount of greenhouse gases (GHG) emission as compared to land filling without energy recovery (Ilham and Esa, 2017).

However, food waste composting in Malaysia is still poorly applied in the municipal solid waste management hierarchy because the quality of product depends on the waste and hence waste separation is very important. In Malaysia, it has been observed that the rate of food waste reuse and recycle is relatively low which is 5%, in comparison with paper, 60% and plastic, 15% (Ilham et al., 2017). Despite the fact that over 90% of food waste is considered biodegradable and easy to reuse and recycle and many Malaysians are still left behind in terms of knowledge and awareness on reduction of food waste. This is probably due to lack of specified disposal method for food waste, lack of enforcement and limited budget for food waste management in the

country. Thus, separation of food waste is limited at source and composting of food waste is not practiced on a large scale (Ilham et al., 2017).

2.1.4 Current Implementation of 3RS (Reduce, Reuse and Recycle)

To reduce transmission of solid waste to landfills, the Malaysian Urban Welfare, Housing and Local Government has implemented Separation at Source Initiative (SSI) under the Solid Waste Management and Public Cleansing Management Act 2007 (Act 672) through the Solid Waste Management and Public Cleanliness Corporation (SWCorp). This is a law that requires mandatory separation of solid waste at source by type of waste composition such as recyclable waste, residual waste and bulky waste or yard waste. Besides, information and brochures on source separation of waste are also disseminated to encourage households to adopt the practice of recycling in their daily lives.

However, it was reported that urban households in Kuala Lumpur performed the worst in source separation of waste. In the first two weeks of implementation, households in the city received the most reminders - nearly 5,000 or more than a quarter of the 18,752 reminders issued across seven states. Excuses given for not complying with mandatory source separation included lack of time and other commitments such as family and work. Many residents, especially those living in houses without plots and in high-rise buildings, claim ignorance about the new requirements. Abdullah et al., (2017) also reported similar findings as 398 respondents believe that lack of awareness and knowledge are the main causes of the problem. The study also reported that households rarely adopt other ways of minimizing waste such as reuse, recycling and composting. Another study by Teo (2016) found that reluctance and low involvement to environmental protection was due to lack of information, inability to incorporate ideals of an environmentally friendly lifestyle into everyday life, and low self-efficacy. Individuals who exhibited reactive recycling behaviors tended to perceive a willingness to recycle as a socially undesirable behavior; therefore, they were more likely to be reluctant recyclers. Recycling habit was influenced by situational factors and ambivalent attitudes towards the benefits,

convenience and awareness of recycling. This could explain their eco-unfriendly behavior.

The national development plans and solid waste management plans in Malaysia are compiled in Table 2.4 to provide an overview of the evolution of waste management in Malaysia from the late 1970s to the present.

Table 2.4: Solid Waste Management Policies and Plans Transformation in Malaysia

Legislation & regulation	Year	Agency	Description
Street, Drainage and Building Act 1974, Environmental Quality Act 1974 Local Government Act 1976	1970s	Local authorities	Process of transporting waste to assigned landfill and street cleanliness
Action Plan for a Beautiful and Clean Malaysia (ABC Plan)	1988	Local authorities	Even though, this plan not authorized and implemented, it had become the start for a milestone that inspires policymakers for better management planning
Vision 2020	1991	Local authorities	Malaysia aiming to grow into a developed nation by 2020
First National Recycling Day	1993	Local authorities	Malaysia announced November 11th as National Recycling Day
Second National Recycling Day	2000	Federalization and Privatization	Since then, National Recycling Day was custom to be the annual recycling program
National Strategic Plan (NSP)	2005	Federalization and Privatization	NSP was formulated to be use until year 2020
Waste Minimization Master Plan (WM-MP)	2006	Federalization and Privatization	Part of NSP framework
Solid Waste and Public Cleansing Corporation Act 2007 (Act 672)	2007	Federalization and Privatization	Aims to standardized solid waste management and public cleansing services in Malaysia
Solid Waste and Public Cleansing Corporation Act 2007 (Act 673)	2011	Federalization and Privatization	Under this act two agencies were set-up which are JPSPN and SWCorp Malaysia
SWCorp Strategic Plan	2014	Federalization and Privatization	Seven core strategies of solid waste planning for year 2014 until 2020 is introduced
Comprehensive Action Plan of Solid Waste Management 2015-2020	2015	Federalization and Privatization	Created to improvise the management of the solid waste system
Separation at Source Initiative (SSI)	2016	Federalization and Privatization	Mandatory for household to practice waste separation at source started from 1st June 2016

Source: Razali and Wai (2019)

2.2 PERSUASIVE TECHNOLOGY

2.2.1 Definition of Persuasion

Generally, the term “persuasion” means an effort to change an individual or group’s belief, attitude, and behavior. According to Perloff (2016), persuasion is a *“communicative process to persuade or influence the person to change their attitude or behavior regarding a matter through the communication of a message in an atmosphere of free choice.”* Persuasion forms an essential aspect in the field of human interaction. Various types of persuasion help to persuade people to behave in a certain way.

According to Stiff and Mongeau (2016), persuasion can involve deceptive and coercive methods. However, Kelman (1961) and Hoppe (1994) disagreed and acknowledged that deception and coercion are very effective in changing a person's immediate state of mind. The complexities and biases in this area also extend to behaviour and attitude. This is because they form the basis for change, and to this day psychologists are divided on the relationship between behaviour and attitude. Some researchers believe that there is a relationship between behaviour and attitude (Ajzen, 1991, Cacioppo, Petty and Rodriguez, 1986), while others believe the opposite (Wicker, 1969). However, the majority of existing research acknowledges that there is some relationship between attitude and behaviour. On the other hand, Fogg (2003) mentioned that coercion can change behaviour, but it is not the same as persuasion which requires intentional change in behaviour and attitude.

Since the analysis of these psychological concepts is beyond the scope of this research, we will endeavour to use working definitions so as not to fall into the ambiguity net. For the rest of this study the following definitions will be used:

Behavior refers an individual’s action in relation to the environment. It may be conscious or unconscious, voluntary, or involuntary.

Attitude defines the general evaluation that someone hold with regard to themselves, other people, subjects, objects, or events.

Persuasion is a form of communication that aims to influence people by changing their beliefs, values, behavior, or attitudes without deception or coercion.

2.2.2 Definition of Persuasive Technology

According to Tim et al., (2018), research on technology and environmental sustainability has coalesced into 2 different streams. First, we have the “Green IT” research that focuses on exploring ways to minimize the negative environmental implications of technologies. This stream of research contributes insights into developing the design, production, use, and disposal of ICT in a more environmentally friendly and sustainable fashion. The second emerging stream of research investigates how technologies can support sustainability transformation. This stream of research often referred to as the “green IS” research that highlights the transformative power of technology in providing or creating solutions for complex environmental problems. Green IS research is motivated by the observation that technology could serve as a potential enabler of behavioral change and sustainable solutions (Vom Brocke et al., 2013).

Persuasive Technology founded by Fogg (2003) could effectively facilitate Green IS to achieve this goal. Persuasive technology is defined as *“technology that is designed to change the attitudes or behaviors of users through persuasion and social influence, but not through coercion”* (Fogg (2003). However, it is important to note that persuasive effects of technology must be intentional and planned to persuade. Thus, the technological devices or applications do not have the intention to persuade by themselves, rather it depends on the designers or developers to decide the type of intent of persuasive devices. The importance of intentionality in the design of persuasive technology have been highlighted by Fogg (1998) stating that *“a computer qualifies as a persuasive technology only when those who create, distribute, or adopt the technology do so with an intent to affect human attitudes or behaviors”*.

Further, Fogg (1998) classified three types of persuasive intent, which are: endogenous; exogenous and autogenous. The *endogenous* intent implies that the intent come from the designers who developed the technology. The *exogenous* intent implies that the intent come from those who give the technology to others. Whereas the *autogenous* intent implies that the intent come from those who are adopting the technology to change their behaviour. Table 2.5 shows the three main types of persuasive intent in persuasive technology.

Table 2.5: Classification of Intent in Persuasive Technology (Fogg, 1998)

Type of Intent	Where intent comes from	Example
Endogenous	Those who creates the interactive technology	<i>Nike+ Running</i> app was developed by the developers at Nike Inc. to encourage people to exercise.
Exogenous	Those who give access to or distribute the interactive technology to others	A person gave his friend <i>Garmin Vivosmart HR</i> , a wearable fitness tracker as a gift to motivate his friend to exercise.
Autogenous	The very person adopting or using the interactive technology	A person may use <i>TakaCycle</i> app to learn good environmental habits of sorting and recycling waste and track his/her solid waste collection data.

2.2.3 Classification of Persuasive Technology

Fogg (2003), classified persuasive technologies by playing three different roles which are as “tools”, “media”, and “social actors”. This is also known as the function triads (see Figure 2.3).

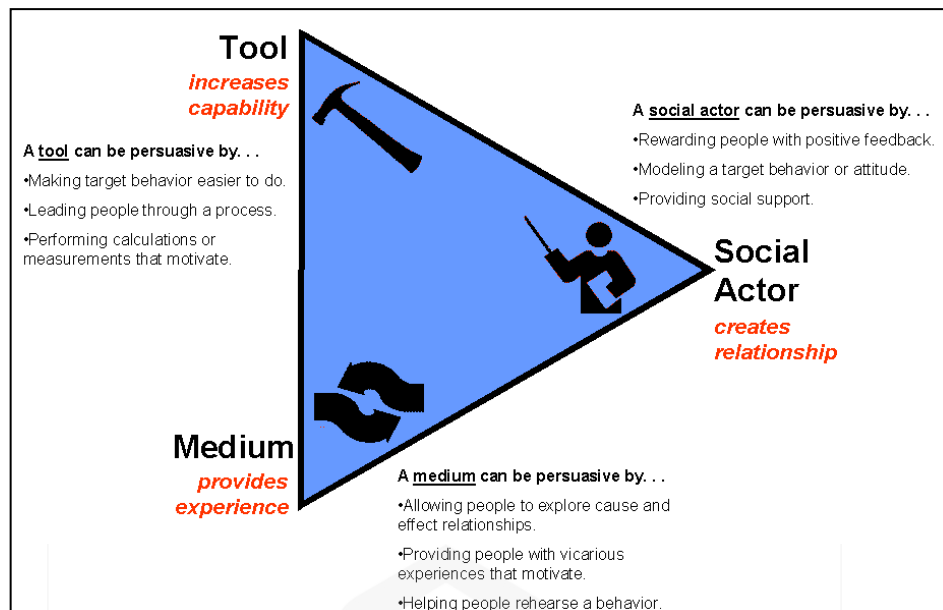


Figure 2.3: The Functional Triad (Fogg 2003)

a. Persuasive Technology as a Tool

The first corner of the functional triad is persuasive technology play the role as a *tool*. In functioning as a tool, the product can persuade by making target behavior easier to perform, by facilitating the user's capabilities. Fogg (2003) identified seven strategies for persuasive technology *tool*, to change attitude or behaviour or both by making the target behaviour easier to achieve. These tools are *reduction*, *tunnelling*, *tailoring*, *suggestion*, *self-monitoring*, *surveillance*, and *conditioning*. Table 2.6 briefly describes each strategy.

Table 2.6: Persuasive Strategies when Functioning as a Tool

Persuasive strategy	Description
Reduction	Reducing the complex activity to a simpler one.
Tunnelling	Encourages users to become actively involved in the process by leading them through a step-by-step series of actions or events.
Tailoring	Provide customized information to change a person's action.
Suggestion	Intervene at the right time and place that is appropriate to act.

Self-monitoring	Allow people to monitor themselves to modify their attitudes or behaviors to achieve a goal.
Surveillance	Allow people to monitor the behaviour of other user through observation.
Conditioning	Reward to shape complex behaviors into habits

An example of persuasive technology tool is *TakaCycle: Easy Waste Collection app*, designed to encourage people to easily collect recyclable waste (see Figure 2.5). The tool enables users to sort and recycle waste and help user to track progress and impact on the environment from user's solid waste collection data. *TakaCycle* implemented several persuasive strategies, which includes reduction, and self-monitoring strategy. The *self-monitoring* strategy was applied to track the environmental impact and user performance for various types of waste produced on a monthly, weekly, and total basis. *Reduction* strategy was applied by automatically identifying the user's current location to send a request to pick up recyclable waste. The following Figure 2.4 shows the implementation of *self-monitoring* strategy in the *TakaCycle: Easy Waste Collection app*.

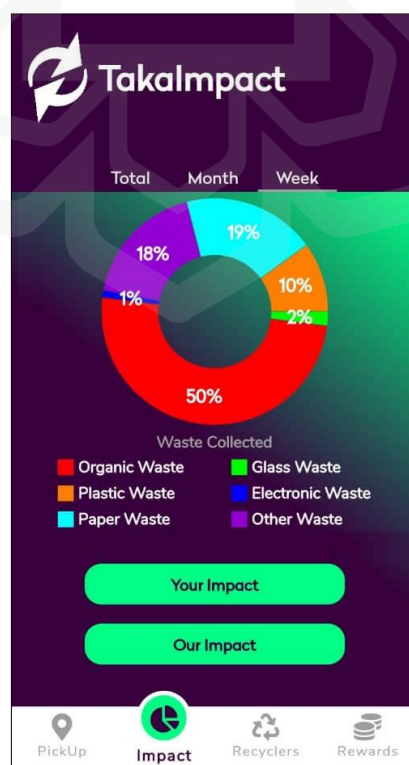


Figure 2.4: TakaCycle: Easy Waste Collection app (*self-monitoring*)

b. Persuasive Technology as a Media

The second corner of the functional triad is persuasive technology play the role as a *media*. Fogg (2003) stated that persuasive technology also function as media focuses on simulations to shape attitudes or behaviors in the real world. Among these simulations, he gives three different strategies that are relevant when functioning as media, which are *cause-effect simulations*, *environment simulations*, and *object simulations*. The following Table 2.7 briefly describes each simulation strategy.

Table 2.7: Simulation Strategies for Persuasive Technology (Fogg, 2003)

Simulation strategy	Description
Cause-and-effect simulations	– Enable users to explore and experiment in a secure setting. – Enable users to clearly observe the cause-and-effect relationship between the target behaviour
Environment simulations	– Create situations that reward and motivate people for a target behaviour – Enable people to rehearse a target behaviour in a virtual environment – Facilitates role-playing adopting another person's perspective
Object simulations	– Fits into the context of a person's everyday life – Less dependent on imagination – Highlight the impact of certain behaviours

Play Recycle! is a recycle game that designed to encourage users for rehearsing waste sorting by giving points within the app. This game is an example of how persuasive technology could function as a *media*. Fogg (2003) argues that such simulation is persuasive because it allows user to practice the target behavior. Figure 2.5 shows the interface of environment simulation strategy.



Figure 2.5: Play Recycle! app (Environment simulations)

c. Persuasive Technology as a Social Actor

The third corner of the functional triad is persuasive technology play the role as a *social actor*. In functioning as a *social actor*, the same persuasion techniques that people use to persuade others will be applied. For example, the persuasive technology could reward users with positive feedback for their good performance, demonstrating a target behavior or attitude, and provide support to create relationships between users and systems. Fogg (2003) identified five main categories of social cues that persuasive technology performs as a *social actor*. Those cues are *physical*, *psychological*, *language*, *social dynamics*, and *roles*. The following Table 2.8 briefly describes the types of social cues.

Table 2.8: Types of Social Cues (Fogg, 2003)

Social Cues	Examples
Physical cues	Movement of eyes, mouth, and other physical attributes.
Psychological cues	Preferences, humor, personality, feelings, empathy, "I'm sorry"

Language	Interactive language use, spoken language, language recognition
Social dynamics	Turn taking, cooperation, praise for good work, answering questions, reciprocity
Social roles	Doctor, teammate, opponent, teacher, pet, guide

Physical cues- Computing technology can persuade using physical cues such as the movement of eyes, mouth, and other physical attributes (Fogg, 2003). Fogg suggested that physically attractive computing products are likely to be more persuasive than unattractive products. If an interface, device, or onscreen character is physically attractive it may benefit from the halo effect, that is, users would perceive the products to be of high quality, efficient, reliable, and credible. In fact, in a study conducted by Khan and Sutcliffe (2014) on the level of attractiveness of virtual agents in a system designed to help guide users through a “desert survival task”, a more attractive agent was significantly more persuasive in user’s decision making, and participants who interacted with the more attractive agent associated higher more positive personality traits toward this agent (see Figure 2.6). Therefore, it is advised that interactive computing devices be visually appealing to increase their persuasiveness.



Figure 2.6: Attractive Physical Cues Applied in a System to Make Decision

Psychological –The use of psychological cues can lead people to believe that a computing product has emotions, preferences, motivations, and even a personality (Fogg 2003). These cues can be simple, as message convey empathy (e.g., “I’m sorry”), icons (e.g., “smiling face”), or even more complex designs. For example, *emoticon-bin* is an example of persuasive technology that is designed to rewards users with smiles and sounds (Figure 2.7). Berenguer et al. (2013) attached a modified recycle bin with an LCD screen that shows an emoticon. That emoticon will switch from a poker face to a happy face each time a bottle is drop into the targeted bin. This playful experience persuade user to make waste disposal more fun.



Figure 2.7: *Emoticon-bin* uses Psychological Cues to Persuade User

Language – Computing technology can use written or spoken language to convey social presence and persuade people. Dialogue boxes, offering congratulations for completing a task, reminders are a common example of the persuasive use of language. According to Fogg (2003) one of the most persuasive uses of language to persuade is through praise. For example, a computing product could enhance its persuasiveness by praising users for their successful performance (e.g., “Thank you! You have recycled). Besides, language cues can also be used for reminders (e.g., Don’t forget to take out your general waste bin”). The following Figure 2.8 shows examples of

language cues used to remind people to collect waste (right) and to praise user for successful performance (left).

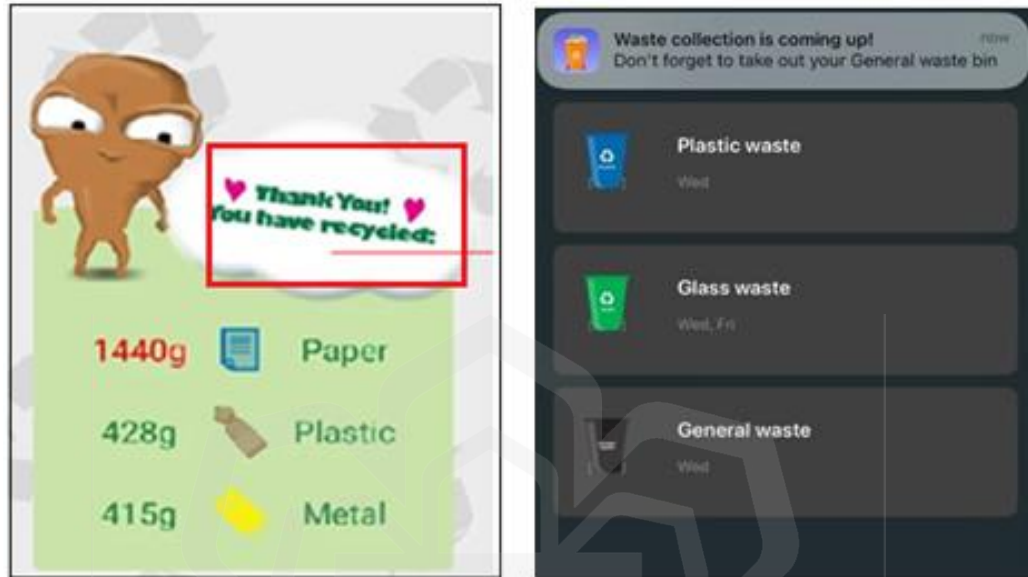


Figure 2.8: Example of Language Cues *Praise* (Left) and *Reminder* (Right) applied in Waste Management App

Social dynamics –Social dynamics refer to the unwritten rules for interacting with others such as taking turn, cooperation, praise for good work, answering questions, greetings, and reciprocity. Fogg (2003) stated that computing technology can apply these social dynamics to convey social presence and to persuade. Reciprocity is an example when someone feel obliged to return a favour as a sign of appreciation. Many open-source websites have used the reciprocity principle to persuade users to make a financial donation in favour for their freely available service. For instance, *Apache* (<http://www.apache.org>), is an open-source software, uses the reciprocity principle to encourage users to donate for their contribution. Figure 2.9 below depicts a page on the Apache website that requesting for donations.



Figure 2.9: Apache.org applied Reciprocity Strategy to Persuade Users to Donate

Social roles –Computing technology also could adopt the social roles to persuade, such as by the role of authority, friend, Teacher, referee, judge, counselor, expert. Fogg (2003) suggested that the role of these authoritative enable the technology to become more influential, as users would expect the authorities to lead them, make suggestions, and provide helpful information regarding their concern. For example, *iClean Selangor* application is developed to persuade residents in Selangor to submit their waste collection and public cleansing complaints to KDEB Waste Management. Figure 2.10 shows the interface of the *iClean Selangor* application.



Figure 2.10: Example of Authority Strategy Implemented in *iClean Selangor* app

The classification of persuasive technology addresses the three different roles in the development of persuasive systems. Some designers use this classification as a framework for developing persuasive technology and assist designers in identifying important persuasive strategies to be implemented. For example, Reville et al. (2007) used the functional triads as a framework for developing a persuasive system that support children's literacy learning. However, Wiafe et al. (2011b) argued that that it is not appropriate to treat the classification as a framework since it does not provide adequate information that can guide the development of persuasive technologies. Rather, it helps the designer to identify the various functions of a computer or technology that can be employed to persuade users.

2.3 THEORIES AND FRAMEWORK

According to Fogg (2003), several research efforts have been conducted to develop frameworks and approaches to guide the design, implementation, and evaluation of persuasive technologies. The persuasive principles and frameworks for inducing behaviour change that have been proposed by researchers are Fogg Behavioral Model (FBM) (Fogg, 2009a), Fogg's eight-step design process (Fogg, 2009b), the Context-Aware, Personalized, Persuasive (CPP) framework (Prost et al., 2013), and Oinas-Kukkonen and Harjumaa's Persuasive System Design (PSD) (Oinas-Kukkonen and Harjumaa, 2009), and Behavioral Change Wheel (BCW) framework (Michie et al., 2011). In the next section, the advantages and limitations of these framework are briefly discussed.

2.3.1 Fogg Behavioral Model (FBM)

The Fogg Behavioral Model (Fogg, 2009b) is a widely accepted behavioral model for designing persuasive technologies. The FBM views behavior as a product of three factors such as motivation, ability, and trigger. The FBM is considered as model designed specifically for behavior analysis. It argues that a person can perform a targeted behavior only if (1) sufficient motivation, (2) sufficient ability, and (3) effective triggers for the behavior are simultaneously present, otherwise the behavior will not be performed. It promotes the idea that these three main factors are further influenced by other factors. First, motivation is divided into three cores, each of which has two sides. Pleasure and pain are the two sides of the first core, and in majority of cases the effect of this core creates an immediate motivation.

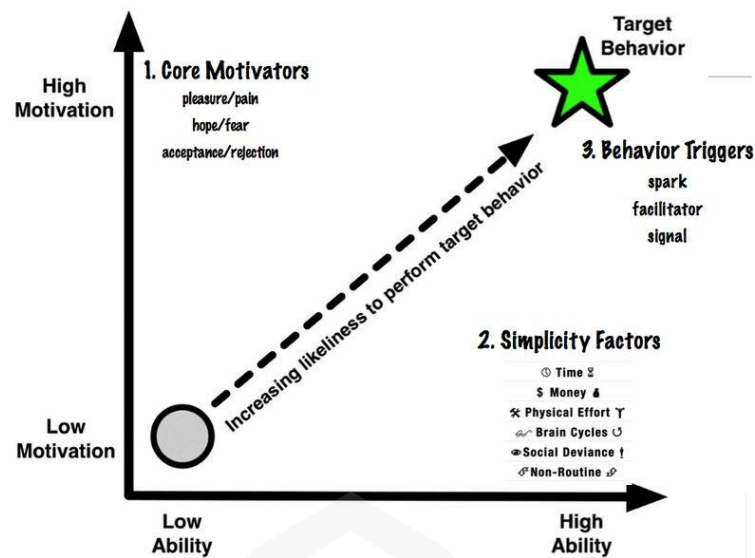


Figure 2.11: A Behaviour Model for Persuasive Design by Fogg (2009b)

The second core is consisting of anxiety and hope and characterized by anticipation of a result. In most situations, hope and fear do not immediately motivate, in contrast to pleasure and pain. But they are powerful than pleasure and pain (Fogg, 2009b). In some cases, an individual will accept pain in order to overcome their fear. For example, of someone getting a flu shot. Despite the discomfort involved, people will get the shot due to the fear of being infected with flu.

The third core is social acceptance or rejection which primarily controls one's social behaviour. Fogg (2009b) asserts that social rejection increases an individual's motivation. Time, money, physical effort, brain cycle, social deviance and non-routine are the six primary categories of ability, whilst triggers are divided into sparks, signal and facilitators.

Although FBM model provides a simple approach for behaviour change analysis, the model has not been validated yet, and currently there is little scientific proof of the applicability of the model. Additionally, Fogg (2009b) acknowledged that the FBM is to serve as a starting point for discussions on methods that would try to

make behaviour change modelling easier for the purpose of persuasive technology development.

2.3.2 Fogg's Eight-Step Design Process Framework

Fogg (2009c) proposed a method for designing persuasive technology based on the assumption that behaviour can be easily measured with the help of modern technology. He pointed out how complex persuasive technologies can be designed by assuming simple and easy behaviour and targeting receptive audiences. He identified eight main steps in designing persuasive technology (Figure 2.12).

1. **Choose a simple behavior:** The first step of designing a successful persuasive technology is to choose a simple target behavior. Target behavior can be considered as the reaction that is intentionally directed to be adopted by the user (Saidin, 2010). According to Fogg (2009c), most persuasive technology designers aim to achieve complex behaviours. However, designers can increase a system's chances of success by concentrating on simple and more specific changes. Designers might try to change one behavior at a time by breaking complex into smaller and well-defined behaviours.
2. **Select a receptive audience:** In this second step, Fogg recommends that the designer should identify the receptive audience who is willing to use the persuasive system. According to Fogg (2009), "Finding the right combination of behaviours and target audience is important in laying the groundwork for subsequent steps in the design process."
3. **Finding what is preventing the target behaviour:** In this stage the designer should figure out what is preventing the target audience from performing the intended behaviour, such as lack of motivation, lack of ability, or lack of a well-timed trigger to prompt behaviour.
4. **Choose an appropriate technical channel:** Choosing an appropriate channel to reach the target audience often depends on the first three steps of this design

process. Therefore, designers can decide on the appropriate channel only after the first three steps are completed.

5. **Finding relevant examples of persuasive technology:** One of the challenges of the design process is to find relevant examples of a successful persuasive technology. Another possible challenge for designer is to rarely find a system that matches the precise behavior, audience, and channel.
6. **Imitate successful examples:** At this stage, successful ideas and design features are adopted from the examples of compelling technologies collected in Step 5.
7. **Testing and iterating quickly:** This step encourages rapid and repeated iterative testing and revision of various persuasive experiences. Following Fogg's (2009) recommendation, a series of small rapid user tests is more effective than one large test.
8. **Expand on success:** In step 8, the designers can expand on this success by making the target behaviour more complex or by including new audiences. The method of expansion should be gradual and systematic – varying one or two attributes from the success achieved in step 7.

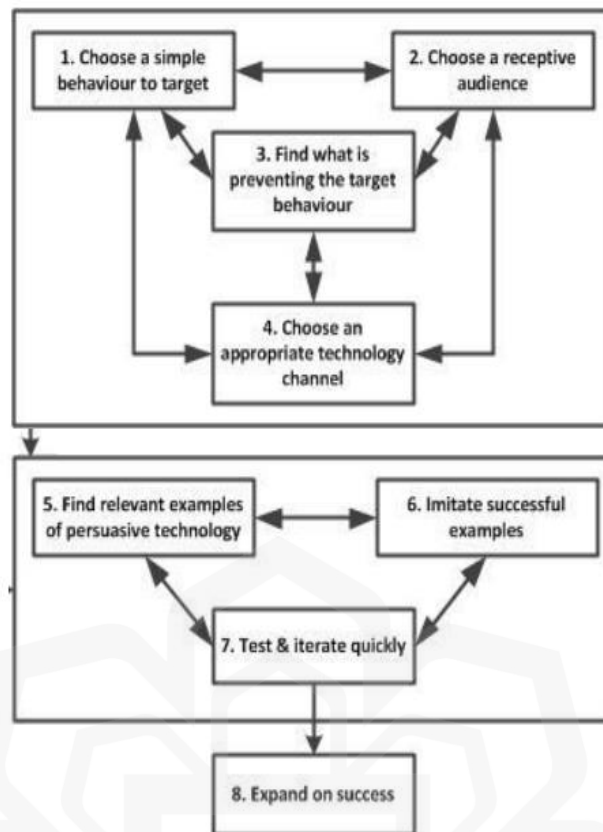


Figure 2.12: 8-Step Design Process for Persuasive Technology by Fogg (2009c)

The model is mainly intended for novice designers (Fogg, 2009c). However, it provides useful data that might guide experienced designers. Nonetheless, it fails to provide comprehensive details on system and design principles. Furthermore, it views the design of persuasive technology as a simple procedure and make the assumption that by identifying a simple behaviour and a receptive audience anyone can easily replicate an existing persuasive system in order to develop a successful persuasive system. However, replicating effective strategies from other persuasive technologies does not ensure success, particularly when designers are unsure of how the change will occur. In other words, considering the complexity of human behavior, it is not possible to draw the conclusion that combining methods used in various successful cases will always result in success. Additionally, due to the lack of appropriate methods and techniques for evaluating effective persuasive technology, it is difficult to find effective persuasive application. This is because the majority of persuasive systems that have been claimed to be successful are mostly experimental and

conducted in controlled settings (Torning and Oinas-Kukkonen, 2009). According to Wiafe et al. (2011a), a variety of external factors might lead to a change in behaviour. The majority of persuasive technology researchers have neglected to evaluate or recognize during the evaluation of behaviour changes. Because human behavior is complex, it is impossible to determine what exactly changes behavior during behavior change interventions that use persuasive technology. Due to these limitations, the potential of this method is not fully realised and to the best of our knowledge this approach has not yet been utilized to create any persuasive technology application.

2.3.3 The Behavior Change Wheel (BCW) framework

The Behavior Change Wheel (BCW) is a three-layered framework for designing behavior change intervention introduced by Michie, Van Stralen, and West (2011). The primary goal of behavior change design is to facilitate the performance of the desired behavior. It integrates the COM-B model (Capability, Opportunity, Motivation → Behavior) and Intervention Functions (e.g., education, persuasion, incentives). The COM-B model assumes that a particular behavior can occur at any point in time as a result of an interaction between three components such as capability, opportunity, and motivation. The purpose of COM-B model is to define the ability blockers that are the root cause of preventing the behavior (West and Michie, 2020).

The model COM -B is located on the green central level of the BCW framework (Figure 2.6). From this central level, the BCW extends to the second level, classified as intervention functions, with nine types of strategies to resolve capability blockers. Intervention functions help to overcome the ability blocker in the most effective way to perform the target behavior. They provide the following specific solutions:

1. Education improves knowledge and skills.
2. Persuasion stimulates positive or negative feelings to elicit an action or thought.
3. Incentivization sets the stage for the expected rewards.

4. Coercion creates the acceptance of expected punishments and costs.
5. Training improves skills through practice and instruction.
6. Enabling breaks down barriers to the desired behavior (e.g., by providing rules and tools)
7. Modeling demonstrates desired behavior by providing an example that inspires.
8. Constraint reduces undesired behavior by using rules

Each intervention function is associated with the causes of ability blockers. The next step was to link the components of the COM -B behavioural model to intervention functions and link the intervention functions to policy categories. This resulted in a framework of linkage to an overarching model of behaviour change (Figure 2.13).

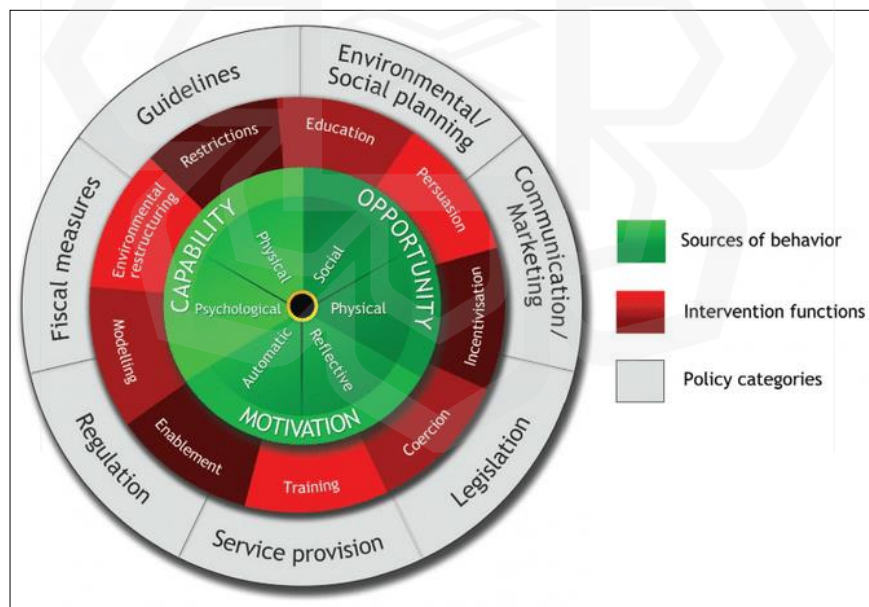


Figure 2.13. The Behavior Change Wheel framework, adapted from Michie et al. (2011)

The framework is widely used model for designing behavior change interventions, but it has many limitations. One major critic of BCW framework is

complexity in implementation (Directory, 2025). The framework consists of multiple layers, including the COM-B model. This complexity can make it difficult for practitioners to implement the framework successfully, particularly in the absence of extensive training. Even when well-designed, BCW-based interventions can be challenging to successfully implement in real-world contexts. This may be due to factors such as lack of resources, limited capacity, resistance to change or conflicting priorities among stakeholders. The BCW is criticized for being too broad and for lacking empirical support in a variety of fields. In comparison to frameworks created by in-depth research in specific domains, it may provide less specificity and predictive accuracy even though it includes several theories Halonen (2024). Another critique is that the BCW outlines broad intervention functions, it does not provide detailed instructions on how to develop interventions in different contexts. Users must rely on additional frameworks or expertise to implement the model successfully.

2.3.4 Context-aware, Personalized, Persuasive (CPP) Framework

The Context-aware, Personalized, Persuasive (CPP) framework was introduced by Prost, Schrammel, Roderer, and Tscheligi (2013) as a system design framework for behavior change support systems. The CPP framework consists of three levels: context-awareness, personalization, and persuasion.

1. **Context-Awareness:** at a context-awareness level, the system adapts to a specific context such as location, time, user activity, environmental conditions, or device usage. For example, a health application reminds users to hydrate throughout the day.
2. **Personalization:** at the personalization level, the system's services are personalized based on user preferences, historical data, and behavioral patterns. For examples: e-commerce platforms displaying product suggestions based on browsing history.
3. **Persuasion:** at the persuasion level, a set of persuasive strategies is implemented. Common persuasive strategies include social proof (showing

product reviews and testimonials), scarcity & urgency (limited time offers or stock availability), and gamification (rewarding users with badges or incentives). For examples: a fitness application uses progress-tracking and social comparisons to encourage workouts with friends.

For each level, behavior change support factors (BCSFs) can be identified. These factors form the basis for linking the three levels, as they describe which factors at one level have an influence on factors at another level. The CPP framework shows below:

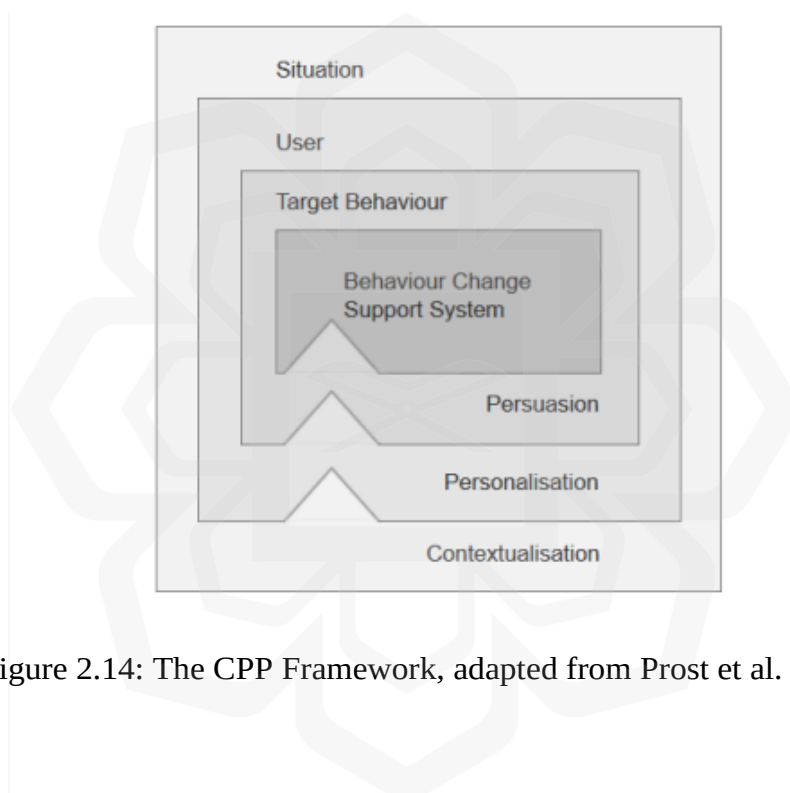


Figure 2.14: The CPP Framework, adapted from Prost et al. (2013)

The CPP framework has several limitations. First, it depends largely on data collection, which raises ethical and privacy concerns (Kaptein et al., 2015). Second, personalization can result in overfitting, where recommendations become too specific, limiting user exposure to a variety of possibilities (Oinas-Kukkonen & Harjumaa, 2009). Thirdly, real-time context awareness demands significant computational resources, which may hinder scalability (Orji et al., 2017). Lastly, persuasive strategies may not be universally effective, as user receptiveness varies based on individual differences (Fogg, 2009).

2.3.5 Persuasive System Design (PSD) Model

The Persuasive System Design or PSD model (Oinas-Kukkonen and Harjumaa, 2009) is currently the only comprehensive framework for developing and evaluating persuasive systems. It addresses some of the limitations of Fogg's (2009c) model to design by structuring the design processes and providing a list of systems features and requirements that can be used for development and evaluation of persuasive system. Thus, it has been successfully applied in developing and evaluating persuasive technologies (Nkwo, B. S. T. O. M., & Orji, R. 2020), Schiefelbein et al., 2019). It consists of three main design stages to design, develop and evaluate persuasive system that influence user attitudes or behavior which are "understanding the key issues behind persuasive system", "analyzing the persuasion context to understand the intent, event, and strategy", and "persuasive design principles that were categorized into four categories which are primary task support, dialogue support, system credibility support and social support" (Figure 2.15). the stages of the PSD framework are described below:

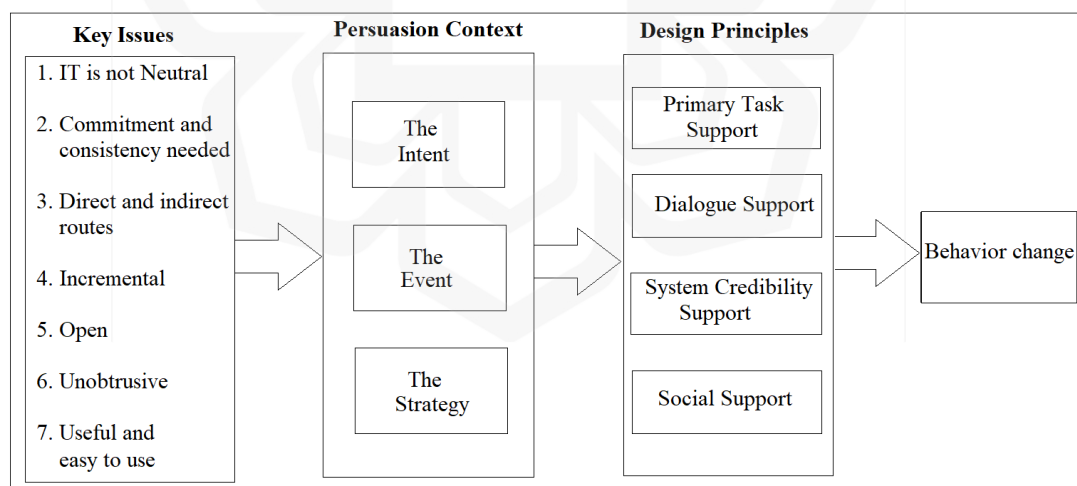


Figure 2.15: The Persuasive Systems Design Framework (Oinas-Kukkonen and Harjumaa, 2009)

Understanding the Key Issues Behind Persuasive System

The first step of PSD framework is understanding key issues of a persuasive system. In this step, Oinas-Kukkonen and Harjumaa (2009) defined seven postulates that need to be addressed when designing or evaluating the persuasive systems. Two of these postulates pertain how we generally see the users, two of the postulates relate to persuasion strategies, and three of the postulates deal with real system features. The postulates are as follows:

- 1) ***Information technology is never neutral-*** The first postulate states that ‘information is never neutral’ but instead ‘always on’. Therefore, every information exchange will influence user’ attitudes and behaviour. Thus, this ongoing process of persuading users requires the persuasive application to be highly adaptive to encourage user to follow the positive waste management practices sufficiently and regularly. For example, people might have a lot of busy schedules, thus notifying them to follow green practices of waste disposal from Shariah by sending push notification about disposing of garbage. Our persuasive technology can adapt for this kind of changes.
- 2) ***People like their views about the world to be organized and consistent*** – The second statement states that ‘people like their views about the world organized and consistent’. This statement is based on the theory on Cognitive Dissonance Theory by Festinger (1957) which suggested that an individual who is not fully consistent in their actions and subsequently feel obliged to reorganize their thinking and restore consistency. This dissonance motivates the person to engage in an attitude or behaviour change. Accordingly, based on this postulate, our persuasive application will increase awareness about the importance of waste disposal practices based on the five dimensions of *Maqasid al-Shari’ah* such as the danger of overconsumption, wastage of resources and so on. If the user is fully aware of the fact that overconsumption and wastage of resources is one of the main reasons for serious environmental pollution. Subsequently enhance their motivation to shape his or her attitudes based on this.

- 3) **Direct and indirect routes are key to persuasion strategies-** The third postulate states that ‘direct and indirect routes are key to persuasion strategies. This idea is based on the Elaboration Likelihood Model (ELM) by Petty & Cacioppo (1986) that proposed two routes of persuasion such as direct and indirect route. According to this theory, direct route persuades an individual who carefully analyzes the content of persuasive message whereas the indirect approach used to persuade an individual who is less thoughtful and uses simple cues or stereotypes for assessing the information. Both direct and indirect processes may act simultaneously and may be supported by a variety of software system features (Oinas-Kukkonen & Harjumaa, 2008). Therefore, Petty et al. (2009) suggested a hybrid strategy that combines direct and indirect approaches to encourage and motivate people towards long-term attitude or behavior change. According to this postulate, our persuasive application should facilitate both direct and indirect persuasion processes, which can be supported by a various persuasive system feature (Oinas-kukkonen & Harjumaa 2009).
- 4) **Persuasion is often incremental-**The fourth postulate states that ‘persuasion is often incremental’ emphasizing that it is easier to persuade people via a system to perform the target behaviour through incremental steps rather than ‘one-time consolidated suggestion’. According to Fogg (2009), focusing on ‘simple behaviour’ is important aspect of designing persuasive technology since encouraging individuals to do simple things would naturally encourage them to persist with the behaviour while targeting at more challenging behaviour. According to this postulate, it is necessary for a persuasive waste management application designed for Malaysian Muslims community to achieve its intended goal through incremental steps by suggesting simple actions with small goals to target at a time.
- 5) **Persuasion through persuasive systems should always be open-** the fifth postulate suggesting that persuasion using persuasive systems must always have a clear for the user what the purpose of the system designer and an overarching objective of the persuasion. In order to designing a persuasive system, Kaptein, Duplinsky and Markopoulos (2011) applied a participatory design approach in which they allow the participants to choose their preferred persuasive strategies

that would best inspire them. Consequently, it results in greater ratings for compliance, usefulness, and user confidence compared to system-assigned strategies - further confirming the idea that involving users in the persuasive design process is indeed beneficial. Based on this premise, it is essential to include Malaysian participants in the design of our persuasive application to ensure designers' intent is well presented and identified.

- 6) **Persuasive systems should aim at unobtrusive-** The sixth postulate states that 'persuasive systems should aim at unobtrusive'. For example, user should perform their task with the aid of the system without any disturbance. This principle of unobtrusiveness also dictates that suggestions should only be made at opportune moments (Oinas-Kukkonen & Harjumaa, 2009). Albaina et al. (2009) also proposed that behaviour-related contextual information should be taken into account when determining the "opportune moments." For example, if we want to trigger a Malaysian people to practice waste management, it is vital to understand their waste management behaviour and meet their positive expectation. The use of persuasive features at opportune moments e.g., suggesting Malaysian people to practice waste management to reduce pollution and make the world better and green is appropriate and may potentially result in desirable outcomes.
- 7) **Persuasive systems should be useful and easy to use** –This seventh postulate states that *"the system should serve the needs of the user and make complex task simpler, be responsive, easy to access, lack errors and convenient"* (Oinas-Kukkonen and Harjumaa, 2009).

Perceived usefulness, according to Davis (1989), is the degree to which an individual thinks that utilizing a particular system would improve his or her task performance. *Perceived usefulness* in our context refers to the degree to which participants feel that utilizing persuasive waste management applications will enhance their level of waste practices and, as a result, improve or change their behaviour to contribute to protect the environment — which would be able to achieve by implementing appropriate persuasive design principles.

On the other hand, *ease of use* describes how easily an individual could utilize the system (Davis 1989). In our case, the target user would be Muslim Malaysian community who are interested to adopt sustainable waste management practices through the use of smartphone applications. Thus, in order to ensure the usability of our persuasive application, it is important to understand the needs and requirements of the community and as well as follow the existing principles and guidelines while designing the user interface. Additionally, Fogg (2009) recommended that designers select a "familiar technology channel" to enhance the persuasive application's usability. This recommendation is based on two factors: 1) a technology channel that aligns with the target behaviour; and 2) a channel that is familiar to the target user.

Analysing the Persuasion Context

The next second and third phase of the PSD framework focus on the choice of strategies needed for PT development. Analyzing the persuasion context, which is the center of PT intervention design consists of three main components which are intent, event, and strategy (Figure 2.16). Oinas-Kukkonen and Harjuma (2009) stated that a detailed analysis on persuasion context is essential because it would help designers to identify any inconsistencies in users' thought processes and decide when the opportune and inopportune moments to deliver persuasive messages and able to persuade effectively.

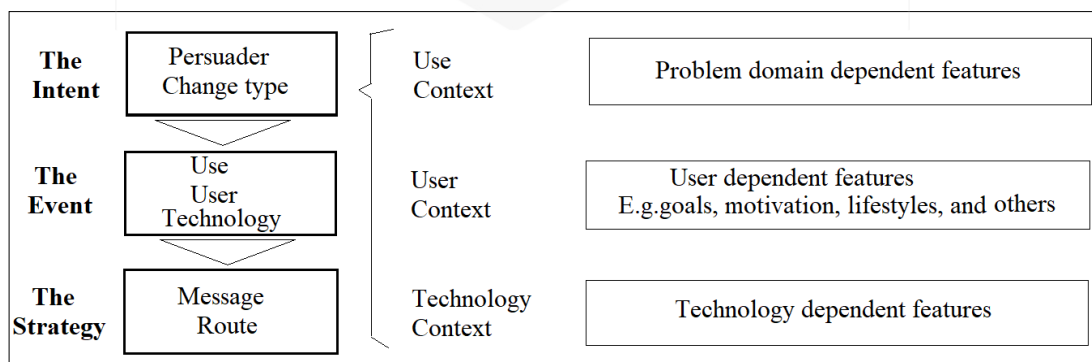


Figure 2.16: Analysis of Persuasion Context (Oinas-Kukkonen and Harjuma, 2009)

a. The Intent

Analysing the persuasion intent comprises two components such as the persuader and change type analyses.

The persuader – Fogg (1998) states that there are three main categories of persuaders: a) those who develop the persuasive technology (endogenous), b) those who give access to/distribute persuasive technology to others (*exogenous*), and c) those who choose/adopt a persuasive technology to alter their own attitudes or behaviour (autogenous). According to Oinas-kukkonen (2010a), a behaviour changes support system (BCSS) developed using the PSD model emphasized autogenous approach. He mentioned that “*BCSSs emphasize the autogenous approaches in which people use information technology to change their own attitudes and behaviours, though building upon their own motivation or goal,*” (Oinas-kukkonen 2010a). Thus, our application would be autogenous in nature because it would be designed based on end-user perspectives and feedback, the type of persuader would be *autogenous*.

The change type – In terms of *change type* analysis, there are two main types of changes, which are attitude change and behaviour change.

The purpose of a behaviour support system is to trigger a long-term behaviour change. According to Oinas-kukkonen (2013) encouraging a long-term behaviour change is much more challenging. An example of behaviour change is to raise awareness and increase recycling activities.

The purpose of an attitude support system is to influence users’ attitudes rather than their actions (Oinas-kukkonen 2013). According to Petty and Wegener (1998), an individual’s attitude is formed by their emotions, beliefs, and past experiences. It is simpler to change users’ attitudes if they are learned from others. On the other hand, attitudes that are formed by long socialization processes or personal experiences are harder to modify (Lerbinger, 1972).

Oinas-kukkonen and Harjumaa (2009) contend that attitudes do not necessarily determine or predict behaviour. They also emphasized that users’ attitudes about

certain behaviours can still be changed using the persuasive system, even if they have a negative attitude about a certain behaviour. This concept is supported by the *theory of cognitive consistency* proposed by McGuire (1973) which holds that a previously held attitude that conflicted with behaviour forces change. Naturally, this change includes changing the attitudes to reflect the current behaviour (which means if the behaviour changes first, the attitude change is likely to follow) (Oinas-kukkonen & Harjumaa 2009).

For example, in our case, green practices are an activity that many people do not pay much attention. They have a lack of attitude, perception, and willingness for reduce, reuse, recycling household waste, thus leading to unsustainable waste management behaviour.

The habitual nature of recycling behaviour entails the need for awareness raising (Bremer, 2018). To change potentially undesirable behaviour, a person needs to become aware of and consciously evaluate the behaviour. However, by adopting a persuasive waste management application embedded with appropriate persuasive design principles (such as personalization, self-monitoring, simulation, rewards, and reminder), the people might gradually be persuaded and eventually increasing their green practices level.

Accordingly, this doctoral thesis aims to increase awareness about the green practices and environmental protection from Shariah perspective and to change or improve Malaysian Muslims' behaviour to adopt their waste management practices. Thus, the type of change that we are aiming for is changing behaviour.

b. The Event

Analysing the persuasion event involves understanding of *the use context*, *the user context*, and *the technology context*.

The use context –According to Oinas-kukkonen and Harjumaa (2012), *use context* involves understanding the specific issues that influence the user behaviour. Thus, in order to identify the barriers of applying green practices of MSW disposal among the

Malaysian people, the socio-ecological model (SEM) has been applied. The SEM model highlights the complex interaction between individual, organization, community, and policy factors that influence behavioural patterns (Brehm, 2014). These analyses on the *use context* enable the identification of various factors influencing their sustainable SWM practices behaviour, which should be considered in determining appropriate persuasive design features.

The user context –Analysing the *user context* involves an in-depth exploration on the user's needs, interests, motivations, abilities, attitudes, persistence of change, cultural factors, and perhaps even the whole personality (Oinas-kukkonen & Harjumaa 2009). In our study, we were very interested to investigate Malaysian urban community's perceptions towards persuasive applications. As this is the first study attempting to change behaviour of Malaysian communities through the use of the persuasive application, we believe understanding urban community's perceptions potentially would encourage and motivate them towards green practices of MSW disposal.

The technology context –Analysing the technology context deals with the strengths and weaknesses, as well as the risks and opportunities of technological platforms, applications and features that would be used for designing the system. (Oinas-kukkonen & Harjumaa 2009). With regard to Malaysians' perspectives towards technology, Saad et al. (2023) revealed that 90% of respondents agreed to use the e-Waze app as one of the strategies for improving the current solid waste management services in Malaysia. This indicates that, it is imperative to design a persuasive waste management application that is useful for Malaysian community.

c. The strategy- The main attribute for defining persuasion strategies is analysing the *message*. According to Oinas-Kukkonen and Harjumaa (2009), the goal of persuasive technology design is persuading the user of something that will alter other people's attitudes and/or behaviours. The primary means of persuasion in this act are symbolic methods that trigger the emotions of the user (Miller, 2002). Therefore, it is crucial to effectively communicating the persuasion *message* to the target population in order to trigger the right emotions that would lead to the desired behaviour (Dubuy et al. 2014).

Secondly, in defining persuasion strategies the proper *route* to is appropriate to deliver *the message* (whether direct or indirect route). This route selection depends on the user's capability to evaluate the content of the persuasive message as proposed in the third postulate.

In this thesis, the proposed persuasive waste management application hence would involve the use of persuasive strategies delivered via direct and indirect routes.

Persuasive Design Principles

In this last stage Oinas-kukkonen & Harjuma (2009) proposed with a set of design principles for persuasive system that comprised the four categories including primary task support, dialogue support, system credibility support, and social support.

- **Primary Task Support**

The design principles in the primary task category include seven principles that assist users in performing the primary tasks and achieving their goals. The design principles in this category are based on the Fogg's principles of reduction, tunneling, tailoring, personalization, self-monitoring, simulation, and rehearsal. Table 2.9 summarizes the categories of each principle, example requirement and the example implementation as per outlined in Oinas-kukkonen and Harjuma (2009).

Table 2.9: Primary Task Support

Persuasive Principle	Example requirement	Example implementation
1. Reduction A system that reduces complex behaviour into simple tasks helps users to perform the target behavior, and it may increase the benefit/cost ratio of behavior.	System should reduce effort that users have in regard to performing their target behavior.	The application displays a color-coding calendar for a garbage collection schedule making it easier for people to know a specific day/date for a specific type of waste collection.
2. Tunnelling Using the system to guide users through a process or	System should guide users in the attitude change process	The application provides step-by-step guide

experience, while providing opportunities to persuade along the way	by providing means for action that brings closer to the target behavior.	instructions on recycling and reusing waste.
3. Tailoring Information that is tailored based on potential needs, interests or other factors relevant to a user group will be more persuasive.	System should provide tailored information for its user groups.	The application provides information about garbage and recycling items collection schedules based on the user home address.
4. Personalization A system that offers personalized content or services has a greater capability for persuasion.	System should offer personalized content and services for its users.	The application offers personalized reminders, time and date for waste disposal, and users' preferred languages. Personal images, addresses, and garbage payment collection alternatives for recyclable rubbish might all be included in the user profile.
5. Self-monitoring A system that keeps track of one's own performance or status, thus supporting the user in achieving goals.	System should provide means for users to track their performance or status.	The application shows different types of waste produced for each day, weekly and monthly.
6. Simulation Systems that provide simulations can persuade by enabling users to observe the link between cause and effect.	System should provide means for observing the link between the cause and effect with regard to users' behaviour.	The application shows the impacts of waste being recycled on the environment. In this example, the application informs that the user has created 57 new plastic products by recycling 4% of the plastic waste generated.
7. Rehearsal A system that enables users to rehearse a behavior so as to help them change their attitude or behavior in the real world.	System should provide means for rehearsing a target behavior.	An application that encourages me to rehearse waste sorting and recycling behavior within the app.

Reduction is commonly implemented strategy in persuasive technology so that users can complete the target behaviors without much effort (Nkwo and Orji, 2021). The *iRecycle* app (<https://earth911.com/irecycle/>) for example implements the *reduction* principle by by showing list the names of nearby recycling centers, distance in mile to the user, and providing map that shows a visual picture of nearby recycling

location and reducing the time spent in finding the closest one. The *tailoring* strategy motivate the users to perform target behaviors by providing information and content that is relevant to the target user group. An example of *tailoring* principle is in the *Whitby Waste Buddy* app (<https://whitby-waste-buddy.com>) developed to persuade user to provide information about garbage and recycling items collection schedules based on their home address. The following Figure 2.17 shows example of reduction and tailoring principles employed in *iRecycle* app and *Whitby Waste Buddy* app.

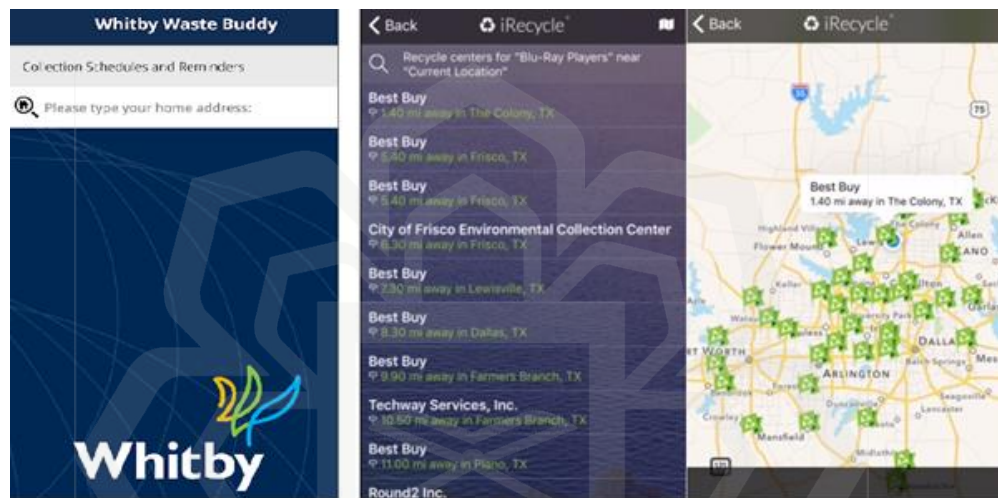


Figure 2.17: Example of Reduction Principle applied in *iRecycle* app (left) and Tailoring Principle applied in *Whitby Waste Buddy* app (right)

Meanwhile, the *self-monitoring* principle was found to be the most common implemented strategies in persuasive applications (Nkwo and Orji, 2021). For example, the *TakaCycle: Easy Waste Collection* app applied the *self-monitoring* principle by showing the different types of waste produced for each day, weekly and monthly. Besides, the app also implements the *simulation* principle by informing users about the impacts of waste being recycled on the environment. In this example, the application informs that the user has created 57 new plastic products by recycling 4% of the plastic waste generated. The following Figure 2.18 shows examples of *self-monitoring* and *simulation* principles applied in the *TakaCycle* app.

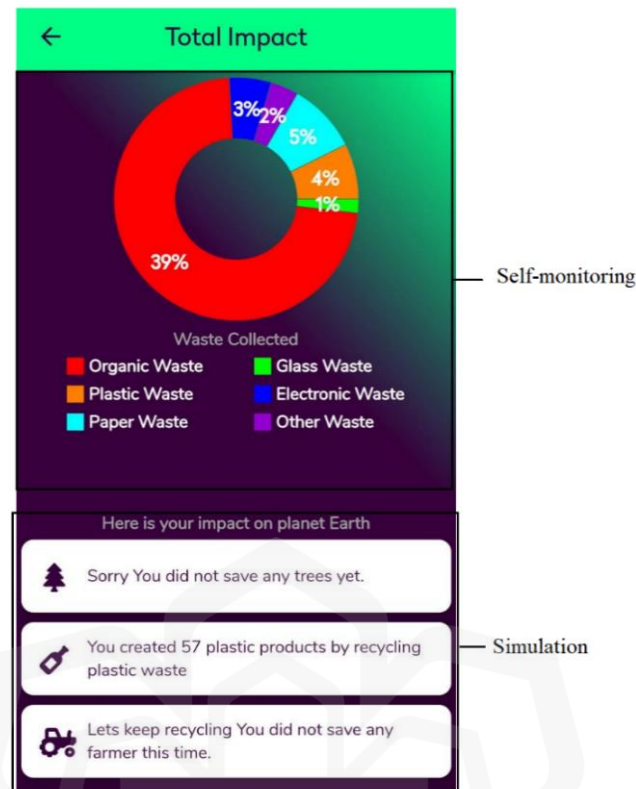


Figure 2.18: Example of Self-monitoring Principle and Simulation Principle applied in TakaCycle app

The *personalization* principle could be applied by providing content and tailored content and services to improve the user experience. For example, on *Garbage Recycling Trash Games* (<https://garbage-recycling-trash-games/>) applied the *personalization* principle by selecting the language and displaying waste items that the player must choose how to dispose of based on whether they are organic, recyclable, non-recyclable, or toxic. The next principle that is used in the application is the *rehearsal* principle, which allows people to practice a certain behavior so that they can change their attitude or behavior in the real world. It can be observed that *rehearsal* strategy is used to help the user to practice waste separation activities that can help them in their everyday waste separation. The following Figure 2.19 shows example of *personalization* and *rehearsal* principles employed in app.



Figure 2.19: Example of Personalization Principle (left) and Rehearsal (right) Principle applied in Garbage and Waste Sorting app

- **Dialogue support category**

Dialogue support category are related to computer-human interaction that focus on supporting the user by providing some level of feedback that might increase the user's motivation to achieve their target behavior. The principles in this category include praise, rewards, reminders, suggestion, similarity, liking, and social role. The following Table 2.10 summarizes the categories of each principle, example requirement and the example implementation as per outlined in Oinas-kukkonen and Harjumaa (2009).

Table 2.10: Dialogue Support

Persuasive Principle	Example requirement	Example implementation
8. Praise By offering praise, a system can make users more open to persuasion.	System should use praise via words, images, symbols, or sounds as a way to give positive feedback for a user.	An application that praises and congratulates me for completing a level of recycling and disposing of waste.

9. Rewards Systems that reward targeted behaviors may have great persuasive powers.	System should provide virtual rewards for users in order to give credit for performing the target behavior.	An application that offers rewards points after completing a certain level of recycling.
10. Reminders If a system reminds users of their targeted behavior, the users will more likely achieve their goals.	System should remind users of their target behavior during the use of the system.	The application reminds user to follow green practices of waste disposal by sending push notifications about disposing of garbage, interesting events, and new events, waste or recycling pickup dates.
11. Suggestions Systems offering fitting suggestions will have greater persuasive powers.	System should suggest users certain behaviors during the system use process.	An app that provides suggestions on alternative ways of reducing waste.
12. Similarity People are more readily persuaded through systems that remind themselves in a meaningful way.	System should imitate its users in some specific way.	The application speaks the user's language, showing images and quotes that remind them of their religion or culture. Any aspects that make users feel familiar with the application.
13. Liking A system that is visually attractive for its users is likely to be more persuasive.	System should have a look and feel that appeals to its users	The app presents information for recycling activities that are visually appealing to the user.
14. Social role If a system adopts a social role, users will more likely use it for persuasive purposes.	System should adopt a social role.	Having a respected and prominent person as an ambassador or role model that practices a sustainable lifestyle and adopts green practices of waste disposal.

The *reminders principle* is commonly implemented strategy in the dialogue support category to remind user to perform target behaviors (Nkwo and Orji, 2021). The *GarbageDay - Waste Reminders* app is an example the implements reminders principle that notifies and reminds users about their task to dispose of garbage, and waste collection schedule. For example, the day /date for recycling item collection. The *TakaCycle: Easy Waste Collection* is another app that implements the rewards principle by offering rewards point or coin after completing a certain level of recycling. The following Figure 2.20 shows examples of *reminder principle* in *GarbageDay - Waste Reminders* app and *rewards* principles applied in the *TakaCycle* app.

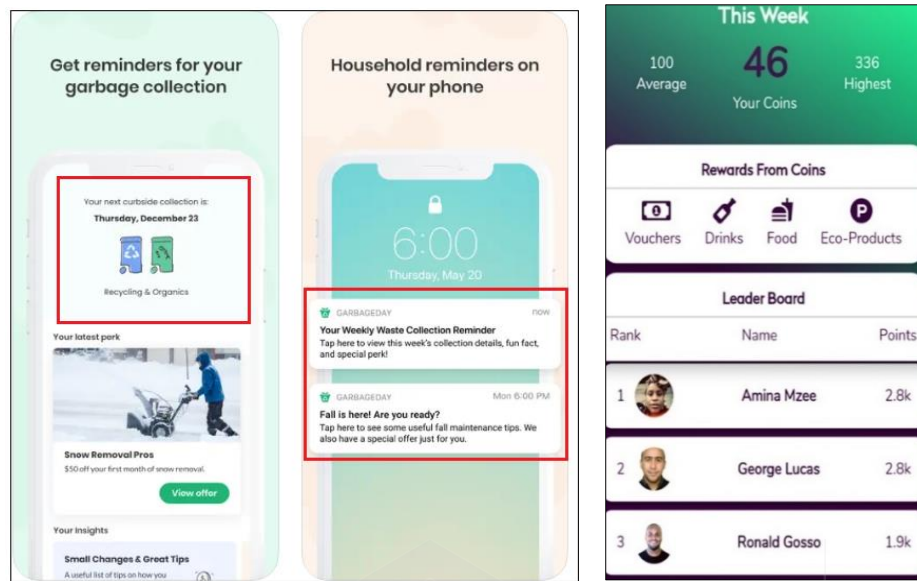


Figure 2.20: *Reminder principle in GarbageDay - Waste Reminders app (left) and Rewards principles applied in the TakaCycle app (right)*

Based on recent systematic evaluation by Nkwo and Orji (2021) the *praise* principle is typically in the form of symbols, words, images, or sounds as feedback for users toward the target behavior. *Sort-your-waste* is a recycling game that implements praise principle to congratulate user for completing a level of recycling and disposing of waste. Figure 2.21 shows an example of the praise principle applied in recycling game.

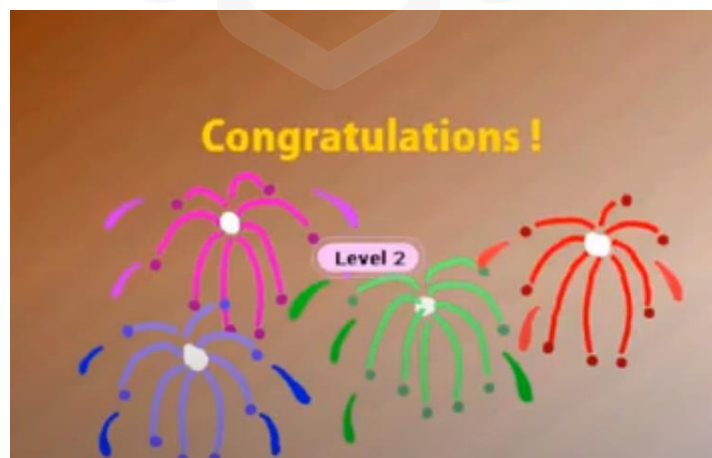


Figure 2.21: *Example of Praise Principle applied in Sort-your-waste Application*

- **System Credibility Support**

The system credibility support category includes principles that make the system more credible and persuasive. It includes trustworthiness, expertise, surface credibility, real-world feel, authority, third-party endorsements, and verifiability. The following Table 2.11 summarizes the description of each principle, example requirements, and example implementation as per outlined in Oinas-kukkonen and Harjumaa (2009).

Table 2.11: System Credibility Support

Persuasive Principle	Example requirement	Example implementation
15. Trustworthiness A system that is viewed as trustworthy will have increased powers of persuasion.	System should provide information that is truthful, fair and unbiased.	An app that provides truthful, reasonable, and unbiased information such as about the basics of composting, composting-related products, and composting methods.
16. Expertise A system that is viewed as incorporating expertise will have increased powers of persuasion.	System should provide information showing expertise.	The app provides a platform for seeking experts to get advice about waste management practices.
17. Surface credibility People make initial assessments of the system credibility based on a firsthand inspection.	System should have competent look and feel.	The user interfaces (UIs) of the waste management application have a competent look and feel.
18. Real-world feel A system that highlights people or organizations behind its content or services will have more credibility.	System should provide information of the organization and/or actual people behind its content and services.	The application provides information about recycle council's services and waste facilities, frequently asked questions, and relevant contact details of the organization.
19. Authority A system that leverages roles of authority will have enhanced powers of persuasion.	System should refer to people in the role of authority.	Facilitate residents to submit waste collection and public cleansing complaints to Waste Management authority.
20. Third-party endorsements Third-party endorsements,	System should provide endorsements from respected sources.	The used of the application was encourage and endorsed

especially from well-known and respected sources, boost perceptions on the system credibility.		by the ministry/government (any well-known respected sources).
21. Verifiability		
Credibility perceptions will be enhanced if a system makes it easy to verify the accuracy of site content via outside sources.	System should provide means to verify the accuracy of site content via outside sources.	To verify the accuracy, the application provides the name of the waste management organization, a link to their website, and contact details.

The *authority* principle postulates that a persuasive system should leverage the role of authority to enhance its credibility. An example of *authority* principles is employed in *i-Clean Selangor* smart application, that facilitate residents to submit waste collection and public cleansing complaints to KDEB Waste Management. Figure 2.22 shows example of *authority* principle applied in *i-Clean Selangor* app. The *third-party endorsement* principle suggests that endorsement from a well-known and respected organization boost perceptions on system credibility. The *i-Kitar* is a recycling app that implements the third-party endorsement principle. The app has been endorsed by Solid Waste Management and Public Cleansing Corporation (SWCorp) in Malaysia and the endorsement has been highlighted through text such as “TRIVIA SWCorp” and incorporating the SWCorp logo on the app. Figure 2.22 illustrates the features of *i-Kitar* app that app that has been endorsed by the SWCorp.



Figure 2.22: Authority Principle applied in *i-Clean Selangor* app (left) and Third-party endorsement Principle applied *i-Kitar* app (right)

In order to enhance the credibility of the persuasive system, the *verifiability* principle could be applied by facilitating users to verify the accuracy of the site's content. An example of *verifiability* principles is employed in *iRecycle* app to provide the name of recycling center, a link to their website and contact information so that user may contact them to verify the accuracy of the information provided. Figure 2.23 shows example of *verifiability* principles applied in *iRecycle* app.

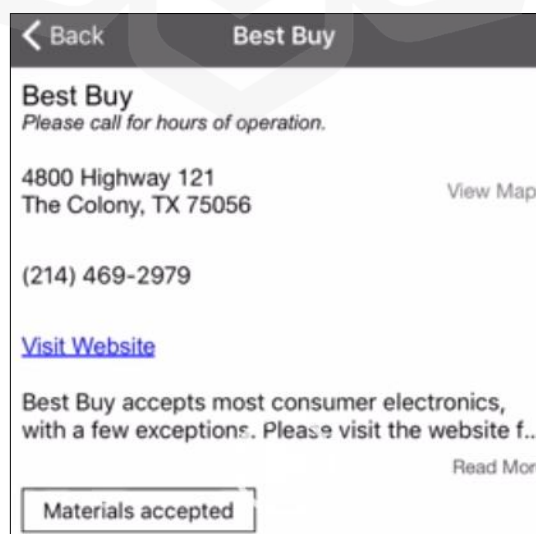


Figure 2.23: *Verifiability* Principles applied in *iRecycle* app

- **Social Support Category**

The design principles in the social support category largely manipulate the user's interpersonal relationship with other human beings (family, friends, colleagues) as a way to enhance their motivation and self-confidence in achieving their targeted behavior (Oinas-Kukkonen and Harjumaa, 2009). The design principles in this category include social facilitation, social comparison, normative influence, social learning, cooperation, competition, and recognition. The following Table 2.12 summarizes the description of each principle, example requirements, and example implementation as per outlined in Oinas-kukkonen and Harjumaa (2009).

Table 2.12: Social Support Category

Persuasive Principle	Example requirements	Example implementation
22. Social learning A person will be more motivated to perform a targeted behavior if he/she can observe others performing the behavior.	System should provide means to observe other users who are performing their target behaviors and to see the outcomes of their behavior.	The application provides opportunity for user to learn about recycling behavior from other people.
23. Social Comparison System users will have a greater motivation to perform the targeted behavior if they can compare their performance with the performance of others.	System should provide means for comparing performance with the performance of other users.	The application provides an opportunity for user to compare 3Rs performance with others.
24. Normative influence A system can leverage normative influence or peer pressure to increase the likelihood that a person will adopt a target behavior.	System should provide means for gathering together people who have the same goal and get them to feel norms.	Application such as recycling app provides a platform that allows governments, recyclers, and the whole community to all work together to gather, share and update recycling information to support an individual to adopt positive waste management behaviors.
25. Social facilitation System users are more likely to perform target behavior if they discern via the system that others are performing the behavior along with them.	System should provide means for discerning other users who are performing the behavior.	The application allows user to recycle better when they feel others are recycling with them.

26. Cooperation A system can motivate users to adopt a target attitude or behavior by leveraging human beings' natural drive to co-operate.	System should provide means for co-operation.	The app provides an opportunity to work together with other people in a team to achieve target behavior
27. Competition A system can motivate users to adopt a target attitude or behavior by leveraging human beings' natural drive to compete.	System should provide means for competing with other users.	The application provides the leader board to see how your recycling habits compare with other members of the community.
28. Recognition By offering public recognition, a system can increase the likelihood that a person/group will adopt a targeted behavior.	System should provide public recognition for users who perform their target behavior.	The app provides a public scoreboard, a wall of fame honoring great performers in reducing waste, and publicly accessible ratings for garbage service providers.

The *social comparison* principle often implemented by comparing recycling activities with different users. For example, in a waste management application allow user to see the recycling behaviour performance (number of points) in comparison with other members of the community. The *social comparison* principle is commonly employed along with the *competition* principle, where the users' recycling performance were not only being compared, but also were put into ranked based on their performances. *TakaCycle* app is an example of a behaviour change application that applied both *social comparison* and *competition* principles (see Figure 2.24 for screenshot of the app).

Leader Board		
Rank	Name	Points
1	 Amina Mzee	2.8k
2	 George Lucas	2.8k
3	 Ronald Gosso	1.9k
4	 Darragh Amelia	1.6k

Figure 2.24: Social Comparison and Competition Principle in *TakaCycle* app.

The *cooperation* principle proposes that a system could motivate users to adopt a target attitude or behaviour by leveraging human beings' natural drive to cooperate (Oinas-kukkonen and Harjumaa 2009). An example of cooperation principle has been proved in the *Gone-for-Good* app that provide opportunity for users to donate unused item for charity or good causes (e.g., donate used for people who were affected by flood disaster). Further, The *Normative influence* principles postulates that a persuasive system would leverage normative influence or peer pressure to increase the likelihood that a person will adopt a target behavior. The *Recycle Mate* is an example of Australia's first community-driven recycling app provides a live national platform that allows governments, recyclers, and the whole community to all work together to gather, share and update recycling information. The following Figure 2.25 shows features of *Gone-for-Good* app that utilize the *cooperation* principle, and *Recycle Mate* utilize the *normative influence* principle.

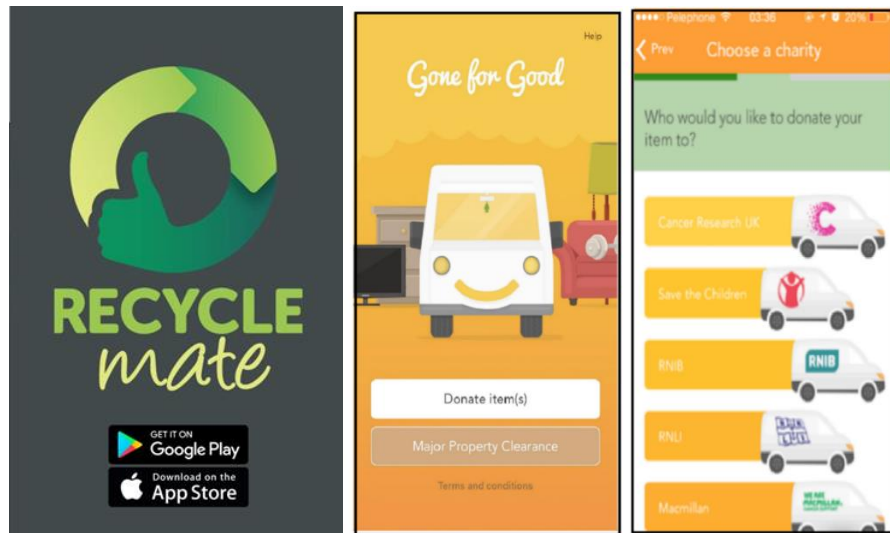


Figure 2.25: *Gone-for-Good* app that utilize the *Cooperation* Principle (right), and *Recycle Mate* utilize the *Normative Influence* Principle (left)

2.4 MAPPING THE PRINCIPLES IN WASTE MANAGEMENT INTERVENTION

Both inside and outside academia, the PSD framework has been used to design persuasive technologies in addressing unsustainable waste management behaviors. For example, Thieme et al. designed (2013) *BinCam*, a social persuasive system designed to persuade change behavior in recycling and food waste. It has three main elements: a trash bin with an embedded smartphone, a Facebook application, and a crowd-sourcing service. Each time waste is disposed on bin by opening its lid. The smartphone takes images of the bin's content and uploads the pictures to a crowd-sourcing service. After identifying and counting the number of waste items, uploaded images will be turned into a score for gamification purposes and shared on the Facebook application.

BinCam designed to invite reflection and to promote behavioral change through social media and strategies of social persuasion such as normative influence, competition, and social surveillance. Although this system increases people's awareness and encourage them to change behaviour in reducing waste, people

experienced acute guilt for not recycling or properly disposing of food waste. Furthermore, this system is exclusively available in private places like apartments and homes.

In another study, a prototype of a waste management application was developed to encourage students to adjust their waste management behaviors and to protect the university environment by providing various personalized persuasive displays and tools (Nkwo et al., 2018). This research utilized three of the social influence strategies of the PSD model, such as *social learning*, *social comparison*, *recognition* and *personalization* to tailor the design to the personal preferences and needs of the users, who were living in a closed community. The findings of this user study showed that it is possible to use relevant persuasive principles to persuade people and organizations to adopt sustainable waste management behaviors, even though the design was not evaluated. The study demonstrated how these principles may be applied to computers and mobile devices to encourage users to engage in the desired behaviors without being forced. The study's scope was later expanded to include residents of a local community in southeast Nigeria. Similar to the prior study, this study's findings were mapped to persuasive strategies of the PSD framework. These guidelines were utilized to create recommendations for socially acceptable mobile persuasive technology design that will encourage good waste management practices in communities in the global south (Nkwo, M.,2019).

Next, Maria Nazarova and Keski-Mattinen applied the Behavior Change Wheel (BCW) framework to design a mobile recycling application aimed at motivating individuals in Saint Petersburg, Russia, to engage in recycling practices (2021). At first, they have identified six ability blockers among citizens that hinder the recycling behaviours such as lack of knowledge of the recycling points, lack of knowledge of the recycling guidelines, lack of simplicity to understand sorting guidelines, lack of time or transport to visit recycling facility, lack of motivation to do the recycling, lack of sorting container within a walking distance. To address these barriers, only three strategies such as education, training, enablement was implemented to initiate, guide, and maintain goal-oriented recycling behaviors among the users. The application was tested with real users from Saint Petersburg. The findings shows that all the survey participants satisfied the design of the application and multi-service as it provides

several services in one click. Some of the participants suggested that this kind of approach could be the first step in addressing Russia's ecological status.

In another study, Gustav Mattsson designed and evaluated a prototype to reduce food waste in workplace kitchens using the Behavior Change Wheel (BCW) framework (2020). The developed prototype was an RFID-activated labeling system that provided users labels with their names and the current date for items kept in shared refrigerators. The goal of this intervention was to encourage users to be more organized and accountable. Fourteen of the seventeen individuals used the system over the two-week testing period. Qualitative feedback indicated a positive reaction, indicating potential for reducing food waste and improving refrigerator organization in workplace settings, even the study did not evaluate behavioral change clearly.

A recent work by Nkwo, Suruliraj, Olagunju and Rita Orji (2020) developed a personalized persuasive mobile app prototype called *Bota* for promoting sustainable waste management behaviour among the African nation. This mobile application implemented twelve (12) persuasive principles in four categories of the PSD model, namely 1) primary task support: *reduction, tailoring, self-monitoring, personalization, rehearsal* principles, 2) dialogue support: *praise, rewards, reminder, suggestion, liking* principle, 3) credibility support: *surface credibility, real-world feel, verifiability*, 4) social support: *social facilitation* principles. Findings from the study showed a positive result in motivating people to make the desired behaviour change toward sustainable waste management. Although the *bota* app showed to be highly persuasive to change behaviour towards sustainable waste management and largely focused on behavior change for the African nation. It is questionable whether similar persuasion attempts would work in the Malaysian community. Besides, this app is a lack of spiritual and religious values on human behavior which may not motivate the Muslim majority of the Malaysia's population.

Bandyopadhyay and Dalvi (2017) explored how designing an interactive installation can influence and modify food waste behavior among university students. The study applied using persuasive strategies like gamification and emotional triggers such as 'pleasure' and 'pain' from behavior change theories, such as Fogg's Behavior

Model (FBM). Statistical analysis and online surveys were conducted to assess the installation's impact among university students. The findings suggested that interactive installations can effectively encourage individuals to modify their food waste behaviors.

However, compared to these existing studies, our study aims at to design a mobile persuasive system to motivate Malaysian Muslims to adopt environmentally friendly behavior by integrating persuasive principles across the four categories of the PSD model, i.e., primary task support, dialogue support, credibility support and social support, and *Maqasid al-Shari'ah* perspective (the objectives of Islamic law). We believe that this gap needs to be addressed to raise awareness in the urban community on the importance of proper disposal of municipal waste from the perspective of Shariah. Although the government in Malaysia has tried to raise awareness on the importance of household participation in environmentally friendly disposal of Municipal Solid Waste (MSW) through numerous measures, it is still inadequate. Therefore, as Malaysia is a Muslim-majority country and religious views have a great influence in directing and positively changing attitudes and behaviors, we believed that integrated persuasive design framework based on maqasid al-shari'ah would increase persuasion in promoting environmentally friendly waste management practices. This will make the application more persuasive and reaches a large number of people to encourage environmentally friendly practices in MSW disposal compared to previous work. Thus, investigating end-user perspectives on effective persuasive design principles based on the Persuasive System Design (PSD) model is crucial to obtain information on the needs and requirements for the development of persuasive sustainable waste management applications targeting Malaysian households. Further, Oinas-Kukkonen and Harjumaa (2009) claimed that “*persuasion should always be open*”, which implies that the designer’s intention of persuading people to change their behaviour through the system should be visible to the user. Table 2.13 summarizes the closely related work on persuasive waste management interventions based on the PSD model, FBM model, BCW framework and behavioural change outcomes.

Table 2.13: Relevant Works on Persuasive Waste Management Interventions

Authors	Article Title	Theory or Framework	Persuasive principles implemented	Behavioural change outcome
Nkwo, B. S. T. O. M., & Orji, R. (2020).	Bota: A Personalized Persuasive Mobile App for Sustainable Waste Management	PSD Framework	Reduction, Personalization, Real-world feel, Surface credibility, Reminders, Self-monitoring, Tailoring, Social facilitation, Rewards, Suggestion, Verifiability, Praise, Liking, and Rehearsal.	The study showed a positive result in motivating people to make the desired behaviour change toward sustainable waste management practices.
Nkwo, M., Orji, R., & Ugah, J. (2018).	Persuasion for promoting clean and sustainable environment.	PSD Framework	Social learning, social comparison, and recognition	The study was not evaluated.
Comber et al., (2013)	BinCam: Designing for Engagement with Facebook for Behavior Change	None explicit	Normative influence, competition, and social surveillance	The user study revealed an increase in users' awareness and reflection about their waste management and their motivation to improve their waste-related skills.
Nazarova and Keski-Mattinen (2021)	The use of Behavior Change Wheel framework in the design of the mobile recycling application	Behavior Change Wheel (BCW) framework	Education, training, and enablement	The findings revealed that all the participants are satisfied with the application and they believed this kind of approach could be the first step in addressing Russia's ecological status.
Mattson, G. (2020)	Applying the Behaviour Change Wheel to design and evaluate a food waste reducing prototype for workplace kitchens	Behavior Change Wheel (BCW) framework	Education, persuasion, coercion, environmental restructuring, modelling, enablement	The study showed positive feedback to reduce food waste in the workplace kitchen even though the study did not evaluate behavioural change conclusively.

Bandyopadhyay and Dalvi (2017)	Can interactive installations bring about behaviour change? Using interactive installation to change food waste behaviours.	Fogg's behaviour model (FBM)	Feedback and monitoring, social support and disapproval, salience of consequences, social comparison, prompts and restructuring the social environment	There was not a significant reduction in food waste, but post survey results indicated increased motivation and awareness.
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2.6 ENVIRONMENTAL ETHICS IN WASTE MANAGEMENT

The problem of waste disposal is increasingly affecting the environment, human health and well-being. People's activities, awareness and willingness are of utmost importance in solving the problem of waste disposal. On the other hand, shaping attitudes, behaviors, perceptions and practices to solve the waste disposal problem is closely related to their faith, culture, worldview and tradition. Hence, religion plays an important role in persuading the new patterns of behavior toward waste disposal. According to Schuman et al., (2018), human behavior is undeniably persuaded by religious beliefs and religion. Such behavioral persuasion includes how people observe and interact with the environment. Another study by Chuvieco, Tucker and Grim (2016) also highlighted that religious belief is a strong motivation of the environmental concern, as religions include a particular cosmology that explains the role of the human being to the environment.

Islam has also occupied wide space in numerous academic writings on environmental ethics. These include its principles and ethics in dealing with the environment and the consequences of not preserving it. According to Gada (2014) the environmental crisis we are currently facing warrants an urgent solution of the environmental ethics. Considering the fact that environmental ethics is closely related to intrinsic values and beliefs, religions have received more recognition for defining appropriate environmental ethics. Accordingly, the entire environmental crisis is due to man's failure to comprehend himself and realize himself as the 'vicegerent' and 'trustee' of the Almighty. It is also believed that the disconnect between worldly affairs

and religion is the main aspect that in turn leads to the environmental crisis (Abedi-Sarvestani and Shahvali, 2008). Conversely, secular life and religion are inseparable, for religion is the best element for shaping attitudes and behavior toward nature, other people, and all living things, such as animals and plants.

This indicates that Islam is a perfect religion which contains truth and provides guidance to all mankind. As a perfect religion, its teachings encompass the relationship between man and God, between man and other men, and between man and the environment. These three holistic relationships have always been widely emphasized in Islamic teachings in order to maintain and preserve a healthy environment and an ecological balance. Therefore, human is responsible to take care, preserve and maintain the environment and all its segments associated with it, according to God's command (Gada, 2014; Abedi-Sarvestani, and Shahvali, 2008).

Various studies have been conducted of the waste management practice and positive roles of Islam based on Qur'an and Sunnah in terms of avoiding wasteful consumption and manners of cleanliness to resolve global environmental health problem caused by poor waste management (Samori et al., 2017; Omar et al., 2018).

According to Zabidi et al., (2021), the responsible behavior to protect the environment can be demonstrated through the religious values. However, this responsible behavior to protect the environment is gradually eroded because the lack of obligation of Islamic values related to environmental protection based on Quran and Sunnah (Abd Rahman et al., 2020; Ibrahim, 2010). One of the consequences is the inefficient waste management in most Islamic countries, including Malaysia, which leads to environmental and human health problems. It is evident that the condition of waste disposal in Malaysia is deteriorating due to uncontrolled consumption, growing population, attitude towards shopping and high standard of living. As a result, many cities in Malaysia are facing waste management crisis due to significant increase in waste generation, uncontrolled production and consumption patterns and lack of adequate resources to manage the waste generated. Religious teaching can change the behavior of the community to avoid various diseases and acts of *tabzir* (useless) and *israf* (excessive), and the highest hierarchical behavior in sustainable waste management (Achmad, 2022).

Therefore, in this study, we believed that improving Muslims' understanding of *Maqasid al-Shari'ah* perspectives on proper disposal of municipal waste will convince Muslims to positively change their behavior and attitude towards environmentally friendly waste disposal practices and protect their religion, life, intellect, lineage and prosperity.

2.6 APPLICATION OF MAQASID AL-SHARĪ'AH IN SUSTAINABLE WASTE MANAGEMENT

2.6.1 Definition of Maqasid al-Shari'ah

Maqasid, the plural form of the Arabic word *maqсад*, denotes objectives, goals, purposes, intentions, and ends (Ibnul-Athīr, 2002, p. 4/60; Auda, 2007, p. 2). Ibn'Āshūr (2001) offers a comprehensive definition, stating that *Maqasid* encompasses the purposes and wisdom behind the enactment of most or all of the Sharī'ah rulings (p. 251). Al-Fasī (1993) further refines the concept, indicating that *Maqasid* refers to the ends sought with each Sharī'ah ruling and the associated wisdoms (p. 7). According to Abu Hamid al-Ghazali, (1413 AH, p. 174) the *Maqasid al-Shariah*, or the objectives of the Lawgiver, are to safeguard the religion (*dīn*), life (*nafs*), intellect (*'aql*), progeny (*nasl*), and wealth (*mal*). These primary objectives form the framework of *maslahah*, denoting well-being.

The subject matter of *Sharī'ah* rules is categorized into two main components: ends/objectives (*maqasid*) and means (*wasā'il*) (Auda, 2007; El-Mesawi, 2006). The means to preserve these five objectives are further categorized into three levels based on the degree of necessity: *daruriyyat* (most essential), *hajiyyat* (essential), and *tahsiniyyat* (embellishments). Additionally, there are supplementary objectives, *mukammilat*, that enhance each of the three levels. In terms of range and inclusion, *Maqasid al-Sharī'ah* is classified into general objectives (*al-maqasid al-'ammah*), specific objectives (*al-maqasid al-khāṣṣah*), and partial objectives (*al-maqasid al-juz'iyyah*). He is also a pioneer in dividing the *Maqasid-al-shari'ah* into three descending categories of significance: *daruriyyah* (essential), *hajiyyah* (supplementary), and *tahsiniyyah* (desirable or embellishments). *Daruriyyah* are

considered absolute requirements for the survival and spiritual well-being of individuals and communities. If they are ignored, the world cannot become coherent and orderly and chaos, disorder and loss prevail (Auda, 2008). *Daruriyyah* relates to five things for human wellbeing and development which are:

- 1) Protection of Faith/Belief
- 2) Protection of Life/Body
- 3) Protection of Reason/Intellect
- 4) Protection of Posterity/Lineage
- 5) Protection of Property/Wealth

In the context of Islamic finance, one of the primary goals of *Sharī'ah* is wealth preservation (al-Qaradawi, 2008b). A survey of various Quranic and Sunnah texts on financial activities demonstrates that the *Sharī'ah*, similar to other disciplines, has considered specific objectives in the enactment of financial laws and principles (Laldin and Furqani, 2013). The principles of *Maqasid al-Sharī'ah*, rooted in preserving well-being and specific objectives, extend beyond financial domains, presenting an opportunity to apply these principles to sustainable waste management practices.

This literature review provides a foundational understanding of *Maqasid al-Sharī'ah*, emphasizing its role in shaping the objectives of *Sharī'ah* and guiding various disciplines, including Islamic finance. The subsequent sections of this paper will delve into the application of *Maqasid al-Sharī'ah* principles to the realm of waste management.

2.6.2 Constituents of Maqasid al-Shari'ah in Sustainable Waste Management

The theory of *Maqasid al-Shari'ah* serves as a comprehensive framework guiding various aspects of human activities and knowledge. It emphasizes the attainment of higher goals, particularly in the context of Islamic principles. This literature review aims to explore the necessary constituents of *Maqasid al-Shari'ah*, focusing on parameters, particular objectives, appropriate means, micro provisions, levels of well-

being, and legal maxims. By understanding these elements, a conceptual framework for harmonizing *Maqasid al-Shari'ah* with sustainable waste management practices will be established. (See Section 6.3)

Parameters of Maqasid al-Shari'ah: Parameters play a crucial role in delineating the principles of *Maqasid al-Shari'ah*. These parameters, such as legality, harmony, certainty, rationality, discipline, generality, and constancy, serve as guiding principles for waste management aligned with Islamic ethical objectives (Al-Mayman, 2005). Legality ensures waste management practices adhere to Shariah evidence, while harmony prevents contradictions with original indicants. Certainty demands definitive proof for waste management objectives, and rationality requires reasonableness and conformity with natural disposition. Discipline ensures restrictions, generality emphasizes universality, and constancy denotes longevity (Al-Būṭī, 1973).

Particular Objectives of Maqasid al-Shari'ah: The objectives of *Maqasid al-Shari'ah* are categorized into general, specific, and partial objectives. General objectives, encompassing the entire body of Islamic law, include the well-being of humanity, justice, and facilitation. Specific objectives, focusing on particular chapters like waste management, ensure a detailed approach. Partial objectives represent immediate benefits, such as exploring facts in legal cases or alleviating difficulty in specific situations (Auda, 2011).

Appropriate Means in Maqasid al-Shari'ah: Appropriate means or *was'il* play a vital role in achieving *Maqasid al-Shari'ah*. Scholars like Ibn-Bayyah identified various means for waste management, including proper management, hoarding prevention, moderation, and mutual consent. These means contribute to the broader ends proposed in the framework of *Maqasid al-Shari'ah* (Ibn-Bayyah, 2008).

Micro Provisions and Maqasid al-Shari'ah: Micro provisions, detailed proofs, and texts of Shariah are deeply intertwined with *Maqasid al-Shari'ah*. The relationship between micro provisions and *Maqasid al-Shari'ah* ensures a balanced interpretation within the framework. Neglecting micro provisions may lead to objectives based on desire and alien to Shariah (Al-Qaraḍawī, 2008a).

Levels of Well-Being in Maqasid al-Shari'ah: *Maqasid al-Shari'ah* categorizes levels of well-being into *darūriyyat* (necessities), *ḥajīyyat* (needs), *taḥsīniyyat* (embellishments), and *mukammilat* (supplementary). Waste management, falling under *darūriyyat*, ensures the preservation of life and environmental sustainability, aligning with broader objectives (El-Mesawi, 2006).

Legal Maxims (Qawā'id) in Maqasid al-Shari'ah: Legal maxims in Islamic jurisprudence, integral to *Maqasid al-Shari'ah*, provide general rules applicable to specific situations. Maxims such as "harm must be eliminated" and "necessity makes the unlawful lawful" guide the interpretation and application of *Maqasid al-Shari'ah* in various contexts (Kamali, 2017).

Therefore, understanding the constituents of *Maqasid al-Shari'ah* provides a foundation for developing a conceptual framework for sustainable waste management practices. Aligning waste management with Islamic ethical objectives ensures environmental conservation and contributes to the well-being of society.

2.6.3 The Role of the Maqasid al-Shari'ah in Waste Disposal

Protection of the environment is one of the goals of Islamic law. In several verses, the Quran commands people to protect the environment. Violation of this commandment is therefore considered a great sin. The Quran and the Sunnah provide the guideline on how to preserve the welfare of mankind and the environment by eliminating all kinds of damage caused by uncontrolled waste management. One of the principles of protecting the environment in Islam that can be invoked is the doctrine of *maslahah* (benefit), which benefits individuals and society or prevents harm through the goals Maqasid of Shariah. These objectives are to protect the five essential values, namely religion, life, intellect, lineage and property. Any action that safeguards these values falls within the realm of *maslahah*, anything that violates them is *mafsadah* (evil) and preventing the latter is also *maslahah*. Therefore, solving the problem of municipal waste disposal can be considered a great *maslahah* as it avoids problems related to the opening of new landfills which pose a threat to humanity and the environment. The role of the *Maqasid al-Shari'ah* in waste disposal is as follows:

i. Protection of Faith/Belief (al-Din):

The first objective of *Shari'ah* is the protection of faith, which refers to the right of individuals to practice their faith. Preservation of faith is the most important thing that leads people to understand the greatness of Allah which guides him to fulfill the role of Khalifah (man's vicegerency) religiously towards people and the environment. The word Khalifah in the Qur'an refers to all humans being considered God's agents or stewards on earth, and God establishes clear principles about this stewardship to care of oneself, others, and the planet. As a *khalifa*, humans have the responsibility to manage, steward and protect the environment, are in fact an '*amanah*' (trust) from Allah and should therefore strive to protect it and avoid any behavior that harms the environment (Samori et al., 2017). This notion of stewardship is a powerful concept used to change behavior to protect the environment. Prophet Muhammad (s. a. w.) mentioned in the hadith that "The world is green and beautiful, and Allah has appointed you his guardian over it." The following surah emphasizes the point:

"Believe in Allah and His messenger and spend of that whereof He hath made you trustees." (Suarh al-Hadid: 7)

The Quran also stated in surah al-Anam verse 165:

"For He it is Who has made you Khalifa on earth and has raised some of you by degrees above others, so that He might try you by means of what he has bestowed on you. And thereupon We made you their Khalifa on earth, so that We might behold how you act." (Surah al-Anam, verse: 165)

In addition, the above verses summarize the roles of human that should have with nature. Therefore, it is the duty of Muslims as Allah's stewards and trustees to protect the environment with utmost care. With reference to the above Quranic verses and Hadith, it can be said that effective and efficient municipal waste management is important not only for the protection of the environment but also for the protection of human beings. Consequently, any action to protect and manage the environment, such as minimizing waste, is considered to achieve the goal of protecting the faith. The Prophet (s. a. w.) mentioned in a hadith that the act of

cleaning garbage and materials hazardous to health from roads and streets is among the seventy branches of faith. Furthermore, Yusuf al-Qardawi in his book titled *Riayah al- Biah fi al-Shariah al-Islamiyah* stated that protecting the environment is the same as observing religion (hifddiin), as this is stated in the Qur'an:

“And do not cause corruption in the earth, when it has been set in order.”

(Surah Al-A'raf:56)

Damage to the environment, misuse and mismanagement of natural resources lead to the elimination of the principle of true faith in religion, harm human functioning on earth, and violate God's commands to preserve the environment, which is related to man's relationship with Allah (s.w.t) (Muslimin et al., 2018). The most important of these goals is to preserve the faith by building the agreed pillars and leaving the agreed forbidden things. In this sense, the preservation of faith is closely related to the management and protection of the environment created by Allah (s.w.t.), and Allah (s.w.t.) warns His servants should not exploit it and use its resources wastefully.

Protecting the environment is another form of *ibadah* (worship) like prayer and fasting, which is promised with reward in the Hereafter (Bilal, 2017). Therefore, it is our responsibility to respect, nurture and care for the environment and not to abuse the trust (*amanah*) that has been given to us. From the Islamic point of view, human is accountable for upholding the unity of Allah's creation and protect the environment and its segments associated with it. On the Day of Judgment, Muslims will be responsible before Allah for how they preserved the balance and harmony of creation. Therefore, every Muslim needs to preserve his/her own faith, and that is by obeying Allah (s.w.t) and fulfilling His *amanah*, and one way of obeying and fulfilling the *amanah* is by protecting the environment and avoiding injustice against Allah's earth because that has been commanded in the Quran in surah al-A'raf verse 85 in following words:

“...and make no mischief on earth after it has been set in good order. That will be best for you, if ye have faith.” (Surah al-A'raf: 85)

The Quran further speaks in surah Al-Maida, Ayah 64 that Muslims are treated as *khalifah* or trustees of Allah to protect the environment and Allah does not love those who spread disorder and corruption in the earth. And further similar injunction repeats in surah Al-An'aam verse 141:

“It is He Who has brought into being gardens - the trellised and untrellised - and the palm trees, and crops, all varying in taste, and the olive and pomegranates, all resembling one another and yet so different. Eat of their fruits when they come to fruition and pay His due on the day of harvesting. And do not exceed the proper limits, for He does not love those who exceed the proper limits.” (Surah Al-An'aam:141)

Therefore, it can be concluded that the absence of true faith in Allah (s.w.t.) has led to an imbalance and lack of balance between man and the environment. Shariah confirms that man was created to fulfill his role as Allah's *Khalifa*, to become His obedient servant and thus to preserve the environment to be part of the religion. In this study, protection of faith demonstrates responsibility, obligation to respect, nurture and care for the environment through adopting green practices. If resident consider that they have the high sense of responsibility and obligation to adopt green practices of MSW to solve the environmental problem then their intention strengthens to dispose waste properly.

ii. Protection of Life/Body (al-Nafs):

The second objective of *Shari'ah* is to protect life. Our safety and health hazard are associated with waste management. People are now continuously producing waste at an insurmountable scale. This accumulation of large amount of waste at landfills increases the carbon and methane emissions that are hazardous to human health. As long as this continues, the danger of human life will likely increase. Thus, people should be made aware that reducing amount of waste is indeed crucial to protect life and body. The Qur'an warns people to take personal responsibility for their wellbeing and health in surah al-Yunus verse 23:

“O people! The excesses you commit will harm only yourselves. Enjoy the (lawful) pleasures of this world” (Surah al-Yunus: 23)

In order to protect our life and body, we should maintain cleanliness of the environment. In Islam, health and cleanliness are linked to purity and purification. This is because a clean surrounding will enable us to save our lives and reduce the toll of disease. Maximize the waste generate cause the environment to lose its cleanliness. With the importance of cleanliness, the Prophet (s. a. w.) has mentioned in a hadith that "cleanliness is half of faith". He (pbuh) also ordered to take care of the cleanliness of the house and garden, "You must clean your house and not follow in the footsteps of the Jews" (reported in Al-Tirmidhi)". Moreover, Allah (s.w.t.) also loves cleanliness. This is also mentioned in the Quran:

“He loves those who keep themselves pure and clean”.(Surah al-Baqarah: 222)

Moreover, the Prophet (PBUH) also give the importance on hygienic lifestyle by removing trashes and health risking materials from the roads and streets, so that the environmental health is maintained. Considering the importance of cleanliness in Islam, it is therefore our religious duty to be clean and lead a hygienic lifestyle, including body, clothing, household as well as our surroundings. In this study, if people have more safety awareness to protect their life, then will look after their health and personal hygiene by reducing amount of waste so that they will be less victimized of solid waste disease.

iii. Protection of Intellect/Reasoning (al-Aql):

The third objective of *Shari'ah* is the protection of the intellect. According to Sarkawi et al., (2015), the protection of the intellect covers the way for people to gain knowledge and be able to judge right from wrong. There are many verses in the Quran that mentioned about the intellect in action shows that thinking is obligatory and strongly encouraged. Qur'an motivated people to use their intellect by asking a question *“afala ta'qilun”* (will you not use your intellect?). Therefore, in the context of waste management, people should feel obliged to learn green practices (reduce,

reuse, recycle) that would assist them to make a good judgment in handling municipal solid waste disposal at home.

The most effective way to increase environmental awareness of green practices (reduce, reuse, recycle) is to acquire environmental knowledge and education. Apart from government plans and campaigns, the success of effective waste disposal depends on our attitude, behavior and contribution, which are strongly influenced by our knowledge. Thus, there is an opportunity to improve our daily behavior in dealing with household solid waste if our knowledge of environmentally friendly waste management practices is improved.

iv. Protection of Lineage/Prosperity (al-Nasab):

The fourth aim of *Shari'ah* is the protection of lineage. Islam pays great attention to social life through the preservation of lineage. The existence of human being on earth is the will of Allah. The natural wealth of the environment that exists is not only to be enjoyed but also to be provided for the next generation. To harm the environment is to deprive it of its rights. The current generation is obligated to preserve its environment as a form of responsibility (Weiss, 2017).

The protection of generations is part of the preservation of descent, human honor, and moral descent. Therefore, to achieve this goal in the context of waste disposal, people should be made aware that we can reduce air and water pollution through green practices. So that our children (offspring) can grow up in a healthy natural environment. The use of environmental resources is bound to a certain period of time. Allah mentioned in the Quran:

“On earth will be your dwelling-place and your means of livelihood - for a time.” (Surah Al Baqara: 36)

The above verse sums up that the definite time frame obliges man to use the natural resources accurately as they belong not only to the present generation but also to the future generation. Moreover, our greed, extravagance and ignorance should be prohibited in order to get the maximum benefit from the natural resources, especially

for the future generation. It is our duty to protect the resources from pollution and waste, and to adopt the 3Rs to pass them on in good condition to the next generation to enjoy the benefits.

v. Protection of Wealth (al-Maal):

Allah has created wealth as a support for human life. Property is not always money or gold, but also natural resources such as land, trees, plants, animals, water and oceans that need to be protected. The preservation of property is a goal that must be wisely protected because of its close relationship to environmental protection and the preservation of its capabilities. Islam has strongly emphasized the wise use of natural resources and the environment. In this regard, any overconsumption, such as wasting food, is indeed non-Islamic as it leads to harmful effects on the environment, such as opening new areas due to inadequate landfills, which eventually lead to an increase in carbon and methane emissions. The Quran has ordered in Surah Al-Araf verse 31:

“Eat and drink: But waste not by excess, for Allah loveth not the wasters.” (Surah al-Araf: 31)

The above verse is sufficient to show the dislike of Almighty Allah (s.w.t.) towards the extravagant people. Moreover, Islam forbids extravagant behavior and excessive consumption. Meanwhile, it encourages moderation in all actions and practices. The Qur'an praises the behavior in Surah al-Furqan verse 67:

“those who, when they spend, are not extravagant and not niggardly, but hold a just (balance) between those (extremes).” (Surah al-Furqan: 67)

Further, Rasulullah (pbuh) stated that the best of all practices lies in moderation. With regard to this environmental protection, as unreasonable excess is more likely to harm the objectives. Therefore, to minimize the waste, our consumption should be based on an overall order and balance of nature. Therefore, to minimize waste, our consumption should be guided by the overall order and balance of nature. The Quran practices an ecological theme when it exhorts mankind to moderation. This is evident from the commandments laid down in the Quran:

“It is He who produces gardens, both cultivated and wild, and palm trees and crops of diverse kinds and olives and pomegranates both similar and dissimilar. Eat of their fruits when they bear fruit and pay their dues on the day of their harvest, and do not be profligate. He does not love the profligate.”
(Surah al-An‘âm: 141).

Thus, Shariah provides both the moral norms and the legal structure where Muslim state can make concrete decisions regarding specific ecological issues. In an Islamic context, Shariah is not only essential for decision making but also provides exceptional examples for theoretical discussion of Islamic environmental beliefs (Mamat et al., 2017). Therefore, it can be accomplished that whatever theories and beliefs are applied in the perspective of environmental science, as long as they are based on the idea of stewardship (khilafah) which is the responsibility (amanah) assigned by Allah in the implementation of Shariah application, it will surely lead to sustainable environmental protection.

Furthermore, from the Islamic perspective, psychology is not only the study of behavior, as Western scholars like to propagate, but is primarily concerned with spiritual matters. According to Othman (2017), not only is the presentation of behavior important, but the spiritual dimension that triggers a particular behavior should also be studied. Therefore, we proposed an integrated persuasive behavior change framework based on *Maqasid al-Shari’ah* to promote green practices -3R (reduce, reuse, recycle) of municipal solid waste disposal in an urban community.

2.6.4 Waste Disposal in Persuasive Technology and Maqasid al-Shari’ah Perspective

Persuasion always concentrates on man, who is the highest level of creatures in the world, as Allah (s.w.t) said:

“And We have certainly honored the children of Adam and carried them on the land and sea and provided for them of the good things and preferred them over much of what We have created, with preference” (Surah al-Isra:70).

The ultimate goal of persuasion is a communicative act that seeks to influence people. The Quran has such a feature which is to influence people and develop a new attitude in their souls. Prophet Muhammad (PBUH) was sent as a communication role model to influence people and develop new attitudes and behaviors. From the perspective of Shariah, persuasion is a practice between two parties in which one party tries to influence or change the other party's perception of a certain behavior, such as praying on time, giving donations, and taking care of parents (Bawazir et al., 2018).

The principles of Shariah always emphasized the use of a persuasive method to encourage the establishment of strong relationships between people and Allah (s.w.t.) through commitment to His commands and doing good deeds to gain reward from Allah (s.w.t.). Allah said in the Quran:

“Let there be a group among you who call ‘others’ to goodness, encourage what is good and forbid what is evil—it is they who will be successful”
(Surah al-Imran verse 104).

To increase the impact created by persuaders on the minds of end users, persuaders typically use technology to create awareness and persuade behavioral change, with the ultimate goal of increasing well-being and quality of life. Despite the limitation of persuasive technology such as cultural differences, Shariah can be used to facilitate better methods to change the behavior and raise awareness of the importance of appropriate municipal solid waste disposal as a Muslim-majority country like Malaysia.

Maqasid Shariah creates a balance in the use of persuasive technology-based on Quran and Sunnah so that the user is always on the balance sheet of goodness and avoids any harm either to individuals or communities. Persuasive technology integrate with *Shariah* perspective can provide new and amusing ways of interaction to a broad audience, stimulate, and drive them to become more aware of waste disposal problems that our planet is facing. Using persuasive technology, a true Muslim can contribute to manage waste and keep their environment clean, while having the basic intention of looking forward to the reward from Allah by following correct orders. Therefore, the Muslims who believe that managing waste is an important part of worship will

certainly exhibit a truly high level of motivation and persuasion to solve the waste disposal problem. This belief will influence designers, end users, and society at a high level of morals and values associated with Islamic principles. That's why, in this study, the persuasive technology will be fitted from *Maqasid al-Shari'ah* to shape the behavior and attitudes towards environmental sustainability, and waste management.

Therefore, there is a need to design the applications from a Shariah perspective to serve as a compass for how people should behave in relation to waste management in order to protect the environment and fulfil their obligations to society and their lives. We believe that the integration of persuasive behavioral changes and *Maqasid al-Shari'ah* is important to develop a holistic framework that able to encourage sustainable behavior changes towards green practices (reduce, reuse, recycle) of waste disposal among Malaysian community. The use of persuasive technology with Islamic shariah will help end users and designers to create very effective systems and produce the best output to improve the society.

2.7 CHAPTER SUMMARY

Generally, this chapter address the literature of Municipal Solid Waste (MSW) management in Malaysia, Persuasive Technology, Persuasive System Design (PSD) framework, and the role of *Maqasid al-Shari'ah* perspective in sustainable waste management practices. It is clear that, *Maqasid al-Shari'ah* plays an important role in shaping the human behavior, therefore, developing persuasive mobile application integrating with *Maqasid al-Shari'ah* would increase persuasion in promoting environmentally friendly waste management practices and impact on the welfare of individuals and the community. The following chapter will be continued with research methodology.

CHAPTER THREE

METHODOLOGY

3.1 INTRODUCTION

In the field of research, persuasive technology heavily rooted in practice as it deals with the design, development, and use of technology. This study is a design and prototype development research that will persuade the user to adopt green practices of MSW disposal from Shariah perspective. In this chapter, researcher discussed the basic principles of research methodology and the procedures used.

3.2 RESEARCH DESIGN

This study recognized the need to explore eco-feedback technology through a process of inductive reasoning. There has been no study on eco-feedback technology from the perspective of Shariah. Therefore, we are interested in designing, developing, and evaluating eco-feedback mobile persuasive prototype for waste management from the perspective of Shariah. Therefore, this study employed a multiphase design method to develop the waste management intervention which involves sequential and concurrent aspects of qualitative and quantitative data collection and analysis throughout the study. The purpose of using the mixed methods design elements is to address a set of interconnected research questions.

According to Creswell and Plano Clark (2011), *“Multiphase designs occur when an individual researcher or team of investigators examines a problem or topic through an iteration of connected quantitative and qualitative studies that are sequentially aligned, with each new approach building on what was learned previously to address a central program objective.”* The multiphase design is most useful when the researcher wants to conduct multiple studies to achieve the research objectives. Besides, this design has been widely utilized in the program development and evaluation testing, in which multiple phases of the project expand over time (Creswell

and Plano Clark, 2011). The general procedure of a multiphase design is depicted in following Figure 3.1

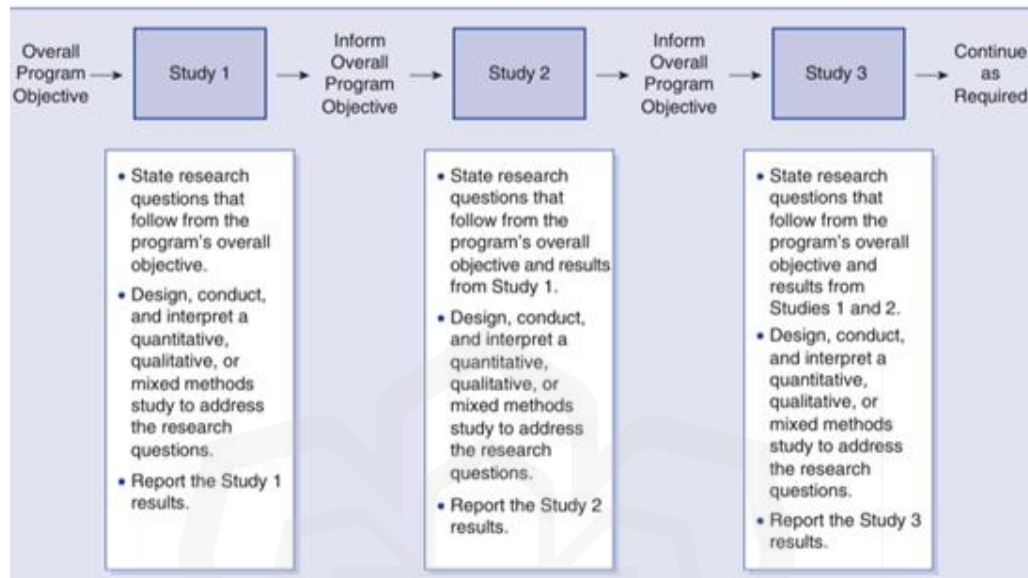


Figure 3.1: Flow chart of the basic procedures in implementing a Multiphase Design
(Adapted from Creswell and Plano Clark (2011))

Therefore, based on these descriptions of the multiphase design, we perceived that our study fits in implementing multiphase design to achieve the research objectives.

3.3 RESEARCH PHASES

To achieve the research objectives, we structured our study in five (5) phases, each using distinctive methods and techniques. We discussed each research phase and its associated methods separately (Figure 3.2). Below is a discussion on how each phase addressed the objective of the study.

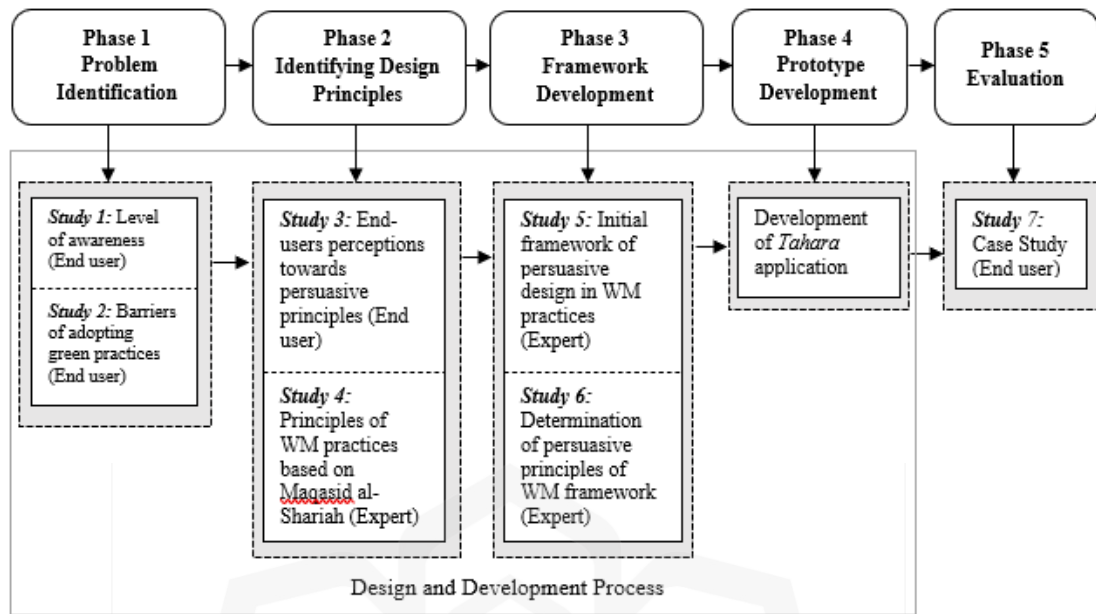


Figure 3.2: Research Phase of the Study

3.3.1 Phase I: Problem Identification

As discussed in chapter one, the aim of this research is to develop a framework that can be used to design persuasive waste management application. The framework aims to adapt users' changing needs throughout the persuasion process. Thus, the result of the research would be a purposeful artifact designed to solve the current problem. The study also aims to determine how well the framework can be applied to address the current problem. As this research involved the awareness to adopt sustainable waste disposal practices based on *Maqasid al-Shariah*, we perceived identifying level of awareness from *Maqasid perspective* is necessary. If people's environmental awareness increases, it will also improve their behavioural intentions. By increasing the awareness and responsibility of Malaysian people from the perspective of Shariah, their intention to protect the environment can be increased more efficiently. Further, in the context of persuasion, Oinas-kukkonen and Harjumaa (2009) suggested researcher to investigate the specific issue that prevent users from performing the target behaviour that the persuasive application is aiming for. Thus, as we are designing a persuasive application to encourage waste management practices among

the Malaysian community, examining what are the problems and challenges of applying green practices of MSW disposal is necessary.

Therefore, we conducted an initial survey study (Study 1) identifying the level of awareness of waste management practices from the perspective of Shariah among the households living in urban community Malaysia. Accordingly, we conducted Study 2, which involved investigation on barriers that hinder waste management practices. The outcome of Study 1 and Study 2 will assist researcher to determine persuasive principles that are potentially relevant to encourage Malaysian community to adopt green practices. Next, the following sub-sections briefly describes the objective, data collection, and the expected outcome of each study.

Study 1: Level of awareness on municipal solid waste disposal based on Maqasid al-Shariah

The objective of this Study 1 is to investigate the level of awareness on the importance of proper MSW disposal based on *Maqasid al-Shari'ah* (the objectives of Islamic law) in the urban community in the state of Klang Valley in Malaysia. The online survey method was used to collect data on respondents' solid waste disposal behaviors and practices, awareness level based on *Maqasid al-Shari'ah* and their intention towards waste disposal practices. The results showed that most of the households have moderate awareness of waste disposal to protect their faith, life, intellect, lineage, and wealth but they do not integrate their religious values into their actual behavior to adopt environmentally friendly practices, thereby justifying the needs for a persuasive application that could encourage them to behave properly in the waste disposal and protect their welfare and the environment. The completion of this study 1 marks the achievement of the first research objective (RO1), which is to investigate urban community awareness on the importance of appropriate MSW disposal based on *Maqasid al-Shariah*. The next study would involve the identification of barriers of adopting green practices among Malaysian community.

Study 2: Barrier of adopting green practices among the residents of Klang Valley, Malaysia

The objective of this Study 2 is to investigate the barriers of adopting green practices among the residents of Klang Valley, Malaysia. Data was collected using in-depth interviews with Malaysian households. The socio-ecological model was used as the guiding framework to construct the questions asked during the interview. This model was chosen to investigate the socio-ecological factors that influence sustainable SWM practices and explored barriers at the individual, community, organization, and policy level. The outcome of this study would provide baseline knowledge on the barriers influencing SWM practices behaviour, which must be considered to develop waste management interventions targeting Malaysian people. The next study would involve the identification of persuasive design principles based on PSD framework and *Maqasid al-Shariah* that are potentially relevant to manipulate these factors.

3.3.2 Phase II: Identifying Key Design Principles

The second phase focused on identification of persuasive behavioral change strategies to encourage waste management practices based on PSD model and *Maqasid al-Shariah*. The PSD model enlisted 28 persuasive design principles that were classified into four categories, which are a) primary task support, b) dialogue support, c) credibility support and d) social support (Oinas-kukkonen & Harjumaa 2009). This phase involves identifying which of these 28 persuasive design principles are effective to encourage Malaysian to practice sustainable waste management (Study 3) and investigating the principles guiding sustainable waste management practices within the framework of *Maqasid al-Shari'ah* namely *hifz al- din*, *hifz al-nafs*, *hifz al-aql*, *hifz al-nasl*, and *hifz al-mal* (Study 4). The outcome of this study will help researcher to propose a new integrated framework to design a persuasive system to encourage green practices of MSW disposal based on *Maqasid al-Shariah*. The following paragraph briefly describe each study.

Study 3: Investigate end-user perspectives on effective persuasive design principles based on the Persuasive System Design (PSD) model

The objective of this Study 3 is to identify the persuasive principles to encourage green practices of MSW Disposal using the PSD model categories of persuasive design features namely (1) primary task support, (2) dialogue support, (3) system credibility support, and (4) social support. A thematic analysis was conducted to identify effective persuasive design principles to encourage sustainable waste management in Klang Valley, Malaysia. Seven (7) participants participated in this study where data was collected using in-depth interviews. During interview sessions, participants were presented with several user interfaces (UIs) of waste management applications showing how each persuasive design principle had been applied. The input from the interview served as the main criteria for which of the strategies are most relevant and more likely to be successful at persuading them to perform waste management. After identified the principles from PSD framework, the researcher will determine the principles of waste management practices based on Maqasid al-Shariah.

Study 4: Investigate the principles guiding sustainable waste management practices within the framework of Maqasid al-Shari'ah

This study delves into the objectives of *Maqasid al-Shari'ah* to identify underlying elements crucial for sustainable waste management. A qualitative content analysis method and an inductive approach has been used to outline the constituent elements that formulate the conceptual framework for implementing *Maqasid al-Shari'ah* in sustainable waste management practices. The study reveals how the principles embedded in *Maqasid al-Shari'ah* provide a foundation for effective waste management practices. The findings emphasize the importance of integrating these principles into human behavior to ensure that waste management aligns with the Shari'ah viewpoint.

After identifying the principles of waste management from *Maqasid al-Shariah*, the framework was validated by the literature of Maqasid scholars. This validation phase was carried out through expert review. An invitation email was sent to the experts. The data was collected through structured interviews to obtain the agreement

and consensus of a group of experts on the conceptual framework's validity. This proposed framework provides an approach to harmonize *Maqasid al-Shari'ah* with sustainable waste management practices, encompassing essential dimensions of religiosity, healthcare and wellbeing, useful knowledge, family wellbeing, and wealth management in the context of *Jalb al-Masalah* (Serve interest) and *Daf'al-Mafsadah* (Protect from harm and corruption). Each dimension includes indicators and principles for responsible waste management practices, such as promoting religious duty awareness, safeguarding public health, encouraging rational resource use, considering family impact, and advocating responsible consumption.

The expected outcome of this study was integrated into a framework of persuasive system design to increase awareness about the importance of waste disposal from Shariah and to encourage the urban community to adopt environmentally friendly practices of MSW disposal. The completion of Study 3 and Study 4 mark the achievement of the second research objectives (RO2), which is to identify persuasive behaviour change strategies that could encourage behavioural change towards green practices of municipal solid waste disposal. The results of this study would produce a framework that maps each behavioral factor with corresponding relevant persuasive principles.

3.3.2 Phase III: Framework Development

Phase 3 will involve the development of an integrated persuasive design framework for waste management application based on the Persuasive System Design (PSD) model and *Maqasid al-Shariah*. To validate the proposed persuasive design framework, expert review has been used to validate the necessary persuasive components through Fuzzy Delphi technique. The fuzzy Delphi method is a technique for obtaining the consent and consensus of a group of experts in a field on a subject. The framework validation was conducted in two iteration rounds until consensus or stability is reached. Skulmonski et al. (2007), and Thangaratinam and Redman (2005) suggested that two or three iterations are sufficient for the majority of research. Figure 3.3 shows the two iterations to validate the framework. In this study, initial framework was validated in Study 5 and the revised framework was validated in Study 6.

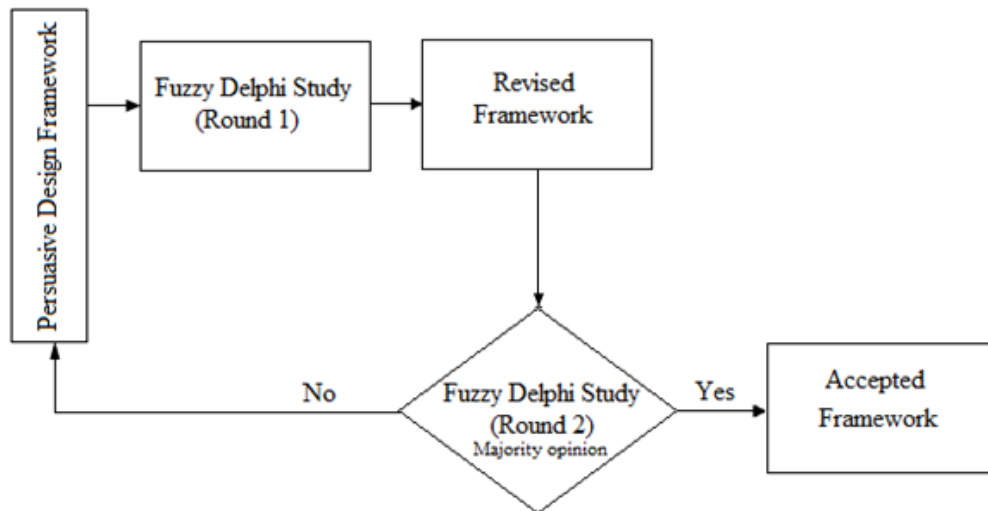


Figure 3.3: Persuasive Design Framework validation using Fuzzy Delphi technique

Study 5: Initial framework of persuasive design in WM application based on Maqasid al- Shariah

The objective of Study 5 is to validate the initial persuasive design framework of waste management practices based on *Maqasid al-Sharaiih*. The expert review has been used to validate the necessary persuasive components through Fuzzy Delphi technique. Twelve experts (Yusoff et al., 2021) were selected using purposive sampling technique who are experienced in Shariah science, *Maqasid al-Shariah*, Islamic Economics, Islamic Jurisprudence, ICT and Islam foundation, Solid Waste Management, and Human Computer Interaction (HCI). The selected experts have significant expertise and have more than 5 years of experience in their respected fields. After selection the experts, an invitation email was sent to them. They were given times to reply to the email with their specific available date and time.

The first fuzzy Delphi study was conducted between January 2023 and May 2023, this study conducted a total of twelve interviews sessions with experts through face-to-face interview, and virtual interview platforms via google meet, and using online questionnaire method to validate the framework.

This study was conducted in four phases which are 1) complete a demographic survey that asked experts about their areas of expertise and years of experience and gives them explanation about the research, 2) sign the expert reviewer consent form, 3) key concepts and definition of terms of the study were presented to the experts, 4) an expert review form was given to obtain the agreement and consensus of a group of experts in our proposed framework. In expert review form, an example of user interface design for each persuasive principle given to the experts. Each of expert panel was asked to gauge the importance of persuasive principles from 1 "very unimportant " to 5 " very important ". Besides, based on the UIs, the participants were also asked to respond to the following query: *"In your opinion, how important and relevant is this persuasive principle to persuade people towards sustainable waste management practices?"* The outcome of this phase will assist experts to validate the persuasive principles that are potentially relevant to encourage Malaysian to adopt waste management practices.

In the second round of Delphi study, our revised framework of WM practices was validated by the experts. The following paragraph briefly describes the outcome of our revised framework.

Study 6: Determination of persuasive principles of waste management framework based on Maqasid al-Shariah

The aim of this Study 6 is to validate the revised framework of waste management practices based on *Maqasid al-Shariah*. In this framework, the selected persuasive design principles were integrated with *Maqasid al-Shari'ah* to guide the design of the application to ensure that it will increase the awareness of importance of waste management practices. The researcher used *Justinmind* prototyping tool to design a medium-fidelity user interfaces that employed *Maqasid al-Shari'ah* perspective.

The second Delphi study was conducted over two months, August, and September 2023. In the second round of Delphi analysis, an invitation email was sent to the experts to our 2nd round of expert review to validate our revised persuasive design framework. Experts were given time to reply to the email with their specific available date and time. In our 2nd round analysis, seven experts were contributed to

validate the framework from the field of *Maqasid al-Shariah*, Human Computer Interaction, Solid Waste Engineering and Waste Management Corporations including KDEBWM and SWCorp. In expert review form, the selected persuasive principles integrating with *Maqasid al-Shariah*, and the example of user interface design for each persuasive principle given to the experts. The study administered 5-point Likert scale in the questionnaire from 1 "very unimportant " to 5 " very important" to obtain the agreement and consensus on each item. Besides, based on the UIs, the participants were also asked to respond to the following query: " *In your opinion, how important is this persuasive principle [x] to persuade people towards sustainable waste management practices based on Maqasid al-Shariah?* " Besides, the experts also gave impression of the design and content of the prototype. The completion of this Study 6 marks the achievement of the third research objectives (RO3) which is to propose a new integrated framework to design a persuasive system to encourage green practices of municipal solid waste disposal based on *Maqasid al-Shariah*.

The outcome of Study 6 would be considered to design the high-fidelity persuasive mobile application prototype called *Tahara* for sustainable waste management practices. The app *Tahara* would be used in the final phase of the research that involves evaluating the effectiveness of the framework at encouraging green practices of municipal solid waste disposal.

3.3.4 Phase IV: Prototype Development

The goal of this phase 4 is to develop the persuasive mobile application prototype-*Tahara* for promoting sustainable waste management behaviour based on *Maqasid al-Shariah*. In this study, an iterative design process was employed to achieve our goals. Iterative design is a cyclic process of prototyping, testing, evaluation, and refinement of new products, where users are always involved (Dix et al., 1998). This process enhances the quality and functionality of the final interface design. The *Tahara* app follows an iterative design process beginning with the validation of the components of persuasive design framework for waste management practices, the result of the review is then used to design a high-fidelity prototype using *Justinmind* (<https://www.justinmind.com/>), authoring tool for web and mobile prototypes.

3.3.5 Phase V: Evaluation

In phase 5, only one iteration was carried out including pilot study to understand the usability of the prototype design in the context of effectiveness in achieving sustainable waste management and gather feedback on usability issues and potential improvements. In the pilot study, two participants provided feedback in an evaluation session and in the last iteration, eleven participants took part in a prototype evaluation to determine the perceived effectiveness of the application at encouraging sustainable waste management practices.

Study 7 Evaluation of Persuasive Smartphone Application for Malaysian

The objective of this Study 7 is to fulfil our fourth and final research objective (RO4), which is to evaluate the effectiveness of the framework at encouraging green practices of MSW disposal through the design of persuasive application prototype- *Tahara*. To fulfil our fourth research objective (RO4), a case study approach was chosen. According to Benbasat et al. (1987), “a case study examines a phenomenon in its natural setting, employing multiple methods of data collection to gather information from one or a few entities (people, groups or organizations)”. This definition is used as a guideline in conducting our case study. To collect data relevant to the study, the study used a pre-test (demographic data and current practice of MSW disposal), a think-aloud protocol and post-test interviews to determine respondents' opinions and perspectives on the app. The completion of this Study 7 marks the achievement of the fourth and final research objectives (RO4).

The following Table 3.1 shows the summary of study design, sampling, data collection, data analysis method, and number of participants involved in each phase.

Table 3.1: Summary of Study Design, Sampling, Data Collection and Analysis Method, and Number of Participants involved in this Research

Study#	Design	Types of data collected	Sampling	Data Analysis Method	Number of participants
Study 1 Investigating awareness on MSW disposal based on <i>Maqasid al-Shariah</i>	Quantitative	Questionnaire	Simple random sampling	Descriptive and regression analysis	n=200
Study 2 Identify the barrier of adopting green practices	Qualitative	In-depth interview	Purposive	Thematic analysis	n=7
Study 3 Investigate persuasive design principles based on PSD model	Qualitative	In-depth interview	Purposive	Thematic analysis	n=7
Study 4 Investigate principles of WM practices within the framework of Maqasid al-shari'ah	Qualitative	Content analysis method, an inductive approach	Purposive	Expert review	n=5
Study 5 Validate initial framework of WM practices	Qualitative + Quantitative	Expert review	Purposive	Fuzzy Delphi method (Round 1)	n=12
Study 6 Determination of persuasive principles of WM framework	Quantitative	Expert review	Purposive	Fuzzy Delphi method (Round 2)	n=7
Study 7 Evaluation of Persuasive Smartphone Application	Qualitative	Pre-study questionnaire, think-aloud, and post-study interview	Purposive	Thematic analysis	n=11

3.4 CHAPTER SUMMARY

This chapter has provided an overview of the methods and approaches used to achieve the research objectives. The research methodology for this study incorporates a multiphase mixed-method design. To meet the objectives, this study was structured in five (5) phases. Phase 1 started with identifying the problem. First, Study 1 conducted aimed to assess the level of awareness and behavioral intention towards waste disposal among urban community. The completion of Study 1 marks the achievement of RO1. Further, Study 2 was conducted to identify the barrier and challenges of applying green

practices among Malaysian community. The completion of Study 2 assist us to move into Phase 2.

Phase 2 involves identifying persuasive behaviour change strategies. A set of design principles from PSD model namely primary task support, dialogue support, system credibility support, and social support (Oinas-kukkonen and Harjumaa, 2009) and five dimensions of Maqasid al-Sharaih such as *hifz al-din*, *hifz al-nafs*, *hifz al-aql*, *hifz al-nals*, and *hifz al-mal* was implemented to identify the persuasive principles that motivate Malaysian to adopt WM practices. This phase 2 consists of Study 3 and Study 4 to achieve research objective RO2. Study 3 was conducted to identify the persuasive principles from PSD model that potentially would encourage and motivate them towards sustainable WM practices Further, Study 4 was conducted to identity the principle of WM practices within the framework of *Maqasid al-Sharaih*. The completion of Study 3 and Study 4 marks the achievement of RO2. Based on findings in Phase 2, we proposed a new framework of WM practices.

Next, in Phase 4, the expert review approach was utilized to validate the initial framework in Study 5. The findings from Study 5 would help researcher to revise the framework. After that, we will ask expert to validate the revised framework in Study 6. The findings from Study 6 would lead to the development of final version of the persuasive application prototype called *Tahara*. The completion of Study 6 marks the achievement of third research objectives (RO3).

In the next phase 5, this application will be evaluated by Malaysian in a case study–Study 7. The outcome of this case study would inform researchers on the effectiveness of persuasive application developed based on persuasive design approach and *Maqasid al-Shariah*. The completion of Study 7 marks the achievement of the fourth and final research objectives (RO4).

All seven (7) studies conducted in this thesis (Study 1 until Study 7) involved the sequential or concurrent collection of both qualitative and quantitative data. In the following chapter, we will provide a detailed analysis of the result of each study that derived from both qualitative and quantitative analysis.

CHAPTER FOUR

DESIGN AND DEVELOPMENT

4.1 INTRODUCTION

We begin this chapter by presenting our initial study on investigating awareness on Municipal Solid Waste (MSW) disposal among the urban community in Klang Valley, Malaysia (Study 1) in section 4.2 (Problem Identification). Following this, we explore the barriers of adopting green practice (Study 2). Subsequently, sections 4.3 until 4.5 provide a detailed discussion of all four studies (Study 3 to Study 6) that contribute to the design and development of the persuasive application.

In order to identify effective persuasive design principles that could encourage behavioural change towards green practices of municipal solid waste (MSW) disposal among the urban community in Malaysia, a methodological triangulation approach was applied. Methodological triangulation involves using multiple qualitative or quantitative methods to approach the same research question. It has been found to be beneficial in generating more comprehensive data, increase validity, provide confirmation of findings, and enhance understanding of studied phenomena (Bekhet & Zauszniewski 2012). In this thesis, the identification of relevant persuasive design principles was based on triangulation of five different studies using different methods of data collections (Study 2- In-depth interview, Study 3 –In-depth interview, Study 4– Expert review (Interview), Study 5–Expert review (Questionnaire and Interview) and Study 6–Expert review (Questionnaire). Figure 4.1 illustrates the flow of research activities to design and develop persuasive WM application.

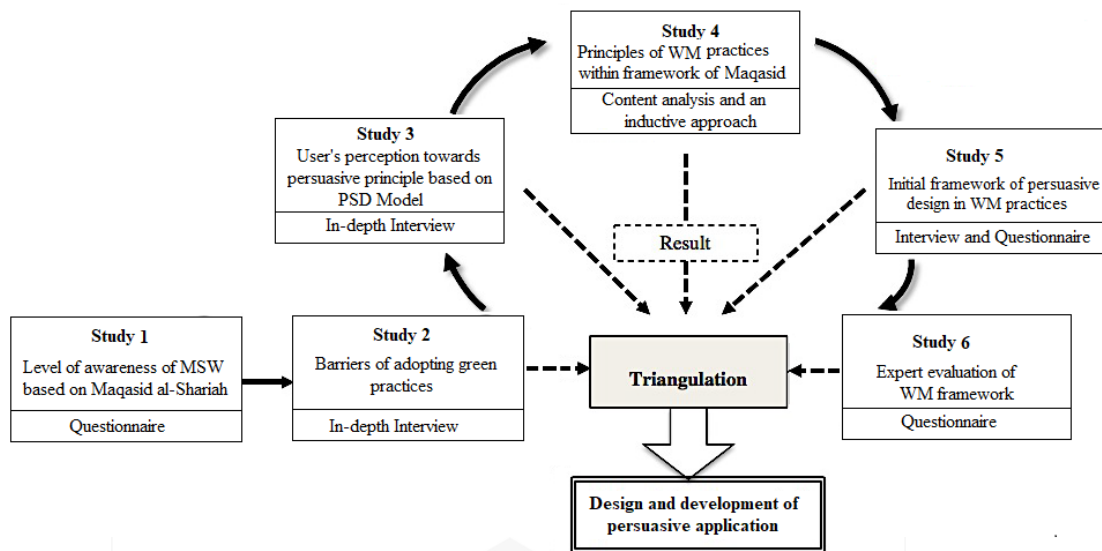


Figure 4.1: Methodological Triangulation Approach to Design and Develop Persuasive WM Application

4.2 PROBLEM IDENTIFICATION

This phase of the study focuses on problem identification. The behavioral challenges were initially identified through a review of the literature. Additionally, we conducted a field study (Study 1) to assess the level of awareness regarding waste management practices among the urban community in Malaysia, using the framework of Maqasid al-Shariah. The following section provides a detailed discussion of Study 1.

4.2.1 Study 1 Investigating Urban Community Awareness Based on Maqasid al-Shariah

As described in section 1.1 (background of the study) and section 2.1.3.2 (MSW Disposal in Malaysia), the level of awareness on appropriate waste disposal of eco-friendly practices is still very weak in Malaysian society. Therefore, it is needed to increase awareness and guide Muslims to dispose of garbage morally in order to protect the environment and achieve prosperity in this world and the next. Therefore, the objective of Study 1 to identify the level of awareness towards waste disposal based on *Maqasid al-Shariah* among the urban community in Malaysia. Further, as people's environmentally conscious behaviour, knowledge and behavioural intentions

also had been proven in the literature to be effective for solving waste disposal problem.

Behavioural intentions reflect individual likelihood and willingness to take a particular action. If people's environmental awareness increases, it will also improve their behavioural intentions. Many researchers agree that behavioural intentions are an important predictor of behaviour (Ajzen, 1991; Strydom, 2018a). Numerous studies have examined individual behaviours and intentions regarding waste separation, recycling, and waste prevention in different countries and regions, cultures, income levels, and environmental conditions. These studies mainly focused on ordinary residents or households and students (Zhang et al., 2015; Xu et al., 2017; Al Mamun et al., 2018). However, no study has specifically attempted to understand households' intentions regarding municipal waste disposal from the perspective of Shariah. By increasing the awareness and responsibility of the respondents from the perspective of Shariah, their intention to protect the environment can be increased more efficiently. Similarly, findings from McKay et al. (2014) highlighted that a better result might be achieved by raising awareness of Islamic teachings about environmental conservation rather than making efforts of raising general awareness to solve an environmental conservation issue – suggesting increased awareness from the perspective of Shariah. Accordingly, the objective of this Study 1 is to assess awareness of MW disposal from the perspective of Shariah among the households living in urban community in Klang Valley, Malaysia.

4.2.1.1 Model and Hypothesis

Based on the role of five elements of *Maqasid al-Shari'ah* in waste disposal (Section 2.6.3), the five hypotheses are developed. Figure 4.2 shows the proposed model for awareness of waste management practices based on the *Maqasid al-Shari'ah*.

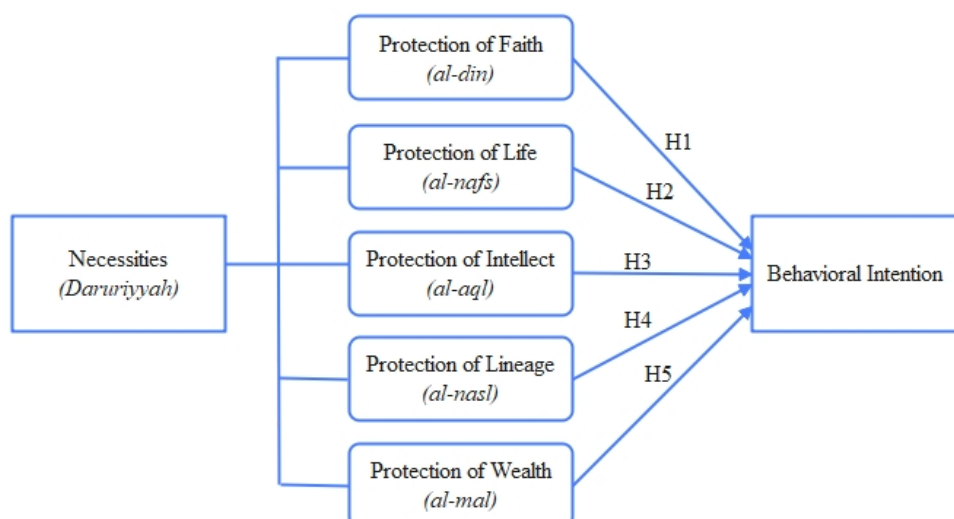


Figure 4.2: The Model for Awareness of WM practices Based on the Maqasid al-Shari‘ah

Hypothesis 1 (H1): Protection of faith has a positive effect on individuals’ intention to dispose of waste.

In this study, protection of faith demonstrates responsibility, obligation to respect, nurture and care for the environment through adopting green practices. If the residents, consider that they have a high sense of faith and obligation as a Muslim to adopt green practices of MSW to solve the environmental problem then their intention strengthens to dispose of waste properly. Therefore, we hypothesized that awareness of protecting faith has a positive relationship with the intention to dispose of waste properly.

Hypothesis 2 (H2): Protection of life has a positive effect on individuals’ intention to dispose of waste.

The people who are more safety conscious and take care of their health and wellbeing by reducing the amount of waste then they will be less likely to fall victim to solid waste-related illnesses. Therefore, we hypothesized that awareness of protecting life has a positive effect on individuals’ intention to dispose of waste properly.

Hypothesis 3 (H3): Protection of intellect has a positive effect on individuals' intention to dispose of waste.

In this study, if the residents gain adequate knowledge about the importance of environmentally friendly waste management practices, then their intention will be increased to dispose of waste at home.

Hypothesis 4 (H4): Protection of lineage has a positive effect on individuals' intention to dispose of waste.

The individuals who have an awareness of environmentally friendly practices in the disposal of municipal waste for the future generation then their willingness to dispose of waste appropriately will be expanded. Therefore, we hypothesized that individuals' awareness to protect lineage by adopting green practices of MSW has a positive effect to dispose of waste correctly.

Hypothesis 5 (H5): Protection of wealth has a positive effect on individuals' intention to dispose of waste.

Finally, we should limit our consumption in purchasing, cooking, using, and especially in the phase of disposing of waste in order to protect the environment. Therefore, we hypothesized that the awareness of wealth protection is related to the intention to correctly dispose of waste.

4.2.1.2 Study Design

In order to achieve the aim of this study, a quantitative method was used. A survey is most suitable because it allows large populations to be measured with relative ease (Jones et al., 2013). This research focusses largely on the household community living in Klang valley as household sector generate more waste compared to others, therefore, simple random sampling (a probability sampling technique) was considered most appropriate to collect information. A Google Form was used to collect the primary data.

4.2.1.3 Recruitment Procedure

The online survey was conducted over two months, July and August 2021. Due to the Covid 19 pandemic, this research opted to conduct an online survey using a Google form. The online survey method was used to collect data on respondents' behaviors and practices related to solid waste disposal from the perspective of *Maqasid al-Shariah*. The researcher employed several strategies to reach as many respondents as possible within the 1st month of data collection at Klang Valley. These include relying on the researcher's personal networks, reaching out to respondents and disseminating the survey through social media. The three main platforms used to disseminate this survey were social media such as Facebook and Instagram, WhatsApp, and email. WhatsApp and Facebook were selected as two of the most popular communication and social media platforms in Malaysia (Malaysian Communications and Multimedia Commission, 2020). A general description of the purpose of the study was provided on WhatsApp messages, email and social media before the link to the English and Malay language versions of the survey was posted. A total of 200 respondents participated in the online survey.

4.2.1.4 Instrument Development

The questionnaire was designed both in English and Malay language. Before the survey started, the briefing about the purpose of doing the study was given to the respondents. The questionnaire was divided into eight major sections (See Appendix I), which were presented in the following order:

Part A contains the demographic information of the respondents which include the gender, age, ethnicity, religion, and the level of education, occupation, types of houses, monthly earning and number of people living in household.

Part B examining the solid waste disposal practices. In this study, this part B was developed to measure behavioral practices on solid waste disposal by covering types of waste generated in household, number of garbage are generated in a week, number of bins people use to dispose waste, methods of waste disposal at home, use

different bins for different type of waste and the type of difficulties that they have experienced in order to reduce, reuse and recycle household waste.

Part C, part D, part E, part F, and part G is examining the awareness on solid waste disposal based on five dimensions of *Maqasid al-Shariah*. Each part consists of four items to measure the awareness in terms of protecting din, life, intellect, lineage and wealth in waste disposal. Each item was rated on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

Part H shows the behavioral intention towards waste disposal. The respondent was asked to rate the level of agreement towards each statement. The items also were measured based on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

4.2.1.5 Instrument Validation

In this study, the questionnaire was validated by expert review. Four (4) experts who have expertise in the field of Islamic Studies, Psychology, ICT and Islam and Waste Management were recruited to validate the questionnaire. Due to COVID-19 pandemic, the validation of the questionnaire by experts was conducted online. Before validating the questionnaire, the purpose of the research was presented to the experts, then invites them to review the questionnaire. The experts were asked to evaluate each item to assess the awareness on solid waste disposal based on the five dimensions of *Maqasid al-Shari'ah* and provided their evaluation based on the 3-point scale (Table 4.1).

Table 4.1: Scale for Questionnaire Validation

Scale	Interpretation
1	Not Relevant
2	Probably Relevant
3	Relevant

A comments or suggestion section was provided at the end of the construct validation section where the experts gave feedback of the construct by the items. The feedbacks from the experts were later analyzed and were used to further improve the questionnaire items.

4.2.1.6 Pilot Study

The pilot study of a questionnaire is a process in which a researcher evaluates and improves the instrument based on the result obtained from a small number of individuals who complete and evaluate the instrument (Creswell, 2008: 402). Thus, the reliability and validity of the instrument was determined by conducting a pilot study. The pilot study was conducted using a Google form with 50 respondents among the Malaysian community. The pilot study was taking place on August 2021. The data of pilot study were collected and analyzed to determine the reliability and validity. The primary objective of conducting the pilot study was to modify any statement of the questionnaire and to know which part is difficult for the respondents to understand. The reliability score for the questionnaire items from the pilot study are as follows in Table 4.2:

Table 4.2: Results of Pilot Study

Variables	No of Items	Reliability
Faith	4	.811
Life	4	.947
Intellect	4	.975
Lineage	4	.908
Wealth	4	.866
Behavioural Intention	3	.758

4.2.1.7 Data Screening

Before analyzing the data, it is very important to check the data and examine the file for errors. In this study, various methods were used for data screening including detecting missing values, outliers, conducting normality, and checking for multicollinearity.

4.2.1.7.1 Missing Data

Sekaran and Bougie (2016) states that missing data in any research is a serious issue as it can significantly affect the survey's results. In this study, the survey was conducted online, and there were no missing values among the 200 responses.

4.2.1.7.2 Outliers

An additional step of data screening is the assessment and treatment of outliers. According to Tabachnick and Fidell (2013), a single variable with extreme values (univariate outlier) or a combination of two or more variables (multivariate outlier) can be defined as an outlier. To represent a single variable, items were clustered so that univariate outliers could be detected. Descriptive statistics in SPSS were used to obtain standardized values (z-score) by changing the values of individual observations. In this way, fewer univariate outliers were found. To deal with the outliers, the researcher changed the values so that they were more representative of the data set. To identify multivariate outliers, the Mahalanobis D2 measure (multidimensional version of the z-score) was used (Hair et.al., 2006). To measure any distance in multidimensional space from the mean of the center of all observations, this method is of great help and provides a unique value (Hair et.al., 2006).

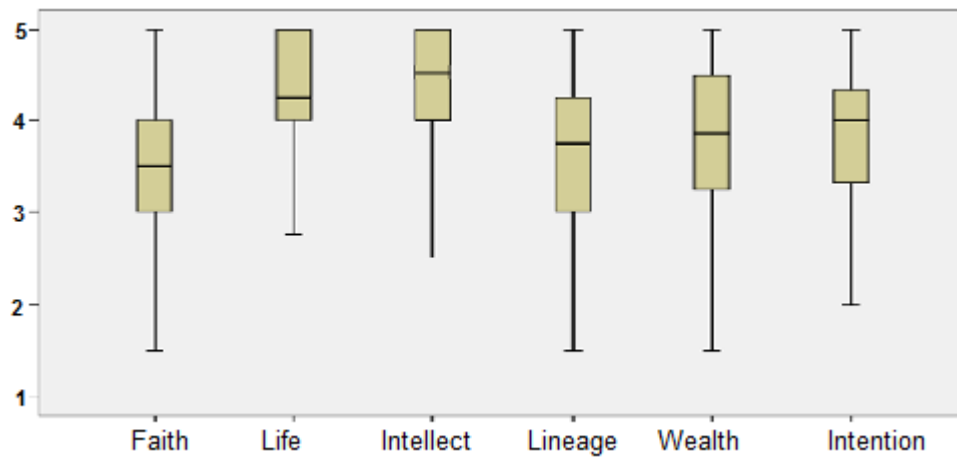


Figure 4.3: Box Plot Representation of the Multivariate Outlier

4.2.1.7.3 Normality

In multiple regression analysis, the most important assumption is normality; researchers always assume that variables are normally distributed (Abdulwahab et al., 2011). Pallant (2007) stated that normality of data can be checked by the statistical method of skewness and kurtosis. According to Sekaran (2003), values that fall within the range of -2 to +2 in the skewness test and -3 to +3 in the kurtosis test are considered normal. Therefore, the normality of the sample is appropriate. Table 4.3 shows that the data fall within a normal range of skewness and kurtosis. Thus, the results have both positive and negative values, but this does not affect the results if the values are in the normal range (Pallant, 2007).

Table 4.3: The Skewness and Kurtosis of Each Item

Construct	Item	Skewness	Kurtosis
Faith	Faith 1	-.412	.248
	Faith 2	-.654	.671
	Faith 3	-.226	.225
	Faith 4	-.073	.284

Life	Life 1	-1.544	2.959
	Life 2	-.897	.895
	Life 3	-1.327	1.774
	Life 4	-1.640	3.011
Intellect	Intellect 1	-1.343	2.191
	Intellect 2	-1.351	2.226
	Intellect 3	-1.243	2.018
	Intellect 4	-.524	-.209
Lineage	Lineage 1	-.309	-.597
	Lineage 2	-.853	.323
	Lineage 3	-.304	-.258
	Lineage 4	-1.188	1.399
Wealth	Wealth 1	-.742	.328
	Wealth 2	-1.014	1.036
	Wealth 3	-.160	-.665
	Wealth 4	-.412	.248
Intention	Intention 1	-.595	.250
	Intention 2	-.624	.220
	Intention 3	-1.096	1.780

4.2.1.8 Reliability Test

Reliability analysis refers to the fact that a scale should consistently reflect the construct it is measuring. After collecting the data from the survey and compiling it into SPSS, a reliability test is conducted. In this study, data analysis was conducted using Statistical Package for Social Sciences for Windows (SPSS, version 23). The validity and reliability of the questionnaire items were undertaken using Cronbach's alpha value to verify that all variables were acceptable and reliable with reliability coefficients (α) above 0.7.

The reliability of the questionnaire items is shown in Table 4.4. All variables met the acceptable reliability level of 0.7 for each level. The result of the reliability test for the whole instrument was found to be 0.968.

Table 4.4: Reliability of the Questionnaires for Community Residents

Variables	No of Items	Cronbach's Alpha	Accepted Level
Faith	4	.914	Excellent
Life	4	.912	Excellent
Intellect	4	.964	Excellent
Lineage	4	.889	Good
Wealth	4	.857	Good
Behavioral Intention	3	.922	Excellent

4.2.1.9 Data Analysis

The study used descriptive and regression analysis to investigate the awareness and practices of solid waste disposal among the urban community in Klang Valley, Malaysia. Descriptive statistics (frequencies) were used to describe the demographics of the respondents and solid waste disposal practices, as well as the mean scores of awareness of solid waste disposal using the five dimensions of *Maqasid al-Shari'ah* and behavioral intentions regarding waste disposal.

In order to interpret the respondents' level of awareness of solid waste disposal from the perspective of Shariah, the following scale was used in Table 4.5.

Table 4.5: Scale for level of Awareness

Scale	Interpretation
4.20 - 5.00	Extremely Aware
3.40 - 4.19	Moderately Aware
2.60 - 3.39	Somewhat Aware
1.8 - 2.59	Not Aware
1.0 - 1.79	Very Unaware

This level of respondents' awareness of solid waste disposal was adopted from Bautista (2019). In addition, a regression analysis was conducted to determine which factors (Din, Life, Intellect, Lineage, and Wealth) have the greatest influence on the respondents' behavioral intention to dispose of waste.

4.2.1.10 Results and Discussion

4.2.1.10.1 Demographic Profile of the Respondents

The results in Table 4.6 show that female respondents (68%) form majority of the participants compared to male (32%). Half of the respondents are Malays (51%) followed by Chinese (1.5%), Indian (6%) and non-Malaysian (41.5%). The religion of majority of the respondent are Islam (98%) and 1.5% was Hindus. Regarding the age of the respondents, majority of the respondents were aged between 21 to 30 years (39.5%), followed by 31 to 40 years (29.5%), 41 to 50 years (13%) and 61 years and above (9.5%), below 20 years (5%) and between 51 and 60 years (3.5%). In terms of education, most of the respondents had bachelor's degree (36.5%) and master's degree (34%), while only 4.5% had SPM.

In terms of occupation, most of the respondents were students (27.5%) and housewives (18.5%). As for the type of house, the largest group of the respondents was living in an apartment 37.5% while the remaining respondents were living in residential terrace (32%), bungalow (12.5%), and condominium (20%) and kampung house (2%). Next, the monthly income of the respondents is considered and most of

the respondents belong to the low-income households. This means that 47.5% of the respondents have a monthly income of below RM 2,500 to RM 4,859, which is the category of ‘B40’ households in Malaysia. With regard to the size of household, 51% reported to live a small family member of 1 to 4 people, while 6.5% reported to have a large family of more than 8 people in a household.

Table 4.6: Demographic Profile of the Respondents

Demographic attribute	N= 200	Percentage
Gender		
Male	64	32.0
Female	136	68.0
Age		
below 20 years	10	5
21-30 years	79	39.5
31-40 years	59	29.5
41-50 years	26	13.0
51-60 years	7	3.5
61 and above years	19	9.5
Ethnicity		
Malay	102	51.0
Chinese	3	1.5
Indian	12	6.0
Non-Malaysian	83	41.5
Religion		
Islam	196	98
Hindu	3	1.5
Buddhist	1	0.5
Christian	0	0.0
Atheist	0	0.0
Level of education		
Primary school	0	0.0

SPM	9	4.5
STPM / A-Level	0	0.0
Diploma	20	10.0
Bachelor's degree	73	36.5
Master's degree	68	34.0
PhD	30	15.0
No formal education	0	0.0
Other		
Occupation		
Government sector	26	13.0
Private sector	33	16.5
Self-employed	30	15.0
Online Drop ship	3	1.5
Full time housewife	37	18.5
Student	55	27.5
Unemployed	5	2.5
Retired	10	5.0
Other		
Horticulturalist	1	.5
Types of houses		
Bungalow	25	12.5
Single-storey Terrace	39	19.5
Double-storey Terrace	25	12.5
Apartment	67	33.5
Condominium	40	20.0
Other		
Kampung House	4	2
Monthly earning (RM)		
less than 2,500	48	24.0
2,500-3,169	28	14.0
3,170-3,969	10	5.0
3,970- 4,849	9	4.5
4,850- 5,879	14	7.0

5,880- 7,099	20	10.0
7,110- 8,699	5	2.5
8,700-10,959	8	4.0
10,960-15,093	5	2.5
15,093 or more	2	1.0
Prefer not to tell	51	25.5
People living in your household		
Small family (1-4 persons)	102	51.0
Medium family (5-7 persons)	85	42.5
Large family (more than 8 persons)	13	6.5

4.2.1.10.2 Solid Waste Disposal Practices

The Table 4.7 below presented the results on the current practices applied by respondents to dispose solid waste. Similar to other urban areas in many other developing countries, the urban area (Klang Valley) investigated in this study also generated a high proportion of food waste. Majority of the respondents (87%) reported generating food waste. The other types of waste reported were plastics (86.5%), paper (74.5%), old clothes (40%), glass (34.5%), electronic waste 27.5% and metal (20%). Majority of the households (37.5%) used 2 bins in their household while 3% did not use any bin for waste disposal. Most households (61%) generated more than 4 bags of garbage per week, and more than half of the respondents (64.5%) reported that they did not separate their garbage into different types of waste before disposal. The study also revealed that (59.5%) of the households disposed their garbage using pick-up truck while 52.5% used the community bins. Meanwhile, only a minority of the respondents reported to use recycling method (14.5%), composting (4.5%), incineration (11%) while the remaining 3.5% disposed their garbage in open places.

In terms of the difficulties or challenges that the respondents experienced in order to reduce, reuse and recycle household waste, the result shows that, half of the respondents (50.5%) reported they did not have enough space at home to store reusable and recyclable waste (50.5%), lack of time to sort waste and send it to the recycling

center (43.5%), and inconvenient recycling facilities or recycling bins near the residential area (38%) were the three main reasons why people did not adopt environmentally friendly waste disposal practices at home. Besides, lack of knowledge about reducing waste (32%), reusing waste (25.5%) and recycling waste (28%) was also important reasons why people did not reduce, reuse and recycle waste in their daily life. This result is consistent with the findings of previous studies where lack of time, no space, lack of knowledge and inconvenient recycling facilities were cited as barriers to reducing, reusing, and recycling waste in household (Strydom, 2018).

Table 4.7: Solid Waste Disposal Practices

Variables	N= 200	Percentage
Types of waste generated in your household		
Food	175	87
Plastics	173	86.5
Glass	69	34.5
Metal	41	20.5
Paper/ Cardboard	149	74.5
Clothing materials	80	40
Electronic waste (e.g., batteries, old phone)	56	27.5
Others		
How many garbage generated by the household per week?		
1 bag	28	14.0
2 bags	24	12.0
3 bags	26	13.0
4 bags or more	122	61.0
How many bins do you use to dispose waste at home?		
1	69	34.5
2	75	37.5
3	20	10.0
More than 3	30	15.0
Do not use	6	3.0
Do you use different bins for different type of waste?		
Yes, I separate different type of waste.	71	35.5

No, I did not separate waste.	129	64.5
How did you dispose your household waste? (Can choose more than one)		
Garbage trucks pick up waste at home	119	59.5
Using community bins	105	52.5
Recycling	29	14.5
Composting	9	4.5
Burning	22	11
Thrown at open places	7	3.5
Other		
Which of the following difficulties that you have experienced in order to reduce, reuse and recycle your household waste? "(can choose more than one)		
I don't know how to reduce my household waste	64	32
I don't know how I can reuse my waste for other purpose.	51	25.5
I don't know how to recycle my household waste.	56	28.0
I am not interested to reduce, reuse and recycle waste.	21	10.5
I did not have time to sort my waste and sent it to recycle center.	87	43.5
I don't have enough space at home to keep reusable and recyclable waste.	101	50.5
Recycling requires too much effort.	60	30.0
Recycling center is too far. There are not much recycling facilities or recycle bin around my housing area.	76	38.0
Others (please state):		

4.2.1.10.3 Respondents' Awareness on Solid Waste Disposal Based on Maqasid al-Shariah

The Table 4.8 illustrates that the highest weighted mean value of 4.23 fell on the variable of “awareness of solid waste disposal based on protection of life/body (al-nafs)” interpreted as “Extremely Aware”. This implies that most of the respondents are fully aware on solid waste disposal from the perspective of Shariah to protect their life. The respondents believed that littering in public spaces has harmful effects on our health and the environment. Therefore, they take care of their health by reducing the

amount of waste so that they can be less victims of waste diseases and thus, adopt safe practices in households to maintain personal hygiene and the cleanliness.

The study also shows that the lowest weighted mean score of 3.51 fell on variable “awareness on solid waste disposal based on protection of faith/belief (al-din)”, interpreted as "Moderately Aware". This implies that the respondents have moderate awareness of waste disposal from the perspective of Shariah to protect their faith. Respondents felt that Islam strongly emphasizes the protection of the environment and that they have a responsibility to understand Islamic teachings as they are religiously obligated to separate, reduce, reuse, and recycle waste properly to protect the environment.

In general, respondents are "moderately aware" of solid waste disposal based on the *Maqasid al-Shariah*, as indicated by the overall weighted mean of 3.89. This could indicate that the household community already has a good awareness of waste disposal from a Shariah perspective to protect their environment and wellbeing, which enables them to adopt environmentally friendly practices, but they do not integrate their religious values into their actual household waste disposal behavior.

Table 4.8: Level of Awareness of the Respondents on Solid Waste Disposal based on *Maqasid al-Shariah*

No	Items	GWA	Interpretation
<i>Awareness on solid waste disposal based on protection of faith/belief (al-din)</i>			
1.	Because of my faith, I separate my waste to protect the environment.	3.53	Moderately Aware
2.	Because of my faith, I reduce my waste to protect the environment.	3.61	Moderately Aware
3.	Because of my faith, I reuse my waste to protect the environment.	3.49	Moderately Aware
4.	Because of my faith, I recycle my waste to protect the environment.	3.43	Moderately Aware
Weighted Mean		3.51	Moderately Aware
<i>Awareness on solid waste disposal based on protection of life/body (al-nafs)</i>			
5.	I keep the bins clean and tidy at all times to preserve my personal hygiene and cleanliness.	4.28	Extremely Aware

6.	I reduce amount of waste produced, knowing that large amount of waste would cause harmful effect on our health.	4.03	Moderately Aware
7.	I dispose my waste properly to preserve my house cleanliness as well as to maintain the cleanliness of the environment.	4.24	Extremely Aware
8.	I did not throw my household waste in public area (such as river and drain) as it would lead to environmental pollution and cause harmful effect to our health.	4.40	Extremely Aware
Weighted Mean		4.23	Extremely Aware

Awareness on solid waste disposal based on protection of intellect/reasoning (al-aql)

1.	I know it is important to learn and understand about green practices (reuse, reduce, recycle waste)	4.30	Extremely Aware
2.	I should know about how to separate my household waste (e.g., food waste, plastics, aluminum, glasses, papers waste).	4.20	Extremely Aware
3.	I should learn more about how to integrate good reuse and recycling practices into my daily life.	4.19	Moderately Aware
4.	I should learn more about how I can reuse different waste items to serve other purpose (e.g., reuse patches of old clothes to make a blanket, reuse box for storage).	4.16	Moderately Aware
Weighted Mean		4.21	Extremely Aware

Awareness on solid waste disposal based on protection of lineage/prosperity (al-nasab)

1.	I purchase environmentally friendly product for my daily needs because I think about the future generation	3.75	Moderately Aware
2.	I avoid buying disposable items (e.g., plastic bags, plastic cutlery and certain kind of plastic wrapping materials) to secure the environment for future generation	3.55	Moderately Aware
3.	I rather reuse the materials that I already have than buying a new one (e.g., reusing plastic bags, glass, bottles, rubber, plastic bands, carton box etc.) because I want to reduce waste and secure the environment for future generation.	3.91	Moderately Aware
4.	I redesign old materials into a new product (e.g., redesigning patches of cloth into blanket) to reduce waste and secure environment for future generation.	3.51	Moderately Aware
Weighted Mean		3.68	Moderately Aware

Awareness on solid waste disposal based on protection of wealth (al-maal)

1.	I purchase only what is necessary so that I can save money and not generating a lot of waste at home.	4.11	Moderately Aware
2.	I always reuse materials, so that I can save money and avoid unnecessary purchases.	3.87	Moderately Aware
3.	I only cook adequate amount of food daily to save money and avoid generating a lot of food waste.	4.04	Moderately Aware

4. I enjoy collecting recyclable materials (such as paper, glass, plastics), send it to recycle center and get some cash reward. 3.17 Somewhat Aware

Weighted Mean	3.79	Moderately Aware
The Overall Weighted Mean Score	3.89	Moderately Aware

Legend: 4.20-5.00 (Extremely Aware); 3.40-4.19 (Moderately Aware); 2.60-3.39 (Somewhat Aware); 1.8-2.59 (Not Aware); 1.0-1.79 (Very Unaware)

4.2.1.10.4 Respondents' Behavioral Intention Towards Waste Disposal

Table 4.9 shows the respondent's behavioral intention towards waste disposal. The weighted mean of the respondents' behavioral intention regarding waste disposal was higher at 3.83. Around 67% of the households had high intention to dispose food waste, recyclable waste and hazardous waste in separate appropriate waste containers.

Table 4.9: Respondents' Behavioral Intention towards Waste Disposal

No.	Intention	GWA	Interpretation
1.	I intend to isolate food waste separately when discarding.	3.69	High
2.	I intend to dispose waste into appropriate bins and separate waste for recycling.	3.81	High
3.	I intend to isolate dangerous waste separately when discarding.	4.00	High
Weighted Mean		3.83	High

Legend: 4.20-5.00 (very high); 3.40-4.19 (High); 2.60-3.39 (medium); 1.8-2.59 (low); 1.0-1.79 (Very low)

4.2.1.10.5 Factors associated with intention to adopt green practices based on Maqasid al-Shari'ah dimension

The Pearson correlation of the behavioral intention to adopt green practices demonstrated that all the variables were associated with intention (Table 4.10). All the variables showed a positive relationship towards intention with wealth having the

strongest correlation ($r = 0.572$), followed by life ($r = 0.518$), lineage ($r = 0.495$), intellect ($r = 0.518$) and faith ($r = 0.459$) which were significant at the 0.01 levels.

Table 4.10: Pearson's Bivariate Correlations between Latent Factors

	Intention	Faith	Life	Intellect	Lineage	Wealth
Intention	1					
Faith	.459**	1				
Life	.518**	.524**	1			
Intellect	.471**	.514**	.733**	1		
Lineage	.495**	.564**	.558**	.531**	1	
Wealth	.572**	.499**	.590**	.545**	.696**	1

** . Correlation is significant at the 0.01 level (2-tailed).

Multiple regression analysis was conducted to investigate the factors that have the greatest influence on respondents' behavioral intention to adopt environmentally friendly practices at source. This is determined by the beta value (β) in the coefficient table which measures how much the independent variable influences the dependent variable. Table 4.11 shows that the awareness of the respondents on faith, life and wealth was statistically significant.

Table 4.11: Regression Analysis Results

Independent Variable	Beta	T	p-value	Remarks
Faith	.137	1.900	.05	Significant
Life	.174	1.965	.05	Significant
Intellect	.076	.884	.37	Not Significant
Lineage	.073	.824	.41	Not Significant
Wealth	.301	3.477	.00	Significant

Dependent Variable: Intention

$R^2=.397$

Significant level at $p \leq 0.05$

The result of this finding shows level of awareness of protecting faith is positively associated with their behavioral intention to dispose waste ($\beta = 0.137$, $t=1.900$, $p= .05$) and it is significant. Thus, hypothesis H1 is accepted. This means that if residents have a high level of faith in reducing, reusing, recycling and segregating municipal waste to protect the environment, then their intention to dispose of waste properly at source will be strengthened. A previous study has shown that the fundamental beliefs of people in a community, especially their religious beliefs, have a major impact on their willingness and ability to adapt to protect the environment (Schuman et al., 2018). A similar study conducted in Pacific Island countries, Nunn et al. (2016) found that high levels of spiritual connectedness to nature based on religious beliefs reduced exposure to environmental hazards and enabled effective and sustainable adaptation to care the environment. Furthermore, Nunn et al. (2016) contend that when environmental protection and stewardship occur through religious contexts rather than secular contexts, reception will be more successful.

As shown in the table, there is a significant and positive relationship between conservation awareness of life and waste disposal behavioral intention ($\beta = 0.174$, $t=1.900$, $p= .05$). Thus, hypothesis H2 is accepted. This means that if the respondents have a good awareness of waste disposal from the perspective of Shariah to protect their lives, there is a possibility that they can better practice proper waste disposal to maintain the cleanliness of the environment and human health. Previous research studies have found that respondents involve in waste management because they value cleanliness and want to curb the occurrence of possible diseases (Desa et al., 2011).

Hypothesis 5 was also confirmed ($\beta = .301$, $t=3.477$, $p= 0.001$). This means that if households are mindful about adopting environmentally friendly practices to protect their wealth, there is a possibility that they will be able to dispose of their waste properly. Therefore, individuals who care about the environment are more likely to

buy necessary products, reuse materials, cook adequate amount of food and like to collect recyclable materials to save money and avoid waste.

In contrast, the coefficient of protection of intellect and lineage shows insignificant and positive associated with intention where the p-value is greater than 0.05 (0.378 and 0.411). Therefore, this relationship cannot be concluded due to the insignificant p-value. This means that level of awareness of protection intellect and lineage on adopting green practices among the household community does not affect their intention to dispose waste. This also would mean that the household communities were not able to practice proper waste disposal to protect their intellect and lineage. This result is consistent with a previous study that the Malaysian households have poor knowledge on material types and handling disposal method (Akil and Ho, 2014). Similar results were found at Mindanao State College in the Philippines where the level of solid waste management awareness of students did not influence waste disposal practices, but awareness did influence waste separation, reduction, reuse, and recycling practices (Paghasian, 2017).

Among all the variables, respondent's level of knowledge of protecting wealth is the best predictor and proving the strong relationship of having an effort towards their intention to perform green practices at home. This suggests that faith, life and wealth constructs are important factors of the intention to separately dispose waste materials. However, these independent variables explained 39.7% of the variance in behavioral intention to practice the 3Rs.

Overall, this analysis supports and accepts only three hypotheses. The summary of the hypothesis of this study is shown in table 4.12.

Table 4.12: Summary of Hypothesis Results

	Hypothesis	Remarks
H1	Protection of faith has a positive effect on individuals' intention to dispose of waste.	Supported

	Hypothesis	Remarks
H2	Protection of life has a positive effect on individuals' intention to dispose of waste.	Supported
H3	Protection of intellect has a positive effect on individuals' intention to dispose of waste.	Rejected
H4	Protection of lineage has a positive effect on individuals' intention to dispose of waste.	Rejected
H5	Protection of intellect has a positive effect on individuals' intention to dispose of waste.	Supported

4.2.1.11 Summary of Study 1

The findings of this study attempt to determine the level of awareness on the importance of proper disposal of municipal solid waste based on *Maqasid al-Shari'ah* in the urban community in the state of Klang Valley in Malaysia. The results show that most of the households have moderate awareness of waste disposal to protect their faith, life, intellect, lineage, and wealth but they do not integrate their religious values into their actual behavior to adopt environmentally friendly practices. The results of the regression analysis revealed that the respondents' awareness of faith, life, and wealth influenced their intention to dispose of waste correctly but did not influence their intention to dispose of waste in relation to their intellect and lineage. However, the result of this study has provided new knowledge and a new perspective for further studies to educate people to behave morally in waste management. With this knowledge, it will help Muslims to behave properly in the waste disposal and protect their welfare and the environment. The next Study 2 will identify the barrier of adopting green practices among Malaysian Community.

4.2.2 Study 2 Identify the Barrier of Adopting Green Practices

To design a persuasive application, Oinas-kukkonen and Harjumaa (2009) emphasized the importance of identifying specific issue that hinder users from engaging in the target behaviour. Thus, as we are designing a persuasive application

that encourage Malaysian to adopt sustainable waste management (WM) practices, it is crucial to examine the barriers and challenges influencing their WM behavior. To address this, we conducted Study 2, which explores the obstacles preventing the community from adopting green practices.

The objective of study 2 is to examine the problems and challenges that preventing the community from adopting green practices among the residents of Klang Valley, Malaysia. The socio-ecological model (SEM) had been utilized to identify the factors at waste management practices at multiple ecological levels mainly microsystem (intrapersonal and interpersonal), meso and exo-system (community and institutional), and macrosystem (policy level) (Bronfenbrenner, 1979). The microsystem includes factors at the individual-level; the mesosystem includes connections between two or more system in which the individual is embedded; and the macrosystem includes larger cultural context or social context – for example, religious beliefs and policies.

Furthermore, despite the widely known of socio-ecological model in identifying behaviour factors, there is a lack of research on investigating the poor waste management behaviour factors of Malaysian households using this approach. Thus, the purpose of this study is to gain further insights on barriers of WM behaviour among Malaysian households by utilizing a social-ecological model in combination with a qualitative approach. Table 4.13 provides a further explanation of the socio-ecological system.

Table 4.13: Overview of Socio-ecological Factors

Socio-ecological Level	Description
Microsystems	Comprises of the individual and the interactions and relationships with the immediate surroundings, such as family and friends.
Mesosystem	Extends beyond the individual's immediate networks to encompass interactions at work, schools, church, neighborhood, etc.
Exosystem	Comprises of organizations (e.g., community groups, community-based organizations, faith-based organizations,

	non-governmental organizations, and environmental organizations) that influence an individual's behavior.
Macrosystem	Contains social, cultural, political/legal, and economic forces that influence individuals, groups, and organizations within the socioecological system.

Source: Collected from Sewak et al., 2021

4.2.2.1 Study Design

An in-depth semi-structured interview method was chosen to explore the problems and challenges of applying green practices of MSW Disposal. The method is one of the most common approach in qualitative research that used to conduct detailed interviews with a small number of participants. The purpose of in-depth interview is to obtain detailed information that clarifies an individual's perspective, experiences, and perceptions of a particular topic or issue (Rutledge and Hogg, 2020). The interview session was designed to engage Malaysian residents in a friendly and one-to-one discussion to stimulate ease and comfort between participant and researcher, so that in-depth investigation on their perspective, experiences and experiences, and perceptions could be easily conducted.

4.2.2.2 Participants Recruitment

Using a purposive sampling method, a total of seven (7) participants (6 females and 1 male) with ages ranging from 31 to 47 years participated in the study. In order to reduce prejudice, we specifically selected interviewees who had different viewpoints on the focal phenomenon. The following are the inclusion criteria for the study's chosen participants: 1) have at least 1 year of experience with smartphone usage, 2) have the intention to adopt green practices of MSW disposal using smartphone applications, 3) have lived in an urban area at least one (1) year. Five participants were recruited from previous study that investigated urban community awareness on MSW disposal based on *Maqasid al-Shari'ah* perspectives (Study1). They were re-invited to participate in this study via email. The remaining two participants was personally invited by the researcher due to their interest in waste management practices using

smart phone application. All the participants in this study gave their consent, including those from the previous studies who were asked for their consent again.

Between June 2022 and July 2022, the researcher conducted seven structured interviews with residents through in-person and virtual interview platforms via google meet and Microsoft Teams that covered the discussion about the effective persuasive principles to be considered in designing waste management interventions for sustainable behaviour change and sustainable waste management in Klang Valley.

In qualitative research, the specific number of participants cannot be determined before the study is conducted. At the point when data reaches at a point of saturation, for instance when new themes stop arising, the researcher can presume that there is no requirement for additional interviews (Marshall, 1996; Wilson et al., 1991). In this study, total 7 interviews were conducted, and it was observed that data reached an acceptable saturation point and the researcher decided that all the questions were responded to satisfactorily. During interview, the researcher noticed that little new data was being obtained by the four interviews. Nonetheless, additional three interviews were led to ensure that saturation point had indeed been reached. The last interview affirmed the data acquired in interviews and in this way shown that the data gathered had reached a point of saturation. At this stage, the researcher chose to close the interviewing process and proceed to analysis.

4.2.2.3 Instrument Development

A set of interview question was constructed based on the socio-ecological model to obtain information on the influence of personal, community, organizational, and policy level factors towards their WM behavior behaviour. In this study, the questions were designed in a semi-structured form along with several guiding questions to make the conversation between the participant and the interviewer more flexible and natural. The questions were first tested in a pilot interview with three (3) residents of Klang Valley to estimate the total time needed to answer all questions and to determine if the questions were asked in an appropriate order and could elicit the desired information.

4.2.2.4 Data Collection Procedures

In this study, the participants were requested first to complete their demographic information such as age, gender, nationality, race, religion, number of years they have lived in the Klang Valley, the area in which they currently reside, and their experience using a smartphone application. (See Appendix II, Part A). After that, participants were asked about the problems and challenges of applying green practices of MSW Disposal in Klang Valley (See Appendix II, Part B). Based on the several level of socio-ecological factor, a series of interview questions were developed to explore the issues and challenges of adopting environmentally friendly practices.

Participants' feedback and facial expressions were audibly and visually captured during each session, which lasted about an hour. At the end of each interview session, each participant received a token of appreciation for their cooperation. These open-ended questions give participants more scope to share their ideas, knowledge, and experiences related to each question. The questioning of each participant lasted approximately one hour, and participants' interactions and expressions were audio- and video-recorded for further analysis. At the end of each session, each participant was thanked for their cooperation and presented with a gift.

4.2.2.5 Data Coding and Analysis

The audio-recorded data were later transcribed and based on the thematic analysis approach by Braun and Clarke (2006), were further coded and categorized into barriers of adopting green practices according to socio-ecological level. The transcribed data were then analysed using NVivo (March 2020 version), a qualitative analysis software package. Next, to analyse the qualitative data generated by open-ended questions, we used a thematic analysis approach. The steps of thematic analysis are:

- a. Transcribing the data, reading, rereading, and noting initial ideas
- b. Highlighting interesting features of the data and assigning them to codes.
- c. Collecting relevant codes for each potential theme.

- d. Creating a thematic "map" of the analysis
- e. Refining each theme and naming each theme
- f. Finalizing the analysis and writing the report.

In order to evaluate the inter-coder reliability using this software, we execute 'Coding Comparison query' function to automatically calculate Cohen's Kappa coefficient value. According to a prior study by Hruschka et al. (2004), codes with a Cohen's Kappa coefficient value of more than 0.80 were considered as having acceptable inter-coder reliability value and were hence selected and finalized as barrier that influenced WM behaviour among households.

4.2.2.6 Results

4.2.2.6.1 Demographic Profile of the Respondents

Table 5.2 summarized the characteristics of all seven (7) participants in this study. Among all the participants, two (2) participants were lawyers and solicitors, two (2) were PhD students from different research areas in ICT and engineering, one (1) participant was a university lecturer, one (1) participant was self-employed, and another one (1) was an employer in a Gamuda Sdn. Bhd, is one of Malaysia's top engineering and infrastructure company.

Regarding smartphone experience, all the participants reported having used smartphones for more than six (6) years. Table 4.14 below summarizes the demographics of the participants involved in this study.

Table 4.14: The Demographics of the Participants

Participant no.	Gender	Age	Occupation	Residency	Years of living	Smartphone experiences
P1	Female	47	Lecturer	Petaling Jaya	17	>6 years
P2	Female	31	Self-employed	Kuala Lumpur	12	>6 years
P3	Male	32	Company Employee	Kuala Langat	9	>6 years

P4	Female	34	Syarie Lawyer	Gombak	14	>6 years
P5	Female	35	Syarie Lawyer	Gombak	16	>6 years
P6	Female	39	PhD Student	Petaling Jaya	1	>6 years
P7	Female	37	PhD Student	Petaling Jaya	1	>6 years

4.2.2.6.2 *Barriers of Adopting Green Practices*

Based on our thematic analysis of participants' (n=7) verbalization, we have identified the different codes classified into three broad themes at micro-level, meso-level, and macro-level (Table 4.15).

Table 4.15: Identified Barrier of Applying Green Practices of MSW Disposal based on Socio-Ecological Factors

Socio-ecological Level	Themes
Microsystem	○ Lack of awareness and knowledge ○ Lack of personal responsibility ○ Lack of motivation ○ Negative Attitude - Garbage is still garbage - People do not want to try new things - Lazy to adopt green practices - Time constraints to separate waste
Mesosystem	○ Lack of community participation in waste separation and recycling activities ○ Insufficient and inaccessibility of information regarding 3Rs ○ Not enough facilities - Unavailability of waste separation facility - No separate bins - Recycle center is very far from residency ○ The infrequency of waste collection
Macrosystem	○ Lack of enforcement ○ Lack of financial initiatives (reward and penalty)

i. Personal Level Factors

At the personal level, four barriers were identified by interview participants as expressing the challenges of adopting environmentally friendly practices at home, including lack of awareness and knowledge, lack of personal responsibility, lack of motivation, and a negative attitude towards green practices of waste disposal.

1. Lack of awareness and knowledge

Lack of awareness and knowledge are the main reason for unsustainable waste management practices. In some cases, people do not know about the climate change and its effects on environment, have inadequate knowledge of waste segregation and recycling practices (Hassan, 2022; Mohd Noor et al., 2022; Ibrahim, 2023). Answers given by participants illustrated that a lack of knowledge on the mitigation of environmental pollution, lack of understanding of the benefits of adopting green practices, and lack of practicing of waste separation in their daily life is a barrier of adopting green practices at home. This ignorance increases the unsustainable practices.

“I think the barriers are regard to awareness. The awareness is very important not for themselves but for the community as a whole to take care of the garbage and handle it properly. And the awareness of how it impacts the personal level and community as a whole”. (P5, aged 35)

“Lack of awareness because not many people understand the good of adopting green practices. Only a few people learn and read more about green practices information and only this kind of people knows about the good of adopting green practices.” (P3, aged 32)

“Lack of concern of environment. Some people do not understand the minimization of pollution from the environment. Sometimes people throw the waste out of the car on road. They are not enough educated.” (P2, aged 31)

“They just gave the yellow bin in front of my gate, but we don’t know what should be in the bin.” (P1, aged 47)

“Sometimes I am confused about the waste should I reduce or recycle or throw out.” (P8, aged 32)

Besides, most of the participants indicated that they have inadequate knowledge about waste management policy. This ignorance on the MSW disposal policy creates an obstacle towards sustainable waste management practices. Participants believed that if the authority imposed a penalty, people would not like it.

“I think the barriers are regard to awareness. People do not know about the law.” (P5, aged 35)

“So far in Malaysia, I didn’t see any regulations that are applied to us. I have never seen any particular policy.” (P7, aged 37)

“Maybe awareness (Policy and laws). People are not much aware. Again, if they (local authority) implement any fees for example any kind of fines people will not like it.” (P7, aged 37)

2. Lack of Personal Responsibility

People, as individual ought to be held responsible to protect the environment. Prior research indicates that individuals who has a great sense of responsibility tend to engage in actions that protect the environment (Mendiola, 2018). In contrast, negligent behaviour has been attributed to a lack of personal responsibility, as exemplified by the comments below:

“People are so irresponsible. Sometimes people throw the waste out of the car on road. They are not enough educated.” (P2, aged 31)

“I think the people need to understand about the rubbish. they are not aware of the things about how to protect the environment.” (P2, aged 31)

3. Lack of Motivation

The participants believed that the mixing of segregated waste by municipal workers resulted in a loss of motivation among residents and negatively impacted perceptions of waste segregation efforts. They felt that only local authorities should be responsible for addressing the solid waste problem.

“If we are disposing of all waste in a different bin but if all the waste goes to one bin, then separation of waste is not meaningful. In that case, people will not separate. In our apartment, the disposal area is not different. Every waste is in one bin. so, people don’t separate in our apartment. They put everything in one bag and dispose of it. I do separate waste into different bags but after separating I put everything in one bin. Sometimes I’m also not motivated. What is the purpose of separating? I am separating but after collecting this garbage, the lorry workers (waste collector) will put everything in one bag [re-mix the separated wastes].” (P7, aged 37)

“Because I see the lorry worker (waste collector) they separate the waste, and they can have money from there. This is what motivates the workers to do it. If I don’t do it (separate the waste) somebody else will do it on the lorry. Why we don’t do it because the management (local authority) says that they have to do it.” (P1, aged 47)

- Negative Attitude

Participants mentioned that a barrier to adopting environmentally friendly practices at home is the negative attitude of people, including those in the community. Some participants stated that they do not separate garbage because garbage is still garbage, and it seems to have no value to them to separate garbage and separating garbage takes time. People do not care to practice the 3Rs and they are too lazy to manage their waste. One of the participants mentioned that *“people do not want to do the new things (waste separation)”*. Such a view is another barrier to effective waste management in Malaysia.

- **Garbage is still garbage**

Waste separation is useful when there is a demand for sorted materials. For example, waste is important for waste collectors who sell recyclable products and for farmers who can process organic waste into compost. Waste separation is the first step to waste management success. But people do not separate waste and have no importance in waste management strategy because garbage is still garbage. In this regard, one participant stated that.

“I think the mindset of the community. Because especially for myself and the community there is no importance of the waste management strategy because garbage is still garbage. Regarding awareness, people will continue doing what they have normal practices”. (P4, aged 34)

- **People do not want to try new things**

One of the participants indicated that people do not want to try new things (e.g., Separating waste) to solve the waste management problem because it is not likely to change people's behaviour.

“I think the people don't want to do the new things (adopt 3Rs), so changing the behaviour is hinder to waste disposal behaviour”. (P3, aged 32)

- **Lazy to adopt green practices**

One of the participants believed that laziness is another barrier of adopting green practices.

“In my opinion, the factor is people have more information, but they are still lazy to do green practices. They don't care about this.” (P8, aged 32)

- **Time constraints to separate waste**

Time constraints to manage waste had become a barrier to adopting green practices at home. A participant stated that:

“I don’t have enough time to separate waste. The difficulties in a house like there are kids in the family. So, all time cannot maintain in a house to put the waste separately like vegetable waste and other materials can not differentiate easily. It’s so difficult for a family.” (P2, aged 31)

ii. Community Level Factor

This theme is explained below:

1. Lack of community participation in waste separation and recycling activities

Community events foster interpersonal relationships and promote group action on environmental and social issues (Sewak et al., 2021). In our study, most of the participants highlighted that a lack of community participation in waste separation and recycling program was a major barrier to adopt environmentally friendly practices in Malaysia. They claimed that most of the community do not separate waste properly and do not participate in government-initiated waste separation programs such as education programs and campaigns. As of the participant stated that:

“I think the problem is the lack of participation in waste separation activities to adopt the green practices because of their lack of awareness, attitude and understanding of the long-term benefits of recycling.” (P8, aged 32)

ii. Organizational Level Factors

The theme of organizational barriers included the problems of insufficient and inaccessibility of information regarding 3Rs, not provided enough facilities such as unavailability of waste separation facility, no separate bins and recycle center is very far from residency, and the infrequency of waste collection facility.

1. Insufficient and inaccessibility of information regarding 3Rs

Participants explained that according to the types of waste, there were no bins labelled

for waste to help with garbage separation. In this regard, a citizen stated that:

“I saw initiatives from MBPJ. They gave the yellow box to throw their recycle product. What is lacking they do not give us how to use it. We don’t know what should be in the box.” (P1, aged 47).

“I live on the 15th floor. Each floor has one dustbin to throw all waste. Even though there are no indications for different waste bins (no information what waste goes to which bin).” (P2, aged 31).

“In my area, they (local authority) are not provided separating those (no separate waste container). They are not emphasizing the community that you need to put those specific waste in specific dustbin.” (P6, aged 39).

2. Not enough facilities

The most cited barrier against the environmentally friendly waste management practices by respondents was that they only had one garbage bin for their waste, and they were not provided with separate waste bins for their solid waste. Many of the participants believed that the waste separation bins are not available enough everywhere except certain condominiums or apartments, airport, and market. One of the participants explained that

“No recycling facilities are provided. Here we throw all waste in one dustbin. I think in public places also, there is one dustbin there is no segregation of waste. So that will be a barrier in order to adopting green practices. Only some of the places these practices are going on. For example, in the airport, and market.” (P6, aged 39).

Some participants also believed that local authorities do not operate or monitor all residential waste sites, but only provide facilities in a specific area.

“I think the proper observation (lack of monitoring by the authority). The facilities are provided by local authorities in a certain area only not all areas.

for example, certain condominiums or apartments have a certain separation of waste containers.” (P4, aged 34).

The recycling centre was also far from their residents. In this regard, one of the informants stated,

“I don’t know the recycling centers near my house and how far is from my home.” (P8, aged 32).

Thus, it is clear that there are not enough recycling bins that have not been properly established by the authorities.

3. The infrequency of waste collection

The most cited issue given by one of the interviewees was the infrequency of waste collection services that cause the odour and increase the disease.

“Disposable waste causes odour while waste is not collected on time. As usual, everywhere people throw waste. For example, the bus stop was so rushed. One bin is not enough, and every people put all the waste in one bin. Sometimes the waste comes in the sitting place. It’s so smelly and not good.” (P2, aged 31)

iii. Policy Level Factors

This theme is explained in the following five subcategories.

1. Lack of enforcement

According to the participants, the local authorities were weak in enforcing the acts of waste separation plan. That is why the people were not taking it seriously and which have resulted in the unsuccessful implementation plan:

“I think the local authority has a waste management plan, but it is not being enforced. It’s like they are not successful yet.” (P1, aged 47).

Some participants highlighted that the policy implementation on solid waste management looks feeble which does not go as its planning.

“I think the policy is in the paper but don’t use it, it doesn’t work” (P8, aged 32). “They have the proposal of what they want to do but they didn’t provide this to us. Actually, the proposal is written but it does not work.” (P1, aged 47)

2. Lack of financial initiatives (reward and penalty)

According to this theme, participants are expected to receive financial initiatives when they separate their waste. They believed that the authority should give them the initiative or a reward for their participation in separating the waste. In this regard, one of the participants (P1, aged 47) mentioned that

“The authority should provide the initiatives by encouraging us to recycle the waste and can redeem the wastes by recycling different the type of waste”.

Another participant (P6, aged 39) also supported this initiative by saying

“If we do separate waste what will be initiatives. For example, if we separate waste, we will get some points and will be added to our card, and we can redeem it”.

In addition, local governments should impose penalties for littering or improper waste disposal to improve waste separation and recycling behaviour.

“First and foremost, they need to make awareness in the public. And also, about these waste disposals and laws and policies. And if you are abiding by those laws what will punishment you will get. If the punishment is strict then it will be a good message to the public because they abide by those laws otherwise it will be a difficult task” (P6, aged 39).

4.2.2.7 Discussion

This study aimed to identify the challenges and issues hindering the adoption of sustainable green practices in Klang Valley, Malaysia. Results showed that various factors of barriers at the personal, community, organizational, and policy level of socioecological model influenced poor practices of waste management.

In this study, personal-level factors such as lack of awareness and knowledge as well as lack of personal responsibility, motivation and negative attitude were identified as main causes of poor WM behaviour among Malaysian residents. Past studies indicated that individual moral obligation and responsibility drive sustainable behaviour and influence to separate the solid waste at source (Sewak et al., 2021; Arshad et al., 2017). The Malaysian Government continues promote waste and sustainability practices among youth through education and awareness activities in Klang Valley (Suhaidi, 2023). Previous studies showed that awareness may motivate behaviour. People are more likely to adopt sustainability when they are aware of the negative effects of poor environmental behavior (Almasi et al., 2019). A lack of knowledge about SWM fosters a society of non-engagement (Mmereki et al., 2016). This finding is consistent with a previous study that highlighted that an educational program on waste segregation among Klang Valley residents is urgently needed, as the majority of respondents lacked the knowledge and awareness to practice waste segregation at home (Rafia and Muhammad, 2011; Choon, Tan and Chong, 2017). Knowledge is the factor that has a significant relationship with household solid waste disposal behavior in Malaysia. Specific knowledge about environmentally friendly practices could improve the outcome of the impact of the practices and reduce the barriers in waste management (Abu et al., 2022). Choon, Tan, and Chong (2017) claimed that people do not sort their household waste because they are too lazy to change and do not have time.

At the municipal level, lack of community participation in waste separation is a common barrier to the adoption of environmentally friendly practices. In a study, it was found that lack of attendance at community meetings is barrier to effective MSW management due to their lack of understanding, and lack of time (Yukalang, Clarke and Ross, 2017).

At the organizational level, several obstacles such as insufficient and inaccessibility of information regarding 3Rs, lack of facilities, and the infrequency of waste collection are factors that are often the reason why solid waste is not separated. According to Zeng et al., (2016), the community that does not separate their garbage at the source indicate that how crucial to have enough facilities, including dustbins, storage rooms, and containers for a community to separate their solid waste. In order to improve household waste segregation practices and recycling behavior, local authorities should improve facilities, provide strategic recycling sites, provide self-help groups and systems, provide regular waste collection schedules, and raise awareness among local people in Malaysia (Abu et al., 2022).

At the policy level, the obstacles are related to lack of enforcement and lack of financial initiatives. This present finding is similar with recent study by Razi et al., (2022) who find out that lack of enforcement, and incentives prevent people from taking part in the Source Separation Initiative (SSI) at Klang Valley, Malaysia. The past studies indicated that municipality authorities are poor in executing the SSI enforcement acts and ultimately lead to the collapse of the 3Rs program in Malaysia (Agamuthu et al., 2016; Razi et al., 2022). Further, Agamuthu et al., (2016) also indicated that sixty-eight percent of Malaysians perceived that recycling is inconvenient and the reason for low level of awareness due to a lack of government initiatives. Numerous studies revealed that incentives are key for encouraging recycling practices and ensuring ongoing support for recycling activities (Fauziah and Agamuthu, 2013). Malaysian will be more participative in 3R program if the government promotes the 3Rs program more successfully and provides incentives such as, reasonable price for recyclable items, redemption programs and rewarding approaches (Fauziah and Agamuthu, 2013).

4.2.2.8 Summary of Study 2

In summary, this Study 2 identified numerous factors influencing poor WM behaviour at each socio-ecological level. We believe that consideration of these barriers is mandatory to inform designers or researchers of the desires and requirements that should be considered when developing waste management applications to promote

sustainable behavior change for target audiences in the Klang Valley, Malaysia. In the next study, we will identify the relevant persuasive design principles that should be utilized to manipulate these factors.

4.3 IDENTIFYING KEY DESIGN PRINCIPLES

In the second phase, the study presents the identification of persuasive behaviour change strategies that could encourage behavioural change towards green practices of municipal solid waste (MSW) disposal based on PSD framework (Study 3) and identify the principles of waste management practices within the framework of *Maqasid al-Shariah* (Study 4).

4.3.1 Study 3 Identify End-User's Perspectives on the Persuasive Behavior Change Principles Based on Persuasive System Design (PSD) Model

In this study, an in-depth interview was carried out to identify end-user's perspectives on the persuasive behaviour change principles based on PSD model proposed by Oinas-kukkonen and Harjumaa (2008). After identified the barrier of adopting green practices, participants were requested to interact with each 'persuasive design element' of the waste management application that potentially would encourage and motivate them towards green practices of MSW disposal. In this study, the 'persuasive design element' referred to the user interface (UI) feature of the waste management prototype that was integrated with the persuasive design principles.

As none of the participants were experts in persuasive design principles and might not be aware of their interaction with persuasive design elements in the waste management prototype, a number of screenshots of user interfaces (UI) of waste management application that used persuasive design principles were presented to them (See Appendix III). As participants interacted with each persuasive design principle in the UIs, they were asked to respond to the following query: "*Do you think the features of persuasive principle [x] would be effective or not effective to persuade*

their behaviour towards sustainable waste disposal? ”. Besides, based on the UIs, the participants were also asked to rank the persuasive design principles based on the following scale in Table 4.16.

Table 4.16: Scale for Interpretation

Mean Score	Interpretation
4.50 – 5.00	High persuasive
3.50 – 4.49	Moderate persuasive
2.50 – 3.49	Somewhat persuasive
1.50 – 2.49	Low persuasive
1.00 – 1.49	Very low persuasive

Participants' feedback and facial expressions were audibly and visually captured during each session. The statements made by the participants during the interviews were then transcribed. Afterward, the transcribed data were coded in accordance with the PSD model using NVivo (launched in March 2020), a qualitative analysis software package released by QSR International. Next, to analyze the qualitative data by open-ended questions, we used a thematic analysis approach to identify the positive and negative perception of each PSD principle that will encourage the sustainable waste management practices.

4.3.1.1 Results and Discussion

The results of this study were presented using the PSD model categories of persuasive design features namely (1) primary task support, (2) dialogue support, (3) system credibility support, and (4) social support. For all participants, the persuasion of each persuasive principle was examined by performing a statistical test to determine if the mean score of the persuasion measure was significantly greater than 3, which was considered significantly persuasive.

The statistical tests (Figure 4.4) indicated that the “rewards” principles have the highest average score of 5. All other strategies have their ratings as follows: “surface credibility” and “simulation” (4.8 each), “self-monitoring” and “personalization” (4.6 each), “verifiability”, “expertise”, “reminder”, “tailoring” and “reduction” (4.5 each) were identified high persuasive principles. By comparing to the mean level of persuasion 14 persuasive principles such as “real-world feel” and “Normative influence” (4.4 each), “liking”, “social facilitation”, and “praise” (4.1 each), “social learning”, “third party endorsement” and “authority” (3.9 each), “competition” and “tunnelling” (3.8 each), “cooperation”, “social comparison”, “trustworthiness”, “Social role” (3.6 each) are moderate persuasive strategy. Four strategies such as “suggestion” (3.4), “rehearsal” (3.1), “similarity” (2.9), and “recognition” (2.9) are marginally persuasive in getting Malaysians to alter their waste management practices.

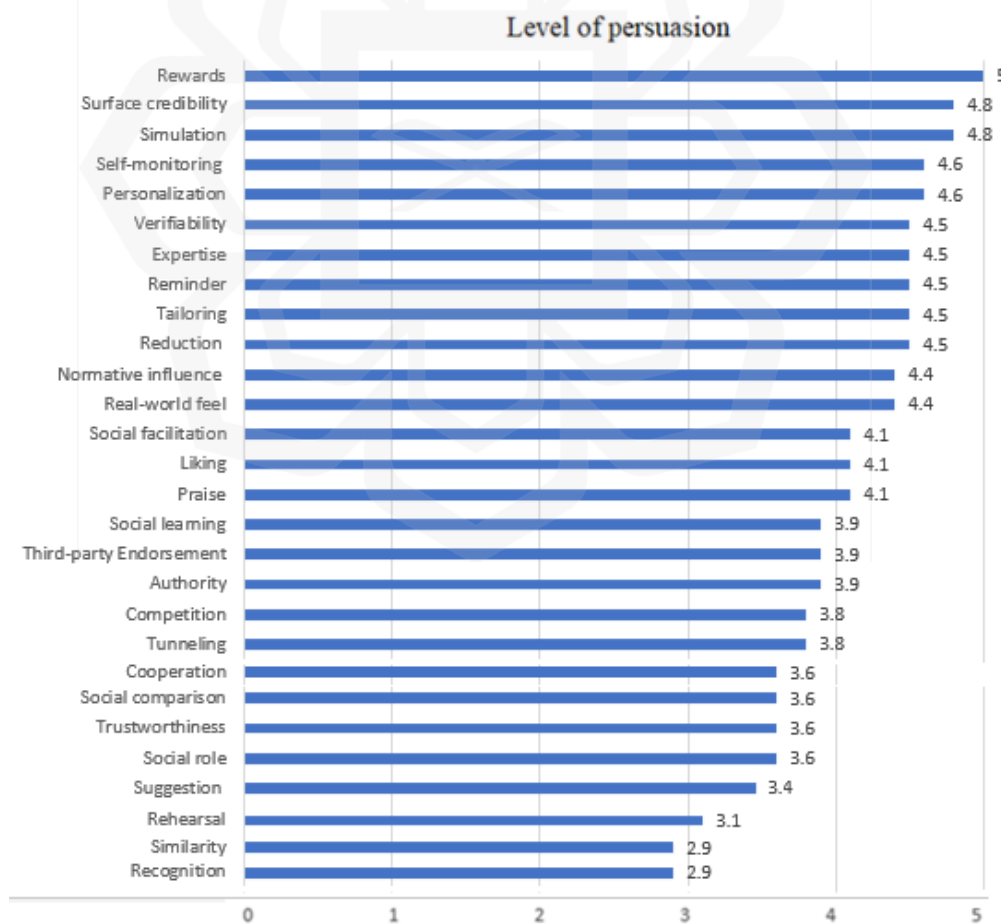


Figure 4.4: Means of Persuasiveness for each Persuasive Strategy

In addition, we asked participants to provide more elaboration on their given rating for each principle. The following Table 4.17 presents an example of one user's participant's excerpt in persuasive design principles of waste management application. Besides, based on the thematic analysis of this study, 20 positives, 3 negatives, and 5 mixed views (positive and negative) perceptions of end users towards the use of waste management applications were identified.

Table 4.17: One User's Perceptions of Persuasive Design Principles in Waste Management Application

Persuasive principles	End-user perceptions
<i>Primary task support</i>	
Reduction (+)	Positive: That will be better. Because this will help me a lot. We produce a lot of waste at my home. so sometimes I just throw in the dustbin or recycling bin. But if more people continuously produce a lot of waste at home, then will also throw the waste at the dustbin. But having this application I know what time and when the agency will come to collect. So, I will plan when I'm free at home, clean the kitchen and throw the rubbish before the date. So, by this date, everything will be clear. So, it's easier for me to plan at home. (P3, 32 years old)
Tunneling (+/-)	Mixed views: Some people may be very reluctant or some people who are very stressed they might not use it. Because people are very busy. To me, I am not sure, whether I might use it or not use it. (P7, 37 years old)
Tailoring (+)	Positive: Yes. That will be effective. So, for me at least I know where can I throw my waste instead of roaming around. and don't know where to throw instead of that I just open this app and find the nearest center to throw my waste. (P3, 32 years old)
Personalization (+)	Positive: This is a common thing. It must be in the app. If you can't personalize you won't be able to use the app. The language is very important and how I can upload my profile. This should be there. Otherwise, the app will be incomplete. (P7, 37 years old)
Self-monitoring (+)	For me it's helpful. So that at least I can understand what kind of waste I produce and so what's other impacts on the environment. That creates more awareness for me. I will be more aware in the future. (P3, 32 years old)
Simulation (+)	It's very effective. Because we do not see the immediate result (what's the impact to the environment, society, and also my life) why we don't do it? I want to see I'm contributing. It will make me feel good that I have done something good for the environment or human beings". (P7, 37 years old)
Rehearsal (-)	Negative: I like to practice physically, not into the game. (P5, 35 years old)

Dialogue support

Praise (+)	Positive: We need motivation even though in the system. (P5, 35 years old)
Rewards (+)	Positive: This will be effective and will be also interesting. With this reward, people will actually start doing all those things (adopt green practices). If you are giving a voucher, then it will be a good option. (P6, 39 years old)
Reminders (+)	Positive: This will be effective in our busy schedule. because although we are having a schedule and you showed some schedule about a particular date for waste collection. In our busy schedule, we don't remind those dates.so if we get some notification for a date then it will be good. (P6, 39 years old)
Suggestion (+/-)	Mixed views: I think suggestion strategy will not be effective because this suggestion is everywhere. Even in the shop itself the suggestion is there that we have to buy plastic bag by using our money. Still people are buying that's it. Suggestion will not work. (P7, 37 years old) "We need suggestion strategy to manage our waste properly. We need daily updates with suggestions. For example, it is not good to buy plastic bottles, so we need a daily strategy with suggestions. Today we do not need plastic bottles. So, tomorrow what we need to focus. So, what is the suggestion to replace plastic bottle." (P4, 34 years old)
Similarity (-)	Negative: Actually, I don't know how this can help me. (P3, 32 years old)
Liking (+)	Positive: If you give a liking point. And if you link it with rewards. Then it will be effective." (P6, 39 years old)
Social role (+)	Positive: Actually, for me, I don't bother who are they. As long as I have the information I will rely on that information, and I will do it on my own. This may be helpful for some people. Their role model is doing something good, so they will follow them. (P3, 32 years old)

System credibility support

Trustworthiness (+)	Positive: This is really effective for those who are doing farming. If we are doing composting, then we need to do dispose of those things. These people will be really interested. The people who are doing farming only will be interested of doing this thing. Same thing is for recycling. If it's a mandatory thing then may be all will watch it. (P6, 39 years old)
Expertise (+)	Positive: This will be effective because if people are watching and reading this expertise comments then they will be knowing that this already happening or happened here.so, the public will be aware in this situation. (P6, 39 years old)
Surface credibility (+)	Positive: This is actually the challenge. Most of the applications have advertisements and everything. Sometimes it's really annoying. So having a good visual interface helps a lot. (P3, 32 years old)
Real-world feel (+)	Positive: This will be effective so the public will get awareness or information about these services and whom we should contact. This is really effective. (P6, 39 years old)
Authority (+/-)	Positive: Contacting the authority is always troublesome. If the app makes it easy for us. This is another motivation point will get. (P7, 37 years old)

Third-party Endorsement (+/-)	Positive: Its good because most of the people will trust (the application) (P1, 47 years old)
Verifiability (+)	Verification is very important. We should have this in the app. (P4, 34 years old)
<i>Social support</i>	
Social learning (+)	Positive: At least I can see and learn from other people what they are doing so it's kind of push factor for me. they are doing better so why not me. (P3, 32 years old)
Social comparison (+/-)	Mixed views: Comparison can be benefit but comparison is not good for us. If its physically then it's good. I don't like comparison through online. (P5, 35 years old)
Normative influence (+)	Positive: At least we know we are not producing solid waste, we can recycle and make money instead of throwing away waste. For example, From the platform, I watched video, I can learn to reduce my expenditure or reduce the use of plastic bags. (P3, 32 years old)
Social facilitation (+/-)	Mixed views: Because I can observe people. and also, people can observe me. For me sometimes it's not comfortable because some of the people tent to compare and I don't like being compare. So, from point of my view this is still good but we have to better control how we can control. Because end of the day it's all come from my own behavior my own self. I decide to throw it based on the information that you have provided earlier (other persuasive strategies). Meaning to say, this application I will do my own myself so I will not reliable from others. (P3, 32 years old)
Cooperation (+)	Positive: Cooperation is good for me to arrange the appointment for garbage collection. (P5, 35 years old)
Competition (+/-)	This will be effective. Because we are competing with others and it will give the motivation. (P6, 39 years old)
Recognition (-)	Negative: I don't think people's names should be there. Sometimes it will make harassment. (P2, 31 years old)

Based on Table 5.4 above, for Primary Task Category, the ***Reduction*** principle was perceived positively by our participants because it reduces complex tasks for busy people to easily adopt appropriate waste management practices. This finding is in line with earlier studies suggested that reduction makes it suitable for people to reduce time spent in searching for a garbage collection schedule and allows them to quickly perform target behaviour (Nkwo et al., 2021; Nkwo and Rita Orji, 2018).

Meanwhile, ***Tunnelling*** principle received both positive and negative views. In this study, some participants were accepting of *tunnelling* features while others did not consider *tunnelling* to be an important aspect of persuasive applications due to their reluctance and hectic schedules. According to their comments: “Some people

may be very reluctant or some people who are very stressed might not use it. Because people are very busy. To me, I am not sure, whether I might use it or not use it.” (P7).

Another participant (P2) mentioned that people do not have the time to read the instruction, they need something which can really be seen and easily understood. However, other participants mentioned that they need the guidance and instruction so that they can make plan and learn more about how to reduce, reuse or recycle. A previous study highlighted the number of waste management applications implemented by *tunnelling* strategy in different categories and found that the *tunnelling* strategy was most used in the education category of waste management compared to cloth, plastic, food waste management and regional waste disposal, and others (Suruliraj et al., 2020).

For ***Tailoring*** principle, all participants highlighted that the principle will be effective to encourage them to do proper waste management as it help them to check their schedules and waste disposal consequently. These findings are consistent with previous study (Suruliraj, Nkwo, and Rita, 2020).

Meanwhile, for ***Personalization***, participants indicated the importance of a *personalization* strategy by selecting a preferred language, a personalized profile with personal photos, addresses, and recyclable waste pickup options in user preferences to make the system more effective. They also mentioned that they may abandon the apps if it does not support personalized access. This is in line with earlier research by Price et al. (2016) which found that an app's usability would increase if users could alter the colours and backgrounds as well as other options.

Additionally, research has demonstrated that personalized persuasive technologies outperform the one-size-fits-all design strategy in terms of inspiring people to engage in specified behaviours (Namara et al., 2018). According to a recent study by Suruliraj et al., (2020) this is also true for interventions in sustainable waste management.

Self-monitoring is another primary task support strategy that was positively perceived by our participants. They indicated that they are more motivated to tackle a

task when they can monitor their performance. As one of the participants pointed out, *"For me, it's helpful. At least this way I can understand what kind of waste I produce and what impact it has on the environment. It creates more awareness for me. I will be more aware in the future "*. (P3)

Another participant said, *"This is good. Because when I look at this, I know if I am managing my waste properly, and that has an impact on the environment"* (P5). This finding is consistent with previous research that *self-monitoring* help users visualize their contribution to the environment, which in turn promotes responsible and conscientious citizens of society and motivates sustainable behaviour (Nkwo et al., 2021).

Our study also shows that **Simulation** is another important strategy to persuade users by observing the impact of waste recycling on the environment, health, and wellness of the people. One of the participants (P7) described that *"Simulation is very effective. Because I am doing something and if I see the effect or my contribution even its small. I want to see I am contributing. It will make me feel good that I have done something good for the environment or human beings"*.

Previous research has shown that *simulation*-based instruction can have significant effects on learners' attention, memory, judgment, and problem-solving approaches, as well as their motivation to engage in learning behaviours (LeBlanc et al., 2022). Therefore, to improve waste management practices, *simulation* principles play an important role in the interaction of individuals with their environment. The **Rehearsal** principle in contrast was perceived negatively. Majority of our participants indicated that they would like to practice waste disposal in real life rather than 'rehearse' the behaviour in application.

For Dialogue Support Category, **Praise** principle was perceived positively by all participants. They indicated that they are motivated to perform better when they are praised by the system followed by the comment of one user, *"We need motivation even though we are in the system."* Further, another participant expressed that they like to see the appraisals that they made *"Praising is also good. This is actually like a record that I have done"*. This finding is similar with previous research which stated that

positive motivation or reinforcement can be attained by praising each sustainable waste management action through virtual praise (Suruliraj et al., 2021).

Meanwhile, **Rewards** principle was highlighted by our participants as a strong motivator to create awareness and reduce waste. Besides, it is undeniable that people love to be rewarded for their behaviour change as shown by the comments: *“It’s given me motivation. People all love to get rewards. It’s a true fact” (P5). “This reward creates more awareness. Then people are willing to do this. We know if we get a reward then we will reduce my expenditure and other things” (P3)*. Previous study mentioned that *rewards* are essential because they provide positive reinforcement regardless of whether it is virtual or real rewards (Nkwo et al., 2021). This principle is important for the continued performance of the target behaviour.

Reminder principle also had been perceived positively by all our participants. In this study, end users emphasized the importance of reminders in their daily lives because we are always forgetful. Another participant (P6) said *“This will be effective in our busy schedule”*. This finding is consistent with the results of the earlier study that found that generic *reminders* were sent out daily or weekly to encourage users to keep using the application (Matthews et al., 2019). *Reminders* also are typically sent to users who do not meet their goals to keep them motivated (Matthews et al., 2019). Meanwhile our participants have mixed views towards

Suggestion principle. Some end-users appreciated apps that include a *suggestion* principle, and they believe that *suggestions* should be more reliable to properly manage our waste. This is in line with a previous study that *suggestion* strategy is important for waste management to provide feedback to users to make them behave in a certain way (Nkwo et al., 2021). However, another user stated that she does not like the suggestions in the apps. Therefore, we believed that the *suggestion* strategy will not be very effective in making changes to adopt an environmentally friendly lifestyle as different users has different preferences.

For **Similarity** principle, five participants indicated that it is not “effective” while two users indicated that they did not know how the principle of similarity could help them adopt green practices in their daily lives. A previous study systematically

evaluated 148 sustainable waste management apps and interestingly found that *similarity* was not employed in any other waste management app (Nkwo et al., 2021). Similarly,

Liking principle also perceived positively among majority of our participants. One participant mentioned that awarding points or credits would be better with linking rewards. She said, *"If you give a liking point. And if you link it with rewards. Then it will be effective (P6)."* Other users also highlighted that *liking* would give them encouragement to adopt green practices. *"It gives some kind of encouragement"* (P5). Previous study also revealed that the *liking* strategy motivates users by displaying relevant information in visually attractive and descriptive formats (Nkwo et al., 2021).

Besides, for **Social Role** principle, our participants indicated that the strategy is effective and attracts them to adopt waste management practices because the information is posted by a prominent person. Generally, this strategy positively influences behavioural norms within the forum. Ironically, despite its potential, a previous study attested that the *social role* is the most underutilized strategy dialogue support strategy in waste management apps (Nkwo et al., 2021).

For system credibility support category, **Trustworthiness** principle was implemented in the app to provide truthful source and reasonable information about waste management practices. Our study found that the conveying trustworthiness in the app is an important aspect of the design because participants trust the source. This agreement is supported by Oinas-Kukkonen and Harjumaa (2009) who mentioned that a system that is trustworthy has greater persuasive power.

Besides, **Expertise** principle also was positively perceived by our participants. They indicated that experts are influential people, and they are more likely to follow an expert's advice and suggestions because it gives them awareness and knowledge. Prior research also demonstrates that applications developed by recognized sources or by professionals were regarded as having greater influence (Matthews et al., 2016).

Meanwhile, **Surface Credibility** principle was found important strategy highlighted by our participants. A 37-year-old participant said that a good interface of

the app is attractive. In addition, being able to respond to user's feedback and emails through the app, an app without add-ons is practical and useful for maintaining a competent app appearance. Another 32-year-old participant shared that the challenges are that the app allows users to ask questions or receive feedback from the apps.

Additionally, an effective persuasive application must enhance users' confidence that their confidential personal data (such as their home addresses in apps) is in trustworthy hands. Oinas-Kukkonen and Harjumaa (2009) claimed that a professional appearance and full disclosure of the owners' details make an app credible. Due to the sensitive nature of the app, Nkwo et al. (2021) assert that *surface credibility* is crucial for integrity, emotion, and pleasant feelings. Apps must look professional, be responsive, and have a visually appealing interface to be adopted because users in these areas are often wary and serious about them. Any app that lacks these qualities can be considered unreliable.

Real-world feel principle emerged as the most popular credibility strategy in the apps, providing details about the individuals or organizations behind the app's content (Nkwo and Rita, 2018). Our participants feel that application that highlight the people behind the system's content, providing information about recycling council services and waste management facilities, and relevant contact information for the organization is important for them to gain more knowledge, information, and who to contact. According to a previous study, the *real-world feel* is important for integrity, emotions, and positive feelings because it is a sensitive app. Therefore, it is important for apps to look professional, and be responsive (Nkwo, Suruliraj, and Rita 2021).

The principle of ***authority*** was also cited as a concern by our participants. Applications designed to complain about garbage collection and public cleaning to the solid waste management authority were perceived as more influential. Majority of our participants indicated that it is important to communicate with the authority when the environment is polluted by waste disposal. They indicated that: *“Contacting the authority is always troublesome. If the app makes it easy for us. This is another motivation point will get”* (P7). Another participant (P6) highlighted that *“Information about authority is also effective. Because the public should have the freedom to communicate with the authority if something is polluted in the environment.*

so, they can directly communicate with them." Previous study has shown that only a few waste management applications (n=11) have implemented the principle of *authority* in a feature that allow user to contact with the authority (Nkwo, Suruliraj, and Rita 2021).

Similarly, majority of our participants also perceived the ***third-party endorsement*** principle positively as the credibility of a system is enhanced by the application being promoted and endorsed by the ministry/government (or other known and respected source).

Verifiability principle also has positive views as our participants express their trust in the app as they able to verify the accuracy of the waste management centres through their official websites. This makes the app more credible and thus increases the likelihood that users will trust it. This agreement is supported by Oinas-Kukkonen and Harjumaa (2009) who pointed out that credibility is increased when a system makes it simple to confirm the accuracy of website content via outside sources.

For Social Support category, ***Social Learning*** principle was perceived positively as all our participants felt that it is a part of the learning process that can be learned by people in the community. The participants would be inspired to accomplish a similar objective if they could see what others have accomplished successfully. As a result, software design and employment of a *social learning* strategy will enable users to follow the progress of other users who exhibit similar behaviours (Oduor et al., 2014).

Social comparison principle provides users with the ability to compare their performance level with other users. In our study, the results show that our participants perceived *social comparison* differently. A 35-year-old participant said, *"It's also an encouragement. Comparison can be beneficial, but the comparison is not good for us. If it is physical, then it is good, but I do not like online comparison (P5)."* A 37-year-old participant said, *"It depends on the age group. At my age, I am not interested in knowing how much my friend is making (P7)."*

The *social comparison* might be upward or downward, as Orji et al., (2018) noted. When used for self-improvement, it has an upward bias because the person

using it compares themselves to others who are performing the same task. It is downward biased when people use it to boost their self-esteem by comparing themselves to those who are superior to them. Therefore, the design of software and the implementation of *social comparison* strategies should enable users to compare their performance with others.

Besides, **Normative influence** principle was perceived positively by our participants. *Normative influence* is an important persuasive strategy for participants. The *normative influence* strategy is implemented in apps through positive peer pressure to increase the likelihood that users would adopt good waste management habits. One of the participants said of this principle, *"At least we know we are not producing solid waste, we can recycle and make money instead of throwing away waste. For example, From the platform, I watched video, I can learn to reduce my expenditure or reduce the use of plastic bags."* (P3). Therefore, the developers of sustainable behaviour change interventions should allow users and groups to share activities with each other and feel that the norm increases their engagement and motivates them to adopt healthy, long-term habits.

Social facilitation principle which encourages recycling activity by indicating that other users perform the behaviour along with them received mixed views among our participants. Some participants said that sharing recycling activities can motivate others, as one of them said, *"I think it's good. This kind of interaction with something environment that I am doing like this, he is doing like this (P4)"*. In this way, the app can better motivate other users who engage in the same behaviour. While other participants mentioned that they will be less motivated because some people do not want to rely on others to adopt green practices.

Cooperation principle provides the ability to work with other people in a team to achieve a specific behavioural goal. For example, the waste management app can offer users the opportunity to donate an unused item to charity or good causes. An important aspect of the *cooperation* strategy emphasized by our participants is the encouragement, mutual support, and sense of making a collective contribution to feel like a part of bigger whole. This outcome is consistent with a prior study that found

that a *cooperation* strategy can be used to increase the persuasiveness of technology designs (Orji, 2017).

Meanwhile, **Competition** principle received mixed views among our participants. Some of the participants appreciated *competition* because it allowed them to compare their accomplishments with other users (Dennison et al., 2013). Users that got social feedback generally exhibited increased competitiveness and exercise more (Matthews et al., 2016). *“This is kind of fun. At least we can know that other people also joining us. So, we are not alone”* (P3). However, two participants are not willing to compete with others. This might discourage them from using the intervention of persuasive technology.

One of their comments is *“I don’t like leader board to compete with other members of the community. It might discourage us if we keep losing.”* Therefore, designers ought to set up a system where users can compete to better one another and be rewarded accordingly. This could supplement the traditional competitive strategy and even replace it for those who react poorly to compete against others to behave better (Orji, 2017).

Recognition principle is operationalized in the system by listing the names of top performers of sustainable waste disposal on a public scoreboard and showcasing their achievement that have successfully carried out the behaviours. In our study, this principle unfortunately was perceived negatively by our participants as they are concerned about privacy issues and harassment since *recognition* is visible to all. They want to focus on how the app can help them with their daily waste management to protect the environment and the people. This is contradictory with finding from previous study which mentioned *recognition* as an effective way to encourage eco-friendly behaviours (Nkwo et al., 2020).

4.3.1.2 Summary of Study 3

This Study 3 has highlighted the importance of understanding end-user perceptions towards waste management practices which are not only useful for ensuring

acceptance and implementation of the application but can also assist designers or developers to better understand user needs and requirements that may lead to design an effective waste management application. The persuasive principles such as *reduction, tailoring, personalization, self-monitoring, simulation, praise, rewards, reminders, liking, social role, trustworthiness, expertise, surface credibility, real-world feel, verifiability, social learning, normative influence, and cooperation* generally received positive perceptions, and *tunnelling, suggestion, authority, third-party endorsement, competition, social comparison, and social facilitation* principles were highlighted the mixed-viewed perceptions by the participants. On the other hand, the *similarity, rehearsal, and recognition* principles were adversely viewed by the Malaysian community with a low level of adoption of waste management practices.

The identification of these principles from PSD model, therefore marked the achievement of our second research objectives (RO2). In next Study 4, the principles of WM practices within *Maqasid al-Shari'ah* framework will be identified by our participants.

4.3.2 Study 4 Identify the Principles of Waste Management Practices Within Maqasid Al-Shari'ah Framework

To identify the principles of WM practices based on *Maqasid al-Shariah*, participants were asked first about their opinions on waste management and natural resource conservation according to the five core values of *Maqasid al-Shariah*, namely the preservation of faith, life, intellect, lineage, and prosperity. Besides, participants were questioned about their opinion how *Maqasid al-Shari'ah* can be integrated into application to encourage people to dispose solid waste at home based on the five dimensions of *Maqasid al- Shariah* (See the questions that were asked to participants in Appendix IV). All participants presented and gave feedback to explain the questions from their general experience.

4.3.2.1 Results and Discussion

The questions in the interview schedule were mostly open-ended. The following Table 4.18 presents some participants' responses on each dimension of Maqasid al-Shariah.

Table 4.18: Participants' Excerpts based on Maqasid al-Shariah

Maqasid al-Shariah Dimension	Excerpts from participants' interview
Protection of Faith	Participant 3: <i>"according to the five fundamental values of Maqasid al-Shari'ah preserving natural resources is very important because faith is part of our Iman. And cleanliness is a part of Iman. So, by preserving the environment we get better life also good environment contributes to good brain development, also lineage, and wealth. All the wealth like these natural resources is given by Allah. So of course, we must take care of this wealth. We cannot neglect everything that is given to us."</i> Participant 6: <i>"Actually, it is directly related to our faith. that is for us Allah has given to all these things. If we have faith in Allah, we need to protect our environment. it is our duty to keep our environment clean and healthy. Actually, it is one kind of gratitude towards Allah. We need to give proper knowledge relationship between faith and cleanliness. Why do we need to dispose of the waste for health? so if you are using the app, you need to give awareness to the republic about the necessity and the connection between this thing and our religion. That will help I think."</i>
Protection of Life	Participant 6: <i>"In our religion, it is said that we should not make any inconvenience to others. That are the prominent things that we need to follow. Because if we are disposing of our waste, it causes some problems to our environment and public. that is also reflecting or faith. This is the most important thing in our religion which is emphasizing. One of the best examples is that we need to take wudu in every prayer. So, our religion, it is insisting that we should always clean our bodies as well as our environment. I think it will give some message. Through our religion, you can give some message to keep healthy and not pollute our environment."</i> Participant 3: <i>"if we don't take care properly of waste management, then it will harm our safety and health. Because disease will affect our body in terms of malaria, cholera, diarrhea and so on. Some people have low immunity of the body so safety and health are also alarming. So how can we go to practice our work, ibadah (prayer)? We cannot do anything because we have weak bodies. In apps, maybe we can spread awareness then people can contribute to dispose better and protect their life."</i>
Protection of Intellect	Participant 7: <i>"If people do not see the result immediately, they cannot take it seriously. This environmental degradation is poisonous and also bad for humans. but they didn't see the immediate effect. That's why they cannot do the"</i>

	reasoning. General people generally if they do not or that much intellectual mostly, they are ignoring it. That's why proper waste disposal is not being done by people. Why do I take some extra effort to manage waste disposal? Also, the benefit is not seen, if people are not very aware. People are trying to make people understand for a long time almost 20 years these things are going on. Still, people are not aware. That means actually they either lack intellectual or lack willingness. That's why they cannot reason or they do not feel motivated to do waste disposal. We have to make them educated to solve the problem. Educated in a way that they make an actual impact in their life. There is a lot of awareness program is going on in Malaysia. But that is not actually impactful. In your app, you have to do something that is more than that only saying this is this or this is that also connecting shariah law is also impactful. In Islam, if you are not doing anything voluntarily rather it is the command of Allah and if you are not doing it then you are having some bad deeds in your amal. It will destroy your good deeds. Then it might be impactful. Because the awareness of the environment is almost 20 years. But people are not getting anywhere." Participant 1: "If we don't use our knowledge then we will not manage our waste properly because we don't know how to do it. We have to follow Islam and gain knowledge about waste disposal. We will be fully aware of what will happen to us if we don't manage our waste properly. So, this advice is coming from the ustaz. The ustaz will give a talk that will encourage us to manage waste properly. We have to understand the effect if we are not doing it then we have to be educated after learning or listening to Uztaz. This will encourage us to manage the waste. By having some knowledge on what the impact of is not doing it."
Protection of Lineage	Participant 4: "If people are unable to manage waste properly it will affect the current generation and also the future generation. It will affect our well-being and emotions. It will impact the people around us. In Islam, we need to have like good quality of life in the environment and cleanliness. So, it's related to the protection of the environment and future generations. We need to manage our waste accordingly. Actually, we are doing it as part of khalifa in this world. It's a very fundamental responsibility. We need to relate them. Through the apps, we need to inform the importance of waste disposal and the protection of lineage. You need to give awareness." Participant 7: "If we think about our future generation actually, we are damaging the environment for a future generation where it will be very difficult to live for them. Actually, we are destroying the present environment. They won't be able to live in a good environment. If we follow Islam this will not happen like we save the environment as for Amanah for the future generation. In that case, we should do proper waste disposal."
Protection of Wealth	Participant 7: "We should not waste our wealth. Even in hadith said that if you are taking wudu (ablution) you should not waste water. Use limited water as much as I need to do daily things. Like I should drink 2 glasses of water. I should not waste a single drop of water. Because every drop is count. If people are aware of that thing that we have to keep. For every drop, we are liable to Allah because these are niyamat (blessing) of Allah. We should not waste that. So, then people will be aware and keep wealth for the next generation properly."

	Participant 3: “If we do not manage our waste disposal it will give bad results to our environment. We want to avoid excessive use of natural resources. If we use more than we need it will create an imbalance of natural resources and living lifestyles. Because that imbalance reflects our lineage, faith, life also our wealth. So having proper waste disposal will create balance in our society.”
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Based on our thematic analysis of participants' (n=7) verbalization, we identified three principles derived based on *Maqasid al-Shari'ah* to encourage sustainable waste disposal behavior among Malaysian Muslim. All the participants believed that developing technologies to manage waste and protect natural resources is consistent with preserving faith, life, intellect, ancestry, and prosperity. The three (3) identified elements include *Taqwa* (following God's commands and avoiding His prohibitions), *Tazkiyah* (purification), and *al-Hikmah* (wisdom). The following figure 4.5 shows identified themes that emerged from *Maqasid al-Shariah*:

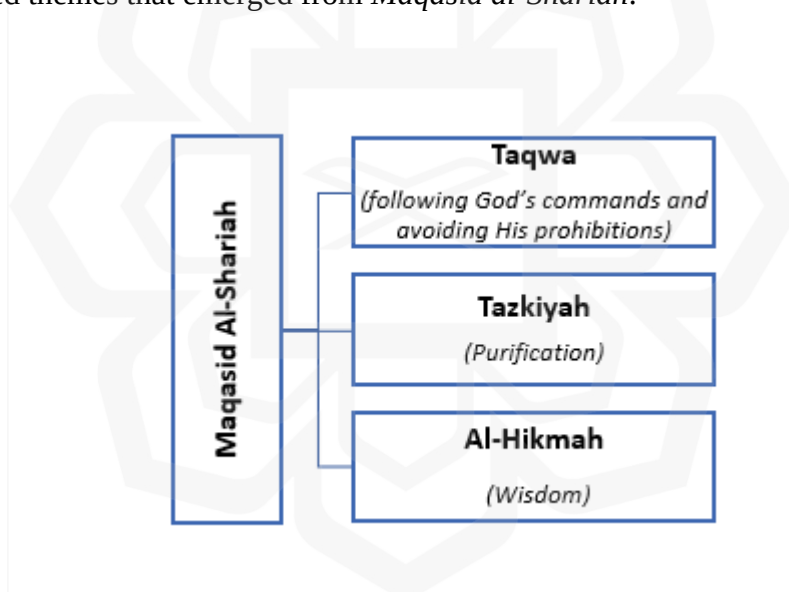


Figure 4.5: Identified Principles from *Maqasid al-Shariah*

Theme 1: Taqwa (following God's commands and avoiding His prohibitions)

Taqwa was one of the main principles highlighted by participants as important for sustainable waste management. *Taqwa* is an Islamic term for being conscious and cognizant of God, of truth, piety, fear of God. ‘Taqwa’ is defined as traits of righteousness or good deeds, which traits Allah SWT commands a believer to have. Allah mentioned in Quran surah al Baqarah verse 82

“Those who believe and do good deeds will go to Heaven, where they will remain eternally. (Surah al Baqarah, 2:82)

Taqwa, as used in this research, is the practice of following God’s commands and avoiding His prohibitions by managing waste. Additionally, it is a religious awareness of God's presence that causes one to abstain from wrongdoing by anticipating God’s acceptance and latent punishment. According to Maham and Bhatti, (2019), *taqwa* keeps one from engaging in behaviour that is against God's commands.

In our study, all participants emphasized that managing waste is another form of *ibadah* (worship) like prayer and fasting. If we do not follow the correct rules of proper waste management, we do not remain in faith. They believed that we must be *Muttaqin* (one who performs *Taqwa*) to maintain the unity of Allah's creation and protect the environment and its associated areas. We have been entrusted (*Amanah*) with this earth, this is a sacred covenant with our Allah. This trust is an obligation to protect the environment. Their comments are shown below:

“In my opinion, managing waste and preserving the natural resources according to shariah I believe as Muslims we need to observe, we need to be Muttaqin. Besides our ritual Ibadah, we need also to regulate our life properly to manage waste disposal.” (P4, 34 years old)

“Proper waste disposal reflects our faith. If you don’t know the proper waste disposal that means you have no faith. Because it’s interrelated. In Islam, Quran teaches us to be more organized. It’s also like a ritual activity like solat (ibadah), and Zakat that deals with waste disposal. By managing your waste properly shows that you have higher faith because it is your Amanah. If taqwa is not inside yourself, you have to be portrait. So, to develop the level of taqwa in our life like how we manage the things in our environment is that managing disposal of waste. So, it’s interrelated. So, you cannot segregate the faith and things outside you. It’s not only within you. If it’s within you or people near to you and also environmental and waste disposal. If a person has higher faith should be the

person to take care of and deal with waste disposal. so, I think in apps we need to promote managing waste. when we do this actually, we are doing part of preserving taqwa or calculating taqwa. So it's a very big thing.” (P5, 35 years old)

In Islam, good deeds are one of the pillars of faith and a testimony to the integrity of *Tawheed*. Removing garbage is a priority because there is hadith that explains that removing garbage belongs to a branch of faith. The faith has many branches, the topmost of which is the *Tawheed* sentence and the lowest is throwing away garbage from the street (Muslimin et al., 2018). In our study, the participants highlighted that managing waste through apps is a means of performing good deeds for every Muslim and they will receive a set reward and remuneration for practicing the sustainable approaches (3Rs). Garbage is denoted in the hadith with the statement, *"Allah thanks the one who removed the tree that blocked his way and admits him to heaven"* (Muslimin et al., 2018). These are examples of effective activities by participants.

“As a Muslim, if we are doing proper waste disposal it will be counted as our neki (reward). So, we can keep a record of what we are doing every day. As we pray five times, we do charity. Same we are doing waste disposal as a duty. So, it is part of our Ibadah. The app is actually keeping a record of our good deeds as waste disposal. So, it will accumulate and sometimes we see that we have done something remarkable. It is also important how many good deeds we have done in the name of Allah.” (P7, 37 years old)

Participants also expressed that disobeying God's commands such as mismanagement of waste will erase the good deeds from our record. As Prophet Muhammad mentioned in Hadith: *“Have taqwa (fear) of Allah wherever you may be and follow up a bad deed with a good deed which will wipe it out and behave well towards the people.”* As stated by one of the end users,

“Through the app, you have to make them educated to solve the problem. Educated in a way that they make an actual impact in their life. There are a lot of awareness programs going on in Malaysia. But that is not actually impactful. In your app, you have to do something that is more than that only saying this

or that. also connecting shariah law is also impactful. if you are not doing anything voluntarily rather it is the command of Allah and if you are not doing it then you are having some bad deeds in your amal. It will destroy your good deeds. Then it might be impactful. Because the awareness of the environment is almost 20 years. But people are not getting anywhere.” (P7, 37 years old)

Other end-users highlighted aspects such as having *taqwa* of Allah, we must be aware and share with all Muslims through apps that we manage the waste to protect our own religion.

“In apps, we need to provide awareness to persuade people. we have to share all the people in fact with all the houses that they are aware they are doing good (managing waste) for their own religion.” (P3, 32 years old)

In the interface design, *Taqwa* is implemented by providing plenty of categories of managing waste based on Quran and sunnah. So that Muslim can feel responsible to follow Allah’s commands. Below Figure 4.6 is the examples of how the concept of *Taqwa* is implemented in the user interface design of a waste management application.

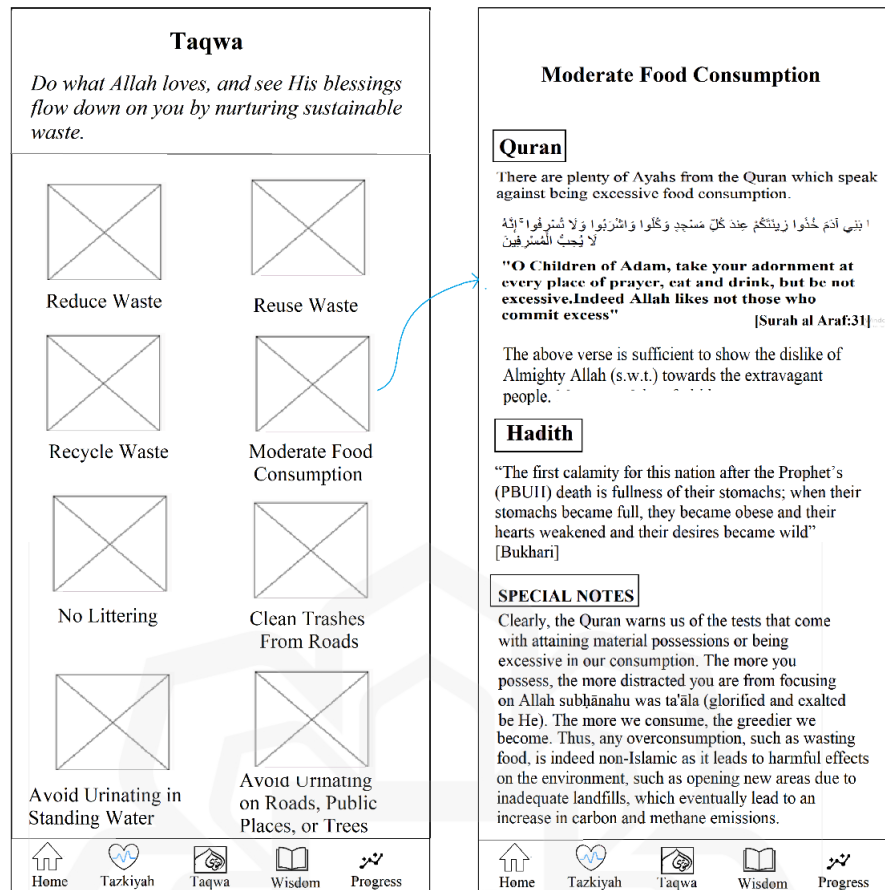


Figure 4.6: Interface Designs of Taqwa in Waste Management App

Theme 2: Tazkiyah (Purification)

Tazkiyah is another key principle emphasized by all participants to stay clean and dispose of waste properly. The word *Tazkiyah* (Arabic: تزكية) is an Arabic-Islamic term referring to "*tazkiyat al-nafs*" meaning "sanctification" or "purification of the self" as the purification of the heart and soul. According to Mohamad, Osman, and Mokhtar (2020) *tazkiyah* means growth, increase, germination, development, formation, upgrade, repair, cleaning, and purification. In this study, the word *tazkiyah* means the purification and cleansing of the individual from any substance or object that is normally discarded by society as garbage so that he/she can reach the point of perfection in a favourable environment. In the study, end users indicated that the ability to choose *tazkiyah* or purification for waste disposal is essential to sustaining

life. They pointed out that physical cleanliness is very important for purifying the heart and that this can only be achieved by managing our waste properly.

“Regarding the protection of life and shariah, I remember the verse “Qad aflaha man tazakka” those who are successful who purify themselves. That means you have to purify your heart. How you want to purify your heart. You need to purify your heart physically. One part of physical is waste disposal. When we manage our waste actually, we are doing tazaaka. This is the protection of life. because inside and outside we need to be tazakka. In apps, you can promote that managing waste accordingly is one of tazakka inside and outside. You cannot separate that thing.” (P5, 35 years old)

Other important aspects mentioned by end users included that the importance of cleanliness reflects our faith, Iman, and religion. They described that waste disposal is a part of cleanliness, and Islam requires us to clean our entire way of life. To achieve this purpose, the app can help people to manage their waste disposal. One of the participants mentioned that it is most unfortunate if we as Muslims do not maintain the cleanliness of our homes and places by separating our waste.

“Actually, our cleanliness reflects our faith. Meaning to say if we don’t take care of the cleanliness of our environment and also our own self. Meaning to say we don’t understand about our faith, Iman, ibadah (prayer), and religion. If we really understand our religion first come first about our cleanliness. In apps, we need to provide awareness to persuade people. We have to share with all the people in fact to all the houses that they are aware they are managing waste for their own religion.” (P3, 32 years old)

“Because as Muslims we need to be clean. Waste disposal is part of cleanliness. Within our area and within our house. Now I just remember 1 verse in surah baqarah ayat 30: Allah created us as khalifa. As a khalifa our job is to manage this world and also to manage all our things. To manage our waste properly our thought will become clear. If the waste is managed properly, we can protect our life and health. The app can help people to manage waste disposal like places to

throw the garbage and find the bins. If they get that facility like something to remind the solat.” (P4, 34 years old)

“I believe, in Islam, we are asked to manage our own waste and always to be clean. That is why separate waste is quite important. We mix all types of waste. Islam teaches us to be clean, but we don’t get to level that yet. The religion asked us to be clean but when we pray, we take wudu, so we have to be clean same applies to how we manage our waste. For example, in the kitchen make sure everything is clean and in order. In Islam, we have to pray 5times a day. Maybe that can be a guideline so whenever we pray every 5times a day to remind us to be clean. Maybe apps can start showing if we don’t preserve cleanliness and if we don’t manage our waste properly these things will happen to us. We can encourage people by listening to religious talk. they are giving advice to us that we have to be clean.” (P1, 47 years old)

In the interface design below (Figure 4.7), the principle *Tazkiya* is implemented by providing plenty of categories of activities or behaviour so that Muslims can indicate the ability to discard the waste properly for sustaining life. Each category has its own reminder from Quran and sunnah, calendar so that user can improve their behaviour.

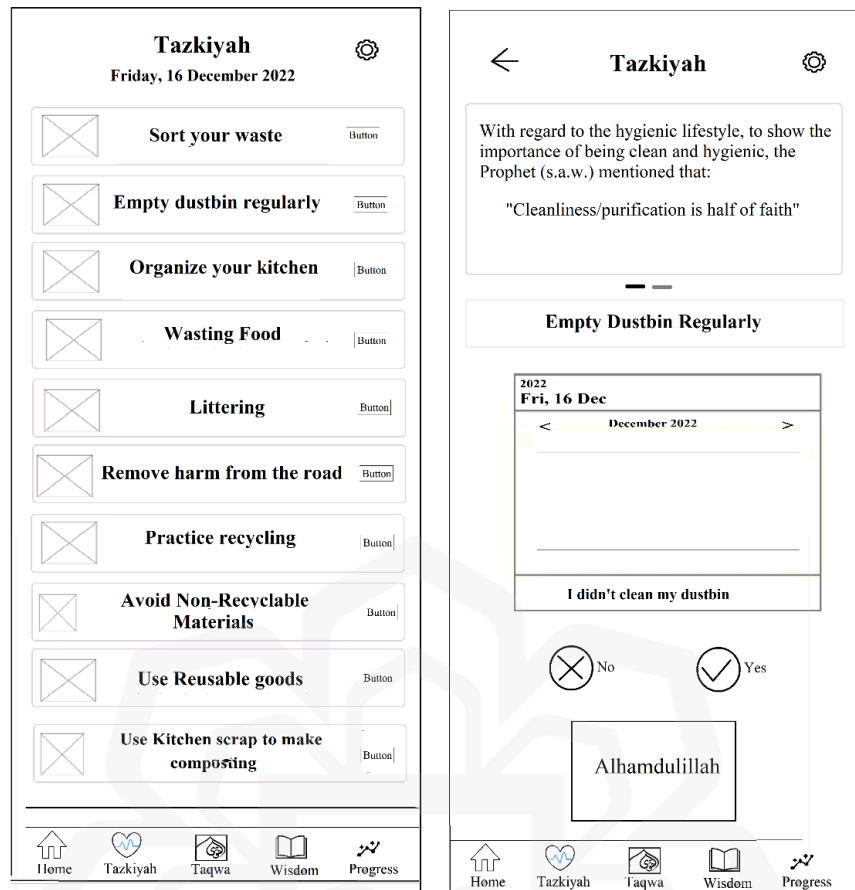


Figure 4.7: Interface Designs of Tazkiyah in the Waste Management App

Theme 3: Al-Hikmah (Wisdom)

Wisdom is a result of the highest virtue in acquiring knowledge. In the Quran, *hikmah* is referred to as الحكيم (all-wise) (Quran 45, al-Jazziyah, ayat 37). It is the All-Wise or Al-Hakim (Allah) who enables mankind to gain wisdom from various events and encounters (*al-hikmah*) in different facets and phases of life (Ismail and Sarif, 2021). In this study, *Hikmah* or wisdom facilitate understanding on the importance of sustainable waste management behaviour based on Islamic perspectives, as well as knowledge on the detrimental effect of improper waste disposal towards progeny (protection of lineage). The *Hikmah*-related content are important to implement in waste management application to make people gain more knowledge about the importance of sustainable waste management practices from Islamic perspectives and subsequently change their own behavior accordingly.

In this study, many end users pointed out that understanding and gaining knowledge about waste management are very important to protect the environment and human being through waste management apps. All end users identified the following features as important for adopting green practices in apps: Facilitate a better understanding of the environmentally friendly practices used, knowledge of the effects of improper disposal, knowledge of policies to organize waste, and what types of waste to reduce, reuse, and recycle. End users also expressed that knowing the benefits of proper waste management can help them become a better person and change their own behavior to adopt environmentally friendly practices:

“Some people may not understand (about 3Rs) according to their limited beliefs. To appreciate waste disposal, we need to educate them in terms of criteria. I also have limited understanding, my knowledge in terms of 3rs is still limited. When people know they will appreciate it. What type of waste to reduce, where to recycle and how to reuse it? Through the apps, you need to define those things. This is very important then people will do the implementation, and then procession and demonstration.” (P4, 34 years old)

“Having this app people can learn something more about green practices. We can create awareness for them in terms of policy, law, and what’s the goods and benefits of having this proper waste disposal. So, we can teach them to be better person. So, they can apply green practices at their home. From point of my view, most of the people don’t know how to apply green practices in daily life. It does not mean they don’t want to apply but they don’t know the information on how to apply.” (P3, 32 years old)

“If we are not aware of what are the problems that will cause if we are doing some improper disposal then they don’t have some knowledge of them. If you can provide knowledge regarding the effects of those disposals through your app then it will be beneficial.” (P6, 39 years old)

“Most of the people don’t know how to practice 3rs. The apps can be quite reasonable and relevant to the community because people will use something that they can understand well, is user-friendly, and give me advantages or

benefits. If not, maybe I just download but not use the app. To encourage, you need to give awareness. We heard a long time ago about waste disposal and green practices. recently I didn't get much information about green practices."
(P5, 35 years old)

Therefore, the conclusion that can be drawn from the above participants is that the principle of wisdom or *hikmah* is important to implement into the application to benefit from useful knowledge about the implementation of green practices. According to Sarif et al. (2022), *hikmah* is the result of integrating the *Tawhidic* paradigm with *Maqasid al-Shari'ah* and enables the expansion of knowledge. Ibn Qayyim Al-Jawziyya (at-Tafsir al-Qayyim, p. 226) stated that *hikmah* is the knowledge of the truth, ability, and correctness in speech and action. The previous study also cited that *hikmah* or wisdom can be denoted as understanding and knowledge of justice, persuasiveness in speech, and constant correctness in a statement that leads to good behavior (Abdullah and Halabi, 2017). In addition, in this study, emphasis was placed on character building through wisdom leading to good decision-making, responsible citizens, and thus a well-behaved society that appreciates values and ethics.

The lack of wisdom is the most overwhelming deficiency that an individual or a community can face because wisdom is the answer to all our problems today and the solution to turn things around. Prophet Muhammad (PBUH) encouraged Muslims to use wisdom in their actions as much as possible. He said: "*Wisdom is like a precious commodity that is lost, a believer must always be on the lookout for it, and wherever he finds it, he must act upon it*" (Abdullah and Halabi, 2017). Therefore, the responsibility of maintaining a good environment and managing waste disposal requires the use of wisdom or *hikmah* to ensure environmental sustainability. The Khalifa will give an account of God's trust on the Day of Judgment, so being wise and making wise decisions will help him give a clear account of how he has maintained God's trust. Wisdom is urgently needed to accomplish the task entrusted to us by our Creator. Allah s.w.t. commands His servants to reflect on the wisdom or *hikmah* behind everything He has prescribed for us.

To maintain environmental sustainability, Islam emphasizes the importance of purity. Thus, the Prophet (PBUH) said, "*Purity is half of faith*". Similarly, the wisdom that "*cleanliness is part of faith*" is widespread among Muslims (Saged et al., 2017). In a previous study, it was suggested that cultivating the five elements of *Maqasid al-Shari'ah* to develop the well-being of society must take into account the content aspect (mawdu') of Maqasid Shari'ah and the wisdom (*hikmah*) based approach of dakwah (Don, Puteh, and Mokhtar, 2022). Thus, wisdom must be incorporated into the application of waste management to convey positive values and ideas that teach Muslims to conserve the environment and human beings.

In the interface design below (Figure 4.8), the principle *Hikmah* is implemented by providing knowledge about the green practices and protecting environment from Shariah perspective.

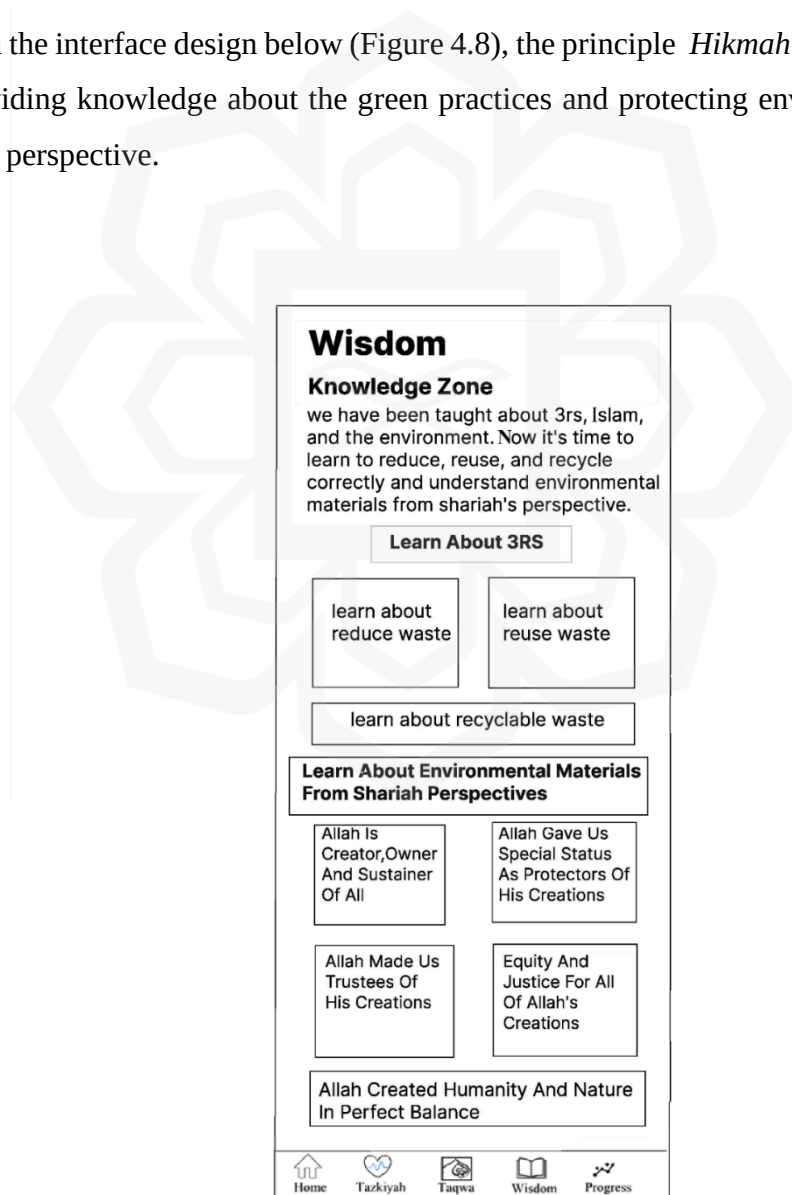


Figure 4.8: Interface Designs of Hikmah in the Waste Management App

4.3.2.2 Summary of Study 4

In summary, this Study 4 contributes to a better understanding of how *Maqasid al-Shari'ah* dimensions can be integrated into the design of a smartphone application based on user perceptions. Our findings indicated that *Taqwa*, *Tazkiyah*, and *Al-Hikma*, are the most important concepts that need to incorporate into the design of a smartphone-based intervention to influence, motivate, and help people to achieve successful waste management behaviors. In Phase 3, a new integrated framework of WM management based on *Maqasid al-Shari'ah* will be proposed to experts in order to validate the framework that should be utilized to encourage green practices of municipal solid waste disposal.

In order to present the concept of *Taqwa*, *Tazkiyah* and *Hikmah* to the experts, a low fidelity user interface of a waste management application was designed in order to encourage sustainable waste management practices. The prototype developed using *Justinmind* (<https://www.justinmind.com/>), UI prototyping tool that enables designers to create web and mobile app prototype easily. This low fidelity initial prototype is easily can built and change which will help experts to validate the principles based on *Maqasid al-Sharaih* and detect earlier problems in the user interface design.

4.4 FRAMEWORK DEVELOPMENT

The aim of this phase is to develop and validate appropriate persuasive components for waste management application that are effective to encourage behavioral change among Malaysian community towards more sustainable waste management practices. The expert review has been used to validate the necessary persuasive components through Fuzzy Delphi technique. The framework validation was conducted in two iteration rounds until consensus or stability is reached. The initial persuasive framework was validated through Delphi technique (Study 5) to confirm the components and features, and the second round of Delphi technique come out from the output Delphi round 1 and, later was validated in Study 6 based on expert consensus.

4.4.1 Study 5 Initial Persuasive Design Framework for Waste Management Application Based on Maqasid al-Shariah

The Figure 4.9 shows the proposed persuasive design framework for waste management application. There are 28 components identified for waste management application that are marked as C1 to C28. These 28 components are grouped into five dimensions to represent the WM framework. The framework consists of two parts: the first part (dimension D1, D2, D3 and D4) contains twenty-five persuasive components for sustainable waste management application using PSD model. These components are selected based on understanding of end-user perspectives in designing persuasive sustainable waste management application for urban community in Malaysia (Study 3). Based on PSD model primary task support (D1), dialogue support (D2), credibility support (D3) and social support (D4) are the core dimensions in the design (Oinas-Kukkonen and Harjumaa, 2009).

The second part (Dimension D5) contains three persuasive concepts that are derived from *Maqasid al-Shari'ah* to be implemented into the design of sustainable waste management applications to persuade people to adopt sustainable waste management behaviour (Study 4). All the components together with its user interface design was evaluated as a model validation to help in achieving the goal of influencing and motivating towards WM practices. The researcher used *Justinmind* prototyping tool to design an initial UI prototype that employed *Maqasid al-Shari'ah* perspective.

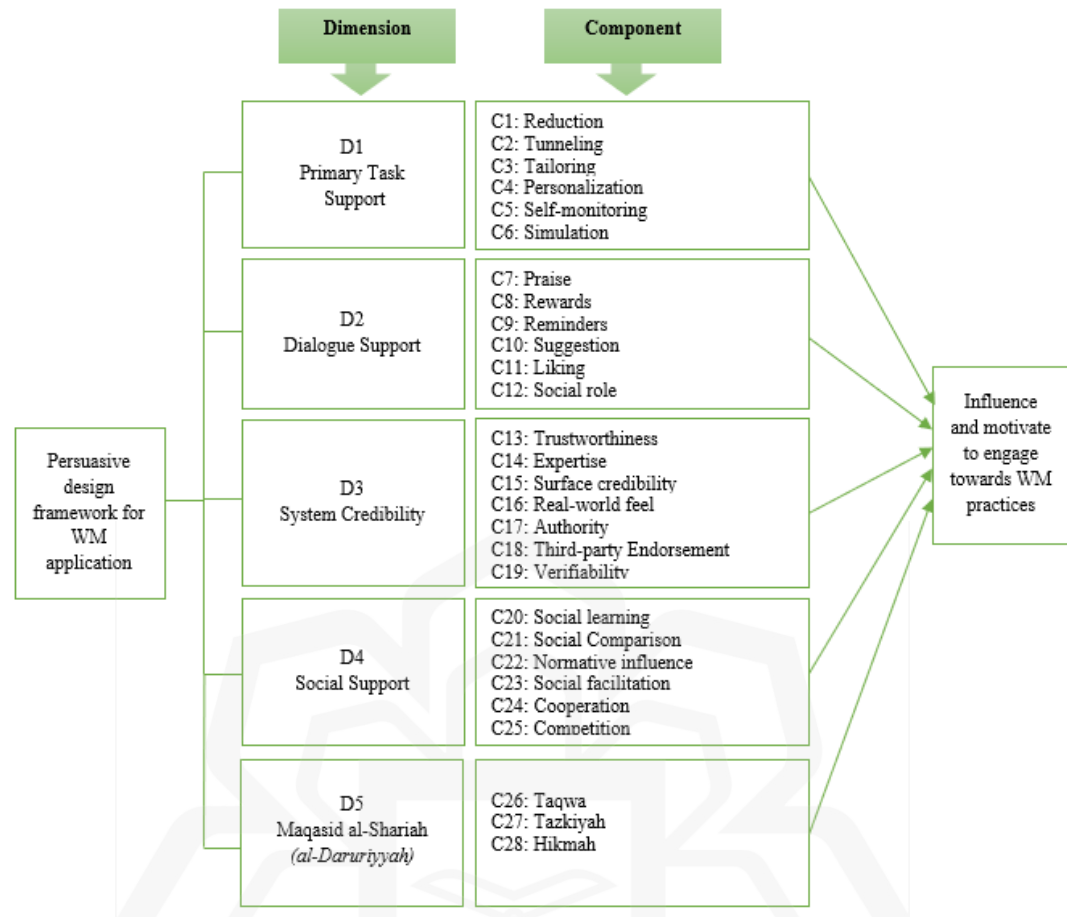


Figure 4.9: Proposed Persuasive Design Framework for Waste Management Application based on *Maqasid al-Shariah*

4.4.1.1 Fuzzy Delphi Method

The fuzzy Delphi method (FDM) is a technique for obtaining the consent and consensus of a group of experts in a field on a subject. The fuzzy Delphi method is the modification of traditional Delphi method developed by Ishikawa et al. (1993) which has been used widely to get the expert opinions via surveys (Hsu, Lee, and Kreng, 2010). It uses fuzzy set numbers or fuzzy set theory where each set has a value from 0 to 1. It is also cost effective and saves time during evaluating each item in a questionnaire. It shortens survey rounds, increases items recovery rate and allows the experts to express their opinions without ambiguity or bias which improves the consistency and completeness of their opinion. Finally, it allows experts to reach a

consensus without jeopardizing their original opinion and eliciting their honest responses to the questions (Manakandan et al., 2017).

4.4.1.2 Expert Selection and Invitation

According to Adler and Ziglio (1996), the number of suggested experts in Fuzzy Delphi method is between ten to 15 people. While Ocampo et al., (2018) stated that the number of experts does not necessarily need to be high because there is no significant correlation between the number of experts in a study and the quality of the results that can be generated from the group discussions. Additionally, the expert's selection in FDM should have expertise in a subject related to the study, as this would enable them to review their evaluation and provide evidence for their judgment on the needs of the study (Pill, 1971). Expert selection criteria aligned with Yusof et al., (2022) assertion that

1. The experts need to be knowledgeable and advanced academic qualifications in a field of study
2. The experts considered skilled in a field studied and at least five years of experience in that field.
3. Able to give full commitment until the study is accomplished.
4. There is no personal interest with the experts in order to avoid biasness of the studies.

Therefore, in this study, twelve experts (Yusoff et al., 2021) were selected using purposive sampling technique who are experienced in Shariah science, *Maqasid al-Shariah*, Islamic Economics, Islamic Jurisprudence, ICT and Islam foundation, Human Computer Interaction (HCI), Solid Waste Engineering and Waste Management Corporations including KDEBWM and SWCorp. The selected experts have significant expertise and have more than 5 years of experience in their respected fields. Table 4.19 shows the experts demographic information of the study.

After selection the experts, an invitation email was sent to them. They were given times to reply to the email with their specific available date and time. The researcher then scheduled an interview session with each expert accordingly.

Table 4.19: Experts Demographic Information

No	Experts	Positions	Areas of Expertise	Years of Experience
1	Expert 1	Associate Professor	ICT, Information Retrieval, ICT & Islam, Information System	15
2	Expert 2	Assistant Professor	Shariah sciences, Maqasid al shariah, Islamic economics	5
3	Expert 3	Assistant Professor	Islamic Jurisprudence	5
4	Expert 4	Associate Professor	Information Retrieval, Semantic Technology, Knowledge Management, Bibliometrics, Maqasid Methodology	30
5	Expert 5	Assistant Professor	Fiqh & Usul al-Fiqh, Maqasid Shariah, Islamic social finance	10
6	Expert 6	Assistant Professor	Solid Waste Engineering and Management, Environmental Engineering, Environmental statistics	14
7	Expert 7	Environmental Health Officer Community Education Division (SWCorp)	Solid Waste Management and Public Awareness	13
8	Expert 8	Assistant General Manager of Corporate Communications Community Education Division, (SWCorp)	Solid waste and public cleansing management	6
9	Expert 9	Assistant General Manager of Corporate Communications (KDEBWM)	Corporate Communication, Human resource and administration, Innovation Practice	25
10	Expert 10	Assistant Professor	Human Computer Interaction, Multimedia Learning	9
11	Expert 11	Associate Professor	Human Computer Interaction	22
12	Expert 12	Assistant Professor	Human-Computer Interaction, Persuasive Technology, Interaction Design, User Experience	5

4.4.1.3 Conduct of Fuzzy Delphi Method (Round 1)

This study was conducted in four phases. In first phase, experts were asked to complete a demographic survey that asked about their areas of expertise and years of experience and gives them explanation about the research (See appendix V- Document 1)

Afterward, experts were asked to sign the expert reviewer consent form. (See appendix V- Document 2)

In the third phase, the key concepts and definition of terms of the study were presented to the experts. (See appendix V- Document 3)

In the last phase, an expert review form was given to obtain the agreement and consensus of a group of experts in our proposed framework (See appendix V- Document 4). In this phase, the persuasive principles, and the example of user interface design for each persuasive principle given to the experts. Based on the UIs, the experts were also asked to respond to the following query: "*In your opinion, how important and relevant is this persuasive principle to persuade people towards sustainable waste management practices?*". Besides, each of expert panel was asked to gauge the importance of persuasive principles based on the following scale in Table 4.20.

Table 4.20: Scale for Experts' Rating

Scale	Interpretation
5	Very Important
4	Important
3	Moderately important
2	Unimportant
1	Very unimportant

4.4.1.4 Data Collection

The data was collected through both interviews and questionnaires method to validate the framework. Between January 2023 and May 2023, the researcher conducted a total of twelve interviews sessions with experts through face-to-face interview, and virtual interview platforms via google meet, and also using questionnaire method to complete the expert review form. During the Fuzzy Delphi analysis, experts interacted with the questionnaire items by indicating their level of agreement on each item. They also had the option to reduce, add, or improve items if they deemed it necessary.

Each interview session lasted approximately one hour, and experts' interactions and expressions were captured on audio and video recordings for further analysis. An expert review form was later were translated into Fuzzy number data and analysed using Excel software. Additionally, experts' comments and suggestions were considered to improve the item. Therefore, the experts' verbalizations that were recorded were transcribed. Table 4.21 shows the level of agreement of the five-point scale and its Fuzzy scale.

Table 4.21: Interpretation of 5 Likert scale to Fuzzy Delphi scale

Level of Agreement	Likert Scale	Fuzzy Scale		
Very important	5	0.6	0.8	1
Important	4	0.4	0.6	0.8
Moderately important	3	0.2	0.4	0.6
Unimportant	2	0	0.2	0.4
Very unimportant	1	0	0	0.2

4.4.1.5 Data Analysis

The data was analyze systematically using Microsoft Excel software as suggested by Mohd Jamil and Mat Noh (2020). The researcher further followed three conditions based on the Fuzzy Delphi technique to validate each item in the questionnaire which

are threshold value (d), percentage of expert agreement and the value of Fuzzy Score (A). The following formula is used:

$$d(\tilde{m}, \tilde{n}) = \sqrt{\frac{1}{3}[(m_1 - n_1)^2 + (m_2 - n_2)^2 + (m_3 - n_3)^2]}$$

In this analysis, we aimed to get the value of Threshold (d) ≤ 0.2 . The expert consensus is reached when the resulting value is less than or equal to 0.2 (Cheng and Lin, 2002). Then we aimed to get the percentage of expert agreement to ensure the second condition is achieved. According to the traditional Delphi methodology, the measured item is accepted if the expert group's agreement is greater than 75% (Chu and Hwang, 2008). On the other hand, defuzzification process is the determination of the fuzzy (A) score value based on the α -cut value of 0.5 (Tang & Wu, 2010; Bodjonava, 2006). If the fuzzy score value (A) is greater than or equal to 0.5, then the measured item is accepted by an expert agreement, and if less than 0.5, then the measured item is rejected. Among other functions, the value of fuzzy scores (A) can be used as a determinant and priority of an element according to expert opinion views. The determination of fuzzy (A) score value was made based on the following formula:

$$A = (1/3) * (m_1 + m_2 + m_3)$$

4.4.1.6 Results

4.4.1.6.1 Results of Expert Consensus on Persuasive Principle for Waste Management Application Based on Persuasive System Design (PSD) Model

The threshold value (d), expert consensus percentage, defuzzification and item position for the persuasive principles for waste management (WM) application are shown in Table 4.22.

Table 4.22: Findings of Expert Consensus on Persuasive Components for Waste Management Application

Persuasive component	Average Likert Score	Triangular Fuzzy Numbers		Defuzzification Process				Experts Consensus
		Threshold Value, d	Percentage of Experts Group Consensus, %	M1	M2	M3	Fuzzy Score (A)	
C1	4.8	0.115	100.00%	0.550	0.750	0.950	0.750	Accepted
C2	4.4	0.208	83.30%	0.483	0.683	0.883	0.683	Accepted
C3	4.5	0.204	83.30%	0.500	0.700	0.900	0.700	Accepted
C4	4.4	0.208	83.30%	0.483	0.683	0.883	0.683	Accepted
C5	4.4	0.238	83.30%	0.483	0.683	0.883	0.683	Accepted
C6	4.7	0.136	100.00%	0.533	0.733	0.933	0.733	Accepted
C7	3.9	0.187	41.70%	0.383	0.583	0.783	0.583	Discarded
C8	4.7	0.153	91.60%	0.533	0.733	0.933	0.733	Accepted
C9	4.3	0.204	83.30%	0.467	0.667	0.867	0.667	Accepted
C10	4.2	0.191	91.60%	0.45	0.65	0.850	0.65	Accepted
C11	4.3	0.204	83.30%	0.467	0.667	0.867	0.667	Accepted
C12	3.5	0.356	33.30%	0.300	0.500	0.700	0.500	Discarded
C13	4.0	0.255	33.30%	0.400	0.600	0.800	0.600	Discarded
C14	3.6	0.328	50.00%	0.333	0.517	0.717	0.522	Discarded
C15	4.1	0.280	8.30%	0.417	0.617	0.817	0.617	Discarded
C16	4.0	0.153	50.00%	0.400	0.600	0.800	0.600	Discarded
C17	4.4	0.238	75.00%	0.483	0.683	0.883	0.683	Accepted
C18	3.8	0.221	41.70%	0.367	0.567	0.767	0.567	Discarded
C19	4.1	0.220	91.60%	0.45	0.65	0.833	0.644	Accepted
C20	3.8	0.322	25.00%	0.367	0.567	0.767	0.567	Discarded
C21	3.8	0.275	41.70%	0.383	0.567	0.767	0.572	Discarded
C22	4.0	0.204	41.70%	0.400	0.600	0.800	0.600	Discarded
C23	3.8	0.272	33.30%	0.367	0.567	0.767	0.567	Discarded
C24	4.0	0.204	50.00%	0.400	0.600	0.800	0.600	Discarded
C25	3.7	0.216	66.70%	0.350	0.550	0.750	0.550	Discarded
Condition: Triangular Fuzzy Numbers 1) Threshold Value (d) ≤ 0.2 2) Percentage of Experts Consensus $> 75\%$ Defuzzification Process 3) Fuzzy Score (A) $\geq \alpha$ – cut value = 0.5								

The persuasive principles are prioritized by the experts as shown in Table 4.23.

Table 4.23: Items are sorted by Priority

Sort by priority	Items	Item Number
1.	The application displays a color-coding calendar for a garbage collection schedule making it easier for people to know a specific day/date for a specific type of waste collection (e.g., Thursday, for recyclable waste, Tuesday for burnable garbage).	C1
2.	The application shows the impacts of waste being recycled on the environment. In this example, the application informs that the user has created 57 new plastic products by recycling 4% of the plastic waste generated.	C6
3.	An application that offers rewards points after completing a certain level of recycling.	C8
4.	The application provides information about garbage and recycling items collection schedules based on the user home address.	C3
5.	The application provides step-by-step guide instructions on recycling and reusing waste.	C2
6.	The application offers personalized reminders, time and date for waste disposal, and users' preferred languages. Personal images, addresses, and garbage payment collection alternatives for recyclable rubbish might all be included in the user profile.	C4
7.	The application shows different types of waste produced for each day, weekly and monthly.	C5
8.	Facilitate residents to submit waste collection and public cleansing complaints to Waste Management authority.	C17
9.	The application reminds me to follow green practices of waste disposal (reduce, reuse and recycle) by sending push notifications about disposing of garbage, interesting events, and new events, waste or recycling pickup dates.	C9
10.	The app presents information for recycling activities that are visually appealing to the user.	C11
11.	An app that provides suggestions on alternative ways of reducing waste. (e.g., reusing plastic bags when shopping, reusing boxes for storage, etc., making an art/craft from old clothes.)	C10
12.	In order to verify the accuracy, the application provides the name of the waste management organization (e.g., KDEB Waste Management Sdn. Bhd.), a link to their website, and contact details	C19

Based on the findings in Table 4.22 above, 100% response rate was obtained from all the twelve experts. All the persuasive components had scored average Likert scoring of 3.5 to 4.8, which was in the scale of moderately important to important. All the scores were converted into fuzzy numbers. From FGD analysis, the first prerequisite was fulfilled where all the items had a threshold value $(d) \leq 0.2$ except the items C12, C13, C14, C15, C20, C21, and C23. This indicates that all the items except for C12, C13, C14, C15, C20, C21, and C23 has achieved expert consensus (Chen & Lin, 2002). For the second prerequisite, only twelve items exceed the percentage of Expert agreement 75%. Third prerequisite was used to rank the items by calculating the average fuzzy numbers. Thirteen items which did not fulfil the second prerequisite similarly had lower ranks during the analysis.

Those thirteen items were discarded and the remaining which fulfilled the prerequisites was retained for the final draft in Persuasive Design Framework for Waste Management Application. As a final draft, a total of twelve persuasive principle were finalized as the result of this Fuzzy Delphi analysis. A result from the FDM output has been finalized as following:

- Dimension 1 (D1): Primary task support {reduction, tunnelling, tailoring, personalization, self-monitoring, simulation}
- Dimension 2 (D2): Dialogue support {rewards, reminders, suggestion, liking}
- Dimension 2 (D2): System credibility {authority, verifiability}

4.4.1.6.2 Results of Expert Consensus on Components of Waste Management Application Based on Maqasid Al-Shariah

The threshold values (d) , expert consensus percentage, and defuzzification for the persuasive components (*taqwa*, *tazkiyah* and *hikmah*) for waste management (WM) application based on *Maqasid al-Shari'ah* are shown in Table 4.24.

Table 4.24: Findings of Expert Consensus on Persuasive Component for Waste Management Application based on *Maqasid al Shariah*

Persuasive component	Average Likert Score	Triangular Fuzzy Numbers		Defuzzification Process				Experts Consensus
		Threshold Value, d	Percentage of Experts Group Consensus, %	M1	M2	M3	Fuzzy Score (A)	
C26	2.80	0.488	9.09%	0.255	0.364	0.564	0.394	Discarded
C27	2.82	0.535	0.00%	0.255	0.364	0.564	0.394	Discarded
C28	2.82	0.535	0.00%	0.255	0.364	0.564	0.394	Discarded
Condition: Triangular Fuzzy Numbers 1) Threshold Value (d) ≤ 0.2 2) Percentage of Experts Consensus $> 75\%$				Defuzzification Process 3) Fuzzy Score (A) $\geq \alpha$ – cut value = 0.5				

Based on the findings in Table 4.24 above, the average Likert score for three components C26, C27, and C28 was 2.8, which is unimportant. As a result, these *Maqasid al-Shari'ah* components were excluded from framework based on FGD analysis.

4.4.1.7 Discussion

6.2.7.1 Discussion of Persuasive Principles for Waste Management Application Based on Persuasive System Design (PSD) Model

From the findings of the analysis using the fuzzy Delphi technique carried out, the researcher identified the persuasive principles as agreed by the experts. This study found from Table 4.22, that the average Likert scale for persuasive design principles for sustainable waste management application by the experts for all the items are from moderately important to important, which means some of the items can be accepted. However, post FDM analysis, only twelve persuasive (48%) principles were fulfilled all the pre-requisites and need to be applied in designing the persuasive waste management application. Around thirteen principles (52%) did not match the terms, hence those items were regarded as failure to achieve consensus from the expert panel

and removed. This 52% is the fuzziness or uncertainty among the expert panel which was not detected by the usual Likert Scale scoring system.

On the aspects of waste management application design, all experts agreed that **Reduction** is the most important principle in waste management application because it displays a color-coding calendar for a garbage collection schedule which assists users in carrying out the desired activity as evidenced by the expert's comments : *"The provided features help people to manage their waste according to the collection day and this will train them to collect and dispose the waste schedule."* (E10, HCI expert). *"It gives the reminder and knowledge for the people about the schedule for waste collection. Somehow in real practices, the schedules are fix into specific day and only applicable to household waste (2x/week) and recycle and bulky waste (1x/week in a same collection). So, it is advisable to integrate with other community programs also such as fabric collection or school recycling programs."* (E7, SWCorp expert) *"Important for users to stay alert about the collection schedules. Suitable for a busy community. They tend to forget if no proper schedule is stated"* (E10, HCI expert).

Next, **Simulation** is the second most important principle as highlighted by experts to persuade users by observing the impact of waste recycling on the environment and wellness of the people. Experts described that *"This is helpful to build a nation that emphasize green and clean environment. This is in line with KDEB Waste Management philosophy that waste is not dirty but waste is money"* (E9, KDEBWM expert). Other experts stated that *"it has the element that can make user proud after they accomplish something and indirectly motivate them do achieve more"* ((E4, Maqasid expert).). *"Totally an important and relevant feature to let the people associate their behavior to the real-world problem"* (E10, HCI expert).

Tunneling is another important strategy that had positive views emphasized by the experts because *"it is very important and proper guidelines can help users better understand and perform recycling activity with proper waste. Users also can help the government to reduce waste from being sent to the landfill."* (E7, SWCorp expert). Besides, other experts mentioned that it is *"Guided, Informative, and more of a reminder"* to encourage people to adopt green practices. Furthermore, all the experts emphasized that by offering a garbage pickup schedule depending on residential

address will effectively motivate users to practice proper waste management. They mentioned that “**Tailoring** features allow people to get information that suits to their needs or preference which will direct them to the targeted behavior” (E9, KDEBWM expert).

Other experts stated that tailoring is “important for users to stay alert about the collection schedules based on their home address. Suitable for a busy community. They tend to forget if no proper schedule is stated.” (E10, HCI expert). “It gives the feeling like the information is giving specifically for the user so they will find the information really useful, helpful and straight to the point” (E12, HCI expert).

For **Personalization** principle, one of the experts mentioned that it is “very important for any application that will be used by all of the community to be user friendly” (E12, HCI expert). However, another expert (E11, HCI expert) stated that the feature given is good UI example can be improved or enhance.

Besides, for **Self-monitoring** principle, our experts indicated that the strategy is effective and allows user keeping track of their activities and indirectly motivate them to do more. They also mentioned that “this feature is very important to let people monitor their performance in managing waste and how much the waste produced at their home may affect/contribute to the environment sustainability good for self-awareness with visual aid. It helps me in becoming minimalist” (E7, SWCorp expert). Another expert mentioned that this feature is relate to *Mahasabah* (self-evaluation) in Arabic which will motivate people to improve. Allah mentioned in Quran: “Rather, man, against himself, is well aware of himself” [Quran 75:14] (E5, Maqasid expert)

For Dialogue support category, **Rewards** is the most important principle in waste management application as highlighted by our experts. They believed that giving rewards can be a strong motivator to perform the target behavior in future as shown by the comments: “Agreed and workable strategy. Many more organization shall implement this culture. Again, to us working in KDEBWM, thrash can create cash.” (E9, KDEBWM expert). “Very important for users to get clear information about their activities. These offering rewards can uplift the user motivation to always participated in recycling activity and separate their waste” (E8, SWCorp expert).

Experts also explain about the rewards from Quran and Hadith. They mentioned that *“And (remember) that Allah is aware of whatever good you do (and you shall be rewarded for it) (Al-Baqarah: 215). “There is a reward in doing good to every living thing.” (Saheeh Al-Bukhari)”*. *“When a person intends to do a good deed, and then does it, ten good deeds will be recorded for him”*. (Sahih al-Bukhari 6491) (E5, Maqasid expert).

The principle of **Reminder** is also identified an important and helpful feature in application to perform the target behavior. Experts mentioned that it is *“very important for users to keep alert due to their packed schedule. User's tent to not doing their task for dispose their garbage and recycling activities based on the right day and time”* (E9, KDEBWM expert). *“Very useful in reminding people to perform task related to the target behavior and at the same time managing their task accordingly to meet the goal”* (E12, HCI expert). Expert also highlighted that reminder benefits civilians, especially believers. He mentioned from Quran *“And remind, for indeed, the reminder benefits the believers”* (Surah Adh-Dhariyat verse 55) (E2, Maqasid expert).

Further, **Suggestion** principle is also important to persuade people as highlighted by all experts because it provides users with knowledge, motivational messages, or suggestions for alternative ways to reduce waste as shown by the comments: *“it can give knowledge to the user and ease them in terms of finding the ideas for 3R activities”* (E9, KDEBWM expert). *“This feature offering advice that associate people to the target behavior by giving option or alternatives towards achieving the target behavior”*.

Liking is also important and useful feature in motivating individuals in a way that the user automatically understands or likes and motivates. One of the experts stated that *“It's good for users to keep on track and give positive motivation. Users feel appreciated towards their contribution for their community and nation”* (E10, HCI expert). However, another expert said that *“This is more on the look of the system rather than the function that may contribute guide towards the target behavior* (E12, HCI expert).”

On the other hand, **Praise** and **Social role** principles were rejected by all experts. As they mentioned that praise feature is very common, hence it may not have any impact to the users. Similarly, another expert said, *“This feature more of showing appreciation to the user for their effort but not really affecting the whole process in achieving the target behavior”* (E12, HCI expert). For social role, all the experts agreed that *“this feature is not relevant and did not contribute much to users’ practices”* (E10, HCI expert). On the other hand, another expert believed that *“This feature may somehow influence some people if the ambassador is a likeable person to the users.”* (E12, HCI expert). ”

For system credibility support category, the principle of **Authority** was also cited as a concern by our experts. Applications designed to complain about garbage collection and public cleaning to the solid waste management authority were perceived as more influential. They indicated that *“this feature more on instill trustworthy towards the app than persuade people to perform target behavior. However, it somehow assists people in performing target behavior”* (E12, HCI expert). ” *“Giving the confidence to the people knowing that the system integrates with authority”* (E10, HCI expert). *“Good initiatives but need to ensure also the complaint need to entertain by the responsible/PIC person and complaint status needs to be stated and mention on the application”* (E9, KDEBWM expert). Besides, all the experts expressed that

Verifiability is must and compulsory to implement in app to gain user trust and information. As one of the experts said that *“this feature is very important and relevant to show that the waste is managed by a legit organization and people will get convince that their collected waste will be handled properly”* (E9, KDEBWM expert).

On the other hand, **Trustworthiness**, **Expertise**, **Surface credibility**, **Real-world feel**, and **3rd party endorsement** perceived unimportant to persuade the Malaysian community to adopt green practices by experts through Fuzzy Delphi analysis. For **Expertise** principle, experts expressed that *“to practice waste management at home does not reach to the extend needing advice from expert”*. However, one of the experts said this feature is *“Moderately important to gain user trust and easy for users to ask if they have and questions”*. The average Likert score for **Trustworthy** and **Surface Credibility** principles is 4.0 and 4.1 respectively, though it is rejected by fuzzy Delphi

analysis. Some of the experts felt that *“trustworthy feature is important in order to make people trust and use the system. This feature applies to the content, look and feel of the system”* (E12, HCI expert).

Likewise, other experts said that *“normally, content is too technical and too informative* (E11, HCI expert). Meanwhile, some of the experts (E11 and E10, HCI expert) mentioned that surface credibility principle is *“simple, provide feedback and feel safe”* and *“the UI look, and feel may drive user to use and continue using the app because of its ease of use.”*

On the other hand one expert mentioned that *“the surface credibility principle is Good for not to interface with a lot of and push notifications. A lot of answer and push notification will make user feel uncomfortable”* (E9, KDEBWM expert).

Real World Feel is somewhat important by few experts as they believed that this feature is important to gain user trust.” and *“This feature not only bring the real world feel but also instill trustworthy for the user to perform the target behavior because they know who to refer to if some problem arises related to waste management* (E10, HCI expert).”

For Third Party Endorsement, some experts assumed that *“the use of the application was encouraged and endorsed by the ministry/government (any well-known respected sources)”* (E9, KDEBWM expert). *“Giving the confidence to the people knowing that the system integrates with authority”* (E11, HCI expert).

For Social Support category, **Social Learning, social comparison, normative influence, social facilitation, cooperation, and competition** are not significant because they include privacy issues and are only applicable to self-learning. Experts believed that **social learning** is *“relevant in offering people to learn from others about and how they perform the target behavior. For people who want others to know about what they do, this feature is a must* (E10, HCI expert). However, *“this feature is not necessary for home activities as the activities might be repeated”* (E12, HCI expert). Some experts believe that it is a matter of privacy and self-learning (E11, HCI expert).

For **Social comparison**, all experts stated that the social comparison is good for physical activity as they stated that *“I don’t see any benefits of comparing their behavior. If this is a sport like running, then yes, users would be motivated competing with other users”* (E10, HCI expert). One expert said that it is *“Good for health competition and have a health recycling community to ask any advice or help if there. The element of competition and motivates the user”* (E12, HCI expert). Nonetheless, *“this feature is important and relevant to people who like to compete and compare what they are doing with others. However, in a way it might also motivate people who do not like to compete with others become more active in performing the target behavior when they see others are doing well”* (E9, KDEBWM expert). While one expert felt that it contains *“a matter of privacy and self- motivated”* (E11, HCI expert).

For **Normative influence**, some experts mentioned that it is *“very important to make recycle is part of the user's lifestyle and stay connected with other. And it can inspire people to adopt a target behavior”* (E7, SWCorp expert) and *“In order to make the target behavior become a norm this feature is very important and relevant to be add in a system”*. While one expert said, *“being connected, but needs a privacy”* (E11, HCI expert).

Social facilitation is designed to encourage recycling activity by indicating that other users perform the behavior along with the user. *Social facilitation* seems to be *“very important to get a positive circle to enhance users to do more recycling activities”* (E10, HCI expert). And *“to some people they may need to feel that they have accompany when performing target behavior, thus this feature is important to drive user motivation towards the target behavior”* (E7, SWCorp expert). On the other hand, experts said that it is motivated but have privacy (E11, HCI expert).

As mentioned in previous chapter that **Cooperation** provides the ability to work with other people in a team to achieve a specific behavioral goal. In fuzzy Delphi analysis, experts agreed that it is also *“an important feature in order for people to work along together in achieving the target behavior. Helping each other will make it easier to persuade and educate people towards performing sustainable waste management”* (E10, HCI expert).

One expert highlighted that *“policy maker shall also enforce and encourage”* (E8, SWCorp expert) Some experts stated that *“it is good for drop an address if there are any places for users to drop off/donate their unused items.”* And it is *“Good to make users fully utilize their recyclable items especially for fabric due to the increasing number of fabric waste”* (E9, KDEBWM expert).

For **competition**, experts believed that this feature is *“good for health competition and appreciation for users' contributions”* (E12, HCI expert). Some experts believed that competition *“depend on individual. Waste management practices might not for competition as compared to e.g., physical activities”* (E11, HCI expert). On the other hand, a few experts mentioned that *“This feature more on encourage people to do waste management rather than persuade them towards the behaviour. However, this feature may be important to people who are competitive and like to become a winner. I will go with my target, not to compete. House cleaning and recycling should be non-stressful”* (E9, KDEBWM expert).

6.2.7.2 Discussion of Persuasive Concepts for Waste Management Application Based on Maqasid Al-Shariah

The findings from Table 4.24 showed that all the experts in Maqasid al Shariah were disagreed about the persuasive components of *taqwa*, *tazkiya* and *hikmah*. The experts suggested that the persuasive components for WM practices based on *Maqasid al-Shari'ah* need to be revised in order to identify more important persuasive components for waste management practices that protect our faith, health, knowledge, family and wealth. As one of the experts stated that

“Taqwa, tazkiyah and hikmah are also important. But why there are only three elements and why there is no Ihsan. Because Iman, Islam and Ihsan are three basic principles of Faith. And this kind of concept should come from experts, not the community.” (E2, Maqasid expert)

He is suggested to use one of the existing frameworks of Maqasid and embedded in the system. Similarly, another expert (E1, Maqasid expert)) also

agreed that Ihsan is more important than taqwa, tazkiyah and hikmah. As stated by our experts:

“Ihsan is more important than taqwa, tazkiyah and hikmah. Ihsan comes from Maqasid and Quran and sunnah. But taqwa, tazkiyah and hikmah does not come from Maqasid. If you ask me to add taqwa, tazkiyah and hikmah into apps. There is no proper justification. Why there is three. For that reason, I cannot give you my will on these three”. (E2, Maqasid expert)

“When we are living, we have to deal with this waste management. Then it has come under Ihsan. What is the meaning of Ihsan, Ihsan is the highest level of beneficent? Usually translated as excellence. Ihsan is a term in the famous Jibril of hadith. There is a question about Ihsan, and the prophet saw answered “أَنْ تَعْبُدَ اللَّهَ كَأَنَّكَ تَرَاهُ، فَإِنْ لَمْ تَكُنْ تَرَاهُ فَإِنَّهُ يَرَاكَ -النبي محمد ﷺ It is that you should serve Allah as though you could see Him, for though you cannot see Him yet (know that) He sees you.” If you even don't see Allah but Allah sees you. So, you have to worship as He sees you. If you are under CCTV or under camera then how much diligence you are, how much focus you are. That kind of things you can bring here.” (E5, Maqasid expert)

Besides, expert also emphasized that *daruriyyah* is the compulsory level in waste management. There are many commands from Allah s.w.t. There are many dos and don'ts from Quran and sunnah. There are some dos are *daruriyyah* level. For example, Allah says do not kill. Not killing is the *daruriyyah* because it is forbidden since it takes another person's life. Further, Experts advised identifying the compulsory level for waste management. As he described that:

“This daruriyyah is the compulsory level in waste management. Of course, if we do not practice appropriate waste management, all our life is at risk, progeny is at risk, and religion is at risk. At the daruriah level, you have to identify the compulsory level in waste management, you have to identify what are the waste we should managed. Taqwa, tazkiyah and hikmah it has nothing to do with maqasid. Then your topic will be an Islamic perspective.” The compulsory

category must be completed. Because if you don't do that you have issue with five fundamental values.” (E2, Maqasid expert)

Further, experts also highlighted about the importance of wasting or extravagance, *Tahara* (purity) and *al-nazafa* (cleanliness) to implement into the application of waste management instead of *taqwa*, *tazkiya* and *hikmah*. According to their comments:

“The taqwa that what you have written here is just إِنَّ الَّذِينَ آمَنُوا وَعَمِلُوا الصَّالِحَاتِ (Those who believe and do righteous deeds) rather than if you can bring here this kind of Ihsan and the kind of activities you are doing. As an Ihsan is one will or another comprehensively in daruli contributing to the preservation of religion. So easily you can bring the matter of taqdir Islamic against. I think you have mentioned in the picture تَبَذَّرَ (wasting) or extravagance. But I would suggest to change taqwa. I just suggest you bring the concept of Ihsan under Hifz al din, طَهَارَةٌ [tahāra] (purity) you can also bring here against تَبَذَّرَ (wasting), وَكُلُوا وَاشْرَبُوا وَلَا تُسْرِفُوا (Eat and drink and do not be extravagant). All these things.” (E5, Maqasid expert)

“Tazkiyah is the purification of the heart. You cannot use tazkiyah in maqasid. Tazkiyah is inner purification. So, how does inner purification become outer purification? Rather the proper word is here طَهَارَةٌ [tahāra] (purity) or النظافة (cleanliness) more proper word to imply or to postulate what you are talking about waste management. You can maximize the interconnection between Tahara and waste management”. (E5, Maqasid expert)

“And the hikmah I don't understand anything how it comes in waste management. You need to revise.” (E2, Maqasid expert)

Therefore, based on the expert's recommendation, the persuasive concept of *Maqasid al-Shari'ah* for waste management need to be revised and revalidated. Additionally, experts recommended to integrate *Maqasid al-Shari'ah* into the system.

4.4.1.8 Summary of Study 5

In summary, this Study 5 validate the initial persuasive design framework for waste management application by obtaining expert consensus on the most important persuasive principles and utilizing the FDM to ultimately remove the unimportant principles applied into the design of waste management application. This study found that only twelve persuasive principles are most important from PSD model that need to be applied in designing the waste management application. And the persuasive components of WM based on *Maqasid al Shariah* were rejected by all experts therefore, the framework need to revise and identify the more important principles of sustainable waste management practices within *Maqasid al-Shari'ah* framework. Therefore, the principles of waste management practices based on *Maqasid al-Shari'ah* will be identified in next section 6.3.

4.4.2 Revised Study 4 Investigate the Principles of Waste Management Practices within the Framework of Maqasid Al-Shari'ah

The aim of this study is to investigate the principles guiding sustainable waste management practices within the framework of *Maqasid al-Shari'ah*. Sustainable waste management refers to the responsible handling, reduction, and disposal of waste in a way that minimizes environmental impact, conserves natural resources, and supports economic and social well-being. It integrates waste prevention, reuse, and recycling while ensuring minimal pollution and efficient resource utilization. A qualitative content analysis method and an inductive approach has been used to outline the constituent elements that formulate the framework, this study delves into the objectives of *Maqasid al-Shari'ah* to identify underlying elements crucial for sustainable waste management.

4.4.2.1 Developing a Conceptual Framework for Implementing Maqasid al-Shari'ah in Sustainable Waste Management Practices

In the exploration of *Maqasid al-Shari'ah*, Ibn 'Āshūr (2001) stands as a pivotal figure, specifically delving into the objectives related to various aspects of life and specific knowledge disciplines. Addressing financial dealings, Ibn 'Āshūr identified five ends, including circulation, transparency, preservation, durability, and equality, contributing to financial well-being (Ibn 'Āshūr, 2001; El-Mesawi, 2006). Similarly, Al-Raysūnī (2013) and Abdullah bin Bayyah (2006) extended the discussion to various life domains, proposing objectives related to Islamic economy and finance. Previous studies, such as Mohammed et al. (2020), Hasan et al. (2016), and Darus et al. (2013), adopted *Maqasid al-Shari'ah* as a regulatory framework for financial institutions. However, these studies, although valuable, focused on adopting *Maqasid al-Shari'ah* in different areas without addressing the specific framework for its realization.

Some scholars, including Usmani (2014), Al-Raysūnī (2013), and al-'Āmilī (2007), highlighted issues of extravagance and negligence in dealing with *Maqasid al-Shari'ah*. However, the literature lacks a comprehensive framework for the actualization of *Maqasid al-Shari'ah* in waste management practices. Dusuki and Bouheraoua (2011) discussed the framework but limited the discourse to the pyramid model of economic well-being and the role of legal maxims. Other studies focused on specific elements of *Maqasid al-Shari'ah*, such as harmony, differentiation between ends and means, and conformity with *ahkam* (Al-Fawzan, 2014; Al-Raysūnī, 2012). Still, these discussions lacked an integrated framework for the proper actualization of *Maqasid al-Shari'ah* in waste management practices.

One of the contemporary Islamic scholars is Shaykh Yusuf al-Qardhawi wrote into his book "*Conservation of the environment in Islamic law*" explained the importance of environmental conservation (*hifz al-alam*) in Islam (Al-Qaradawi, 2022). This shows how close the relationship between preserving environment and *Maqāsid al-sharī'ah*. Yusuf al-Qardhawi into his book claimed that Islam is an eco-friendly religion, using *Maqasid al-Shari'ah* as a form of method. Therefore, in this study, the researcher decided to adopt the thoughts of Yusuf Qardawi about environmental conservation in an Islamic perspective on the *Maqasid al-Shari'ah* to

develop the conceptual framework of sustainable waste management practices. Al-Qardhawi believed that environmental preservation could have two forms: curative (*ijabi*) and preventive (*salbi*). Curative means preserving what already exists, whereas preventative is taking precautions to avoid unwanted damage. More detail, *Maqasid al-Shari'ah* on environmental conservation is protecting the environment is one of the values involved in meeting all five basic elements of primary needs. Then, al-Qardawi articulates the values implied by *Maqasid al-Shari'ah* for environmental preservation, namely that human presence is necessary for *khalifah* to fulfil its duty and function as the earth's prosperity. Al-Qardawi stated in his book that humans have to follow religious principles to decide their behaviors toward nature so that its continuity and availability are appropriately preserved. According to his view, *Hifz al-biah* (protecting environment) is equally essential as keeping *kulliyat al-khams* or *al-daruriyyat al-khams* (five fundamentals to be accomplished, namely protecting religion, soul, descendant, mind and wealth). That is the goal of shari'ah cannot be accomplished in the absence of successful environmental preservation efforts. Yusuf al Qardawi used the following terms:

- a) *Hifz al-biah min al-muhafadhah 'ala al-din* (preserving the environment is part of proecting the religion)
- b) *Hifz al-biah min al-muhafadhah 'ala al-nafs* (keeping the environment is part of proecting the soul)
- c) *Hifz al-biah min al-muhafadhah 'ala al-nasl* (protecting the environment equals to proecting our descendants)
- d) *Hifz al-biah min al-muhafadhah 'ala al-aql* (preserving the environment is part of safeguarding the mind)
- e) *Hifz al-biah min al-muhafadhah 'ala al-mal* (protecting the environment is part of proecting the wealth).

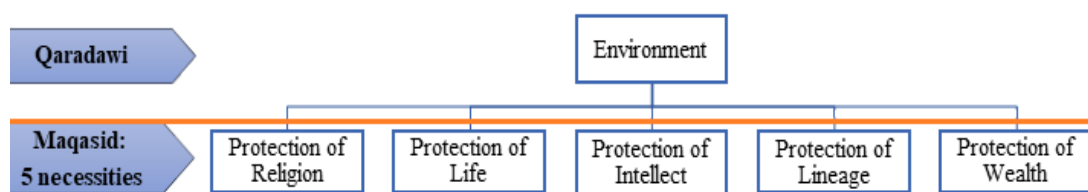


Figure 4.10: Yusuf al Qardawi view on Environment and *Maqasid al-Sharaih*

Various studies emphasized specific elements of *Maqasid al-Shari'ah*, but none provided a comprehensive conceptual framework for its implementation. The existing literature acknowledged the challenges of misusing *Maqasid al-Shari'ah*, prompting the need for a systematic framework (Dusuki and Abozaid, 2007). However, this gap remains unaddressed, and scholars have yet to provide a concrete framework for the actualization of *Maqasid al-Shari'ah* in the context of waste management practices. This study aims to fill this crucial gap in the literature by developing a comprehensive conceptual framework for harmonizing *Maqasid al-Shari'ah* with sustainable waste management practices.

4.4.2.2 Methods

This study adopts a comprehensive and tailored research methodology to align *Maqasid al-Shari'ah* with sustainable waste management practices, ultimately crafting a conceptual framework for principles and implementation. The research process employs a customized technique developed by the authors, integrating various qualitative methods for data collection and analysis. The primary data sources rely on a wealth of secondary materials, including journal articles and published books, providing a foundation for a nuanced exploration of the integration of *Maqasid al-Shari'ah* with sustainable waste management practices.

To discern the essential elements vital for the fusion of *Maqasid al-Shari'ah* with sustainable waste management, the literature review delves into Maqasid elements such as parameters, specific objectives, appropriate means, micro provisions, level of need, and legal maxims (Section 2.6.2). Emphasis is placed on the insights of modern scholars of *mu'amalat*, highlighting the significance of these elements in realizing *Maqasid al-Shari'ah* across various domains of waste management. Additionally, the literature review extends to encompass broader discussions on *Maqasid al-Shari'ah*, addressing elements that may be overlooked in the specific context of Municipal Solid Waste.

The authors' customized technique emanates from the perspectives of Maqasid scholars, particularly emphasizing the identified elements highlighted in the literature

review section. Subsequent to the literature review, the study advances to construct a conceptual framework for the actualization of *Maqasid al-Shari'ah* within the realm of waste management. This framework undergoes qualitative data analysis in several stages as follows:

- Content analysis of the existing literature was used to identify the most relevant insights regarding the actualization of *Maqasid al-Shari'ah* and its essential elements.
- An inductive approach, following Thomas (2006), is then employed for data analysis, involving detailed literature readings to derive concepts, themes, or a model that form the structured framework aligning *Maqasid al-Shari'ah* with sustainable waste management practices.
- Essential elements of Maqasid theory, drawing on the theoretical tenets suggested by Waldt (2020), Jaccard and Jacoby (2019), and Ravitch and Riggan (2016), are gathered as the foundation for formulating the conceptual framework. This encompasses the identification of Maqasid, operationalization in waste management practices, and alignment with consumers' practices in accordance with *Maqasid al-Shari'ah*.
- The constituents of the proposed framework are then represented in both narrative and graphical forms, adhering to the principles outlined by Maree (2012) and Miles and Huberman (1994), ensuring clarity and accessibility in conveying the conceptual framework. The application of this robust methodology provides valuable insights for academia, policymakers, and practitioners interested in the integration of *Maqasid al-Shari'ah* with sustainable waste management practices.

4.4.2.3 *Maqasid al-Shari'ah* and Sustainable Waste Management Practices: Proposed Conceptual Framework

After identifying the principles of waste management from *Maqasid al-Shariah*, the framework was validated by the literature of Maqasid scholars. This validation phase was carried out through expert review. An invitation email was sent to the experts. The data was collected through structured interviews to obtain the agreement and consensus of a group of experts on the conceptual framework's validity. This proposed framework provides an approach to harmonize *Maqasid al-Shari'ah* with sustainable waste management practices, encompassing essential dimensions of religiosity, healthcare and wellbeing, useful knowledge, family wellbeing, and wealth management in the context of *Jalb al-Masalah* (Serve interest) and *Daf'al-Mafsadah* (Protect from harm and corruption). The proposed framework integrates the principles of *Maqasid al-Shari'ah* into various sub-dimensions, indicators, and principles related to sustainable waste management. The suggested framework aligns *Maqasid al-Shari'ah* principles with sustainable waste management. It addresses five core dimensions under *Daruriyyah*, emphasizing religiosity, healthcare, useful knowledge, family wellbeing, and wealth management. Each dimension includes indicators and principles for responsible waste management practices, such as promoting religious duty awareness, safeguarding public health, encouraging rational resource use, considering family impact, and advocating responsible consumption. The framework aligns with the core concepts of Maqasid al-Shari'ah, emphasizing the preservation of essential values and objectives.

During the validation of framework, the *Maqasid al-Shari'ah* experts endorsed and verified the indicators and principles of the *Maqasid* principle into the *Maqasidic* Model of sustainable waste management practices. Those sub-dimensions, and indicators, principles were developed based on literature reviews and expert opinions from expert review conducted by the author. References from scholars validated the integration of Islamic values into waste management, offering a comprehensive guide for a holistic and sustainable approach. Each dimension is given for instance religiosity and is further broken down into principles in the context of *Jalb al-Masalah* and *Daf'al-Mafsadah* as listed in Table 4.25.

Table 4.25: Principles of *Maqasid al-Shari'ah* into various Sub-Dimensions, Indicators, and Principles related to Sustainable Waste Management Practices

Daruriyyah Sub-Dimensions	Indicators	Principles		References
		<i>Jalb al-Maslahah</i> (Serve interest)	<i>Daf'al-Mafsadah</i> (Protect from harm and corruption)	
<i>Hifz al-din</i>	Religiosity	• Awareness on religious duty to preserve • Perform role as a khalifah (<i>istikhlaf</i>) • Manage waste as a form to worship Allah • Encourage to adopt responsible waste disposal practices based on Islamic teaching • Preserve Trust (<i>Amanah</i>) • Belief in reward and punishment in the Day of Judgement • Enhance Islamic value (<i>Qann'ah</i>) in relation to the environment • Maintain purity (<i>Tahara</i>) of the environment and public facilities • Responsibility to protect and ensure the unity (<i>Tawheed</i>) of the God's creation	• Prevent extravagance (<i>Israf</i>) and Pollution (<i>Talwith</i>) • Prevent degradation and destruction (<i>tafsid</i>)	Ramli (2020) Abd Rahman and Jalil (2021) Hartanto, S. (2019) Saputra, A. S., Susiani, I. R., & Syam, N. (2021) Sarkawi, A. A., Abdullah, A., Dali, N. M., & Khazani, N. A. M. (2017) Azizah, A. N., Djalaluddin, A., & Siswanto, S. (2021) Samori, Z., Khairudin, Z., Saedon, R., Anas, N., & Harun, H. M. F. (2017)
<i>Hifz al-nafs</i>	Healthcare and wellbeing	• Safeguarding public health • Maintaining cleanliness (<i>Al-Nazafa</i>) and hygienic lifestyle • Highlight potential health risk of improper waste disposal • Advocating responsible waste handling and recycling	• Preventing harm to human life • Avoid excessive consumption	Hartanto, S. (2019) Azizah, A. N., Djalaluddin, A., & Siswanto, S. (2021)
<i>Hifz al-aql</i>	Useful Knowledge	• Promotion of rational resource use • Encouragement of balanced consumption • Fostering innovative thinking • Role of proper upbringing		Ramli, R. M. (2020)

		• Importance of knowledge in waste handling		
<i>Hifz al-nasl</i>	Family Wellbeing	• Focus on future generation • Advocacy for family safety • Leaving a positive legacy for family • Practice Islamic value <i>ta'awun</i> in the family • Community participation for environmental health		Zabidi, F. N. M., Abd Rahman, N., & Halim, L. (2021) Azizah, A. N., Djalaluddin, A., & Siswanto, S. (2021)
<i>Hifz al-mal</i>	Wealth Management	• Encourage responsible consumption and environmental Balance (<i>Wasat & Tawazun</i>) • Promote recycling for resource conservation • Advocate cost-effective waste management systems	• Reduction of unnecessary expenditure • Prevent wastage of resources (<i>Tabdhir</i>)	Ramli, R. M. (2020) Hartanto, S. (2019) Omar, S. M., Chowdhury, A. J. K., & Hashi, A. A. (2018)

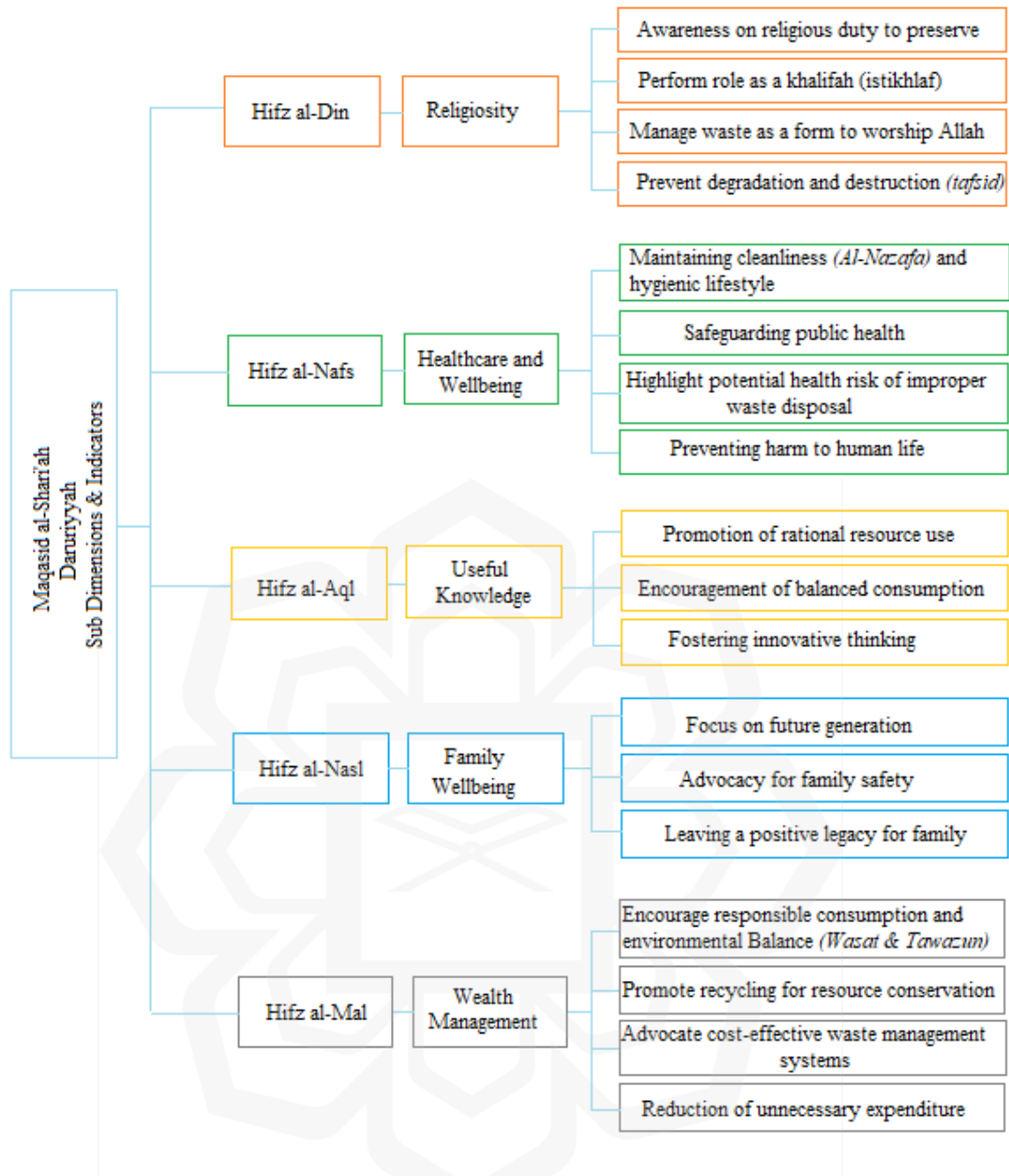


Figure 4.11: The Framework of the Principles of *Maqasid Al-Shari'ah* into various Sub-Dimensions, Indicators, and Principles Related to Sustainable Waste Management Practices

The conceptual framework for integrating *daruriyyah*, the Islamic principles of necessities, with sustainable waste management encompasses five key dimensions of preservation (*hifz*): religion (*al-din*), life (*al-nafs*), intellect (*al-aql*), progeny (*al-nasl*), and wealth (*al-mal*). Each dimension is further detailed through specific indicators that highlight the importance of actions and beliefs in promoting environmental stewardship within an Islamic ethical context. For instance, *hifz al-din* emphasizes

religious duties towards preservation, including the role of humans as stewards (*khalifah*) and the importance of maintaining the purity of the environment.

Similarly, other dimensions focus on safeguarding public health, promoting rational resource use, ensuring family wellbeing, and managing wealth responsibly, all guided by the overarching principles of serving interest (*jalb al-masalah*) and protecting from harm (*daf' al-mafsadah*). This framework aims to harmonize Islamic ethical objectives with sustainable waste management practices, advocating for a holistic approach that encompasses religious duty, health, intellectual responsibility, familial legacy, and economic sustainability in preserving the environment.

i. Hifz-al Din (Preservation of Faith)

Hifz-al Din is the most crucial that lead individuals to embrace the presence of Allah in each human endeavor, acts or oversights, as guided by His revelations documented in the Qur'an and Sunnah. According to Sahih Bukhari, al-din includes three essential components namely Islam, Iman, and Ihsan. To preserve religion within the practice of sustainable waste management practices, religiosity is seen as playing an important role in preserving the environment. Religiosity is defined as the extent of knowledge, the intensity of the belief, the orderliness of worship and the profundity of the appreciation of religion. A person's level of religiosity based on their religious work or practices (*Islam*), belief in God (*Faith*), and the spirit of self-actualization to do good and benevolence (*Ihsan*) (Mohd Mahudin et al., 2016).

Many studies have studied the role of religiosity in environmental sustainability and environmentally friendly behavior. For example, some studies found that religiosity plays a significant role to eco-literacy and environmental concern towards ecologically conscious behavior among Moslem Society in Indonesia (Nurhaida et al., 2022). These findings also indicate that the influence of three levels of religiosities-Islam, Faith, Ihsan on environmentally friendly behavior provide enlightenment to individual and help them learn more so that their literacy level rises and ultimately motivates them to act in an environmentally friendly manner based on and considering Islamic moral values.

Therefore, we could say religiosity can play an important role in practicing the sustainable waste management among the Muslim society in Malaysia. A high level of religiosity and having a conscientious attitude toward caring the environment, for a Muslim is an effort to fulfill the call of Allah in Surah Al Anbiya verse 107. Therefore, Muslims must practice the following principles to manage waste and preserve the environment.

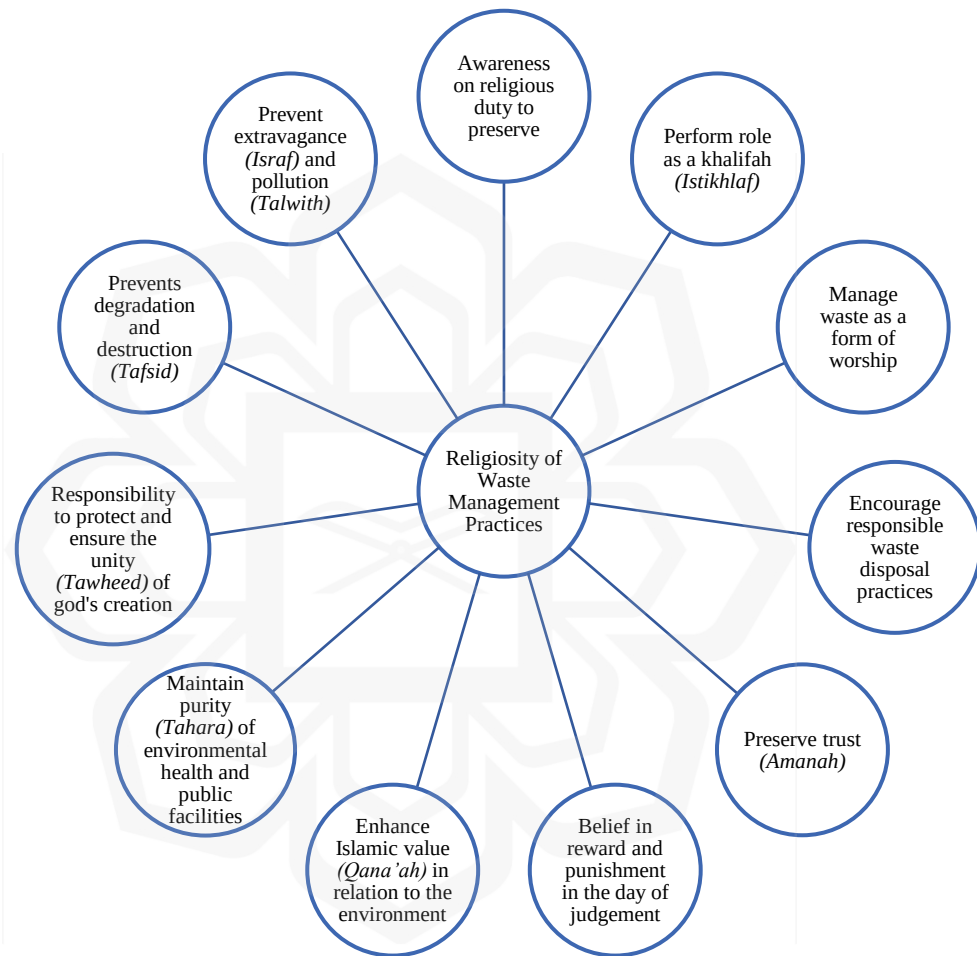


Figure 4.12: Religiosity of Waste Management Practices Based on *Maqasid al-Shariah*

Figure 4.12 presents a conceptual map that integrates the principles of Islamic law (Shariah) with the objectives of environmental stewardship and waste management. This framework underscores the religious imperative for Muslims to recognize waste management as part of their faith practice. Central to this is the

concept of *Tawheed*, the oneness and unity of God's creation, which demands a responsibility to protect and maintain the purity (*Tahara*) of the environment and public facilities. The role of Muslims as *khalifah* (stewards) on Earth is emphasized, where managing waste is not only a societal duty but also an act of worship (*Ibadah*) that is ultimately accountable in the Day of Judgement. The figure also highlights the need to prevent degradation and destruction (*Tafsid*) of the Earth, as well as to avoid exploitation (*Israf*) and pollution (*Talwith*), promoting balance and moderation in consumption. Furthermore, it calls for enhancing the Islamic value of contentment (*Qana'ah*) and preserving the trust (*Amanah*) bestowed upon humans to care for the planet. This holistic view encourages Muslims to adopt responsible waste disposal practices rooted in religious teachings, aiming for a sustainable interaction with the environment that aligns with the broader goals of Shariah for the well-being of all creation.

Table 4.26: Religiosity of Waste Management Practices based on *Maqasid al-Shariah*

No.	Principles	Key points
1.	Awareness on Religious Duty to Preserve:	- Waste management is a religious duty for Muslims to preserve al-din (religion) and maintain ecological balance, emphasizing Quranic wisdom (<i>hikmah</i>). - Preservation of the environment is a mandatory religious obligation based on <i>tawhid</i>, <i>khalifah</i>, and accountability principles. - Muslims are accountable for sustaining and protecting the environment and will be judged in the Day of Judgement for their actions (Quran 54:49).
2.	Perform Role as a Khalifah (<i>Istikhlaf</i>):	- Muslims are entrusted as <i>khalifah</i> of the earth, responsible for preserving and caring for the environment. - Quranic references highlight Muslims' role as <i>khalifah</i> to protect the environment, emphasizing accountability and disapproval of spreading disorder.
3.	Manage Waste as a Form of Worship:	Managing waste is considered an act of worship (<i>Hifz al-din</i>) for Muslims, earning rewards in this life and the Hereafter.

		• Quranic calls for proclaiming and perfecting the religion include responsible waste management as an integral part.
4.	Encourage Responsible Waste Disposal Practices:	• Islamic teachings advocate responsible waste disposal practices to maintain ecological balance and treat all living things with beneficence (<i>Ihsan</i>).
5.	Preserve Trust (<i>Amanah</i>):	• Poor waste management goes against justice and <i>ihsan</i>, leading to environmental damage and degradation. • The environment is considered a trust (<i>Amanah</i>) in Islam, and Muslims are khalifah obligated to manage, steward, and protect it. • Neglecting this trust leads to imbalance and disharmony, emphasizing the importance of respecting responsibilities for Allah's pleasure.
6.	Belief in Reward and Punishment in the Day of Judgement:	• Muslims believe in accountability for every action in the Day of Judgement, emphasizing the realization of their role as khalifah and working for the environment as an <i>ibadah</i> (act of worship). • Building an environment in line with Quran and Sunnah generates rewards in this world and the Hereafter.
7.	Enhance Islamic Value (<i>Qana'ah</i>) in Relation to the Environment:	• Muslims need to instill Islamic values, including gratitude (<i>Qana'ah</i>), for the abundance of nature and contribute to environmental sustainability. • Strengthening religious faith and knowledge helps cherish and respect Allah's creation, fostering love for the environment.
8.	Maintain Purity (<i>Tahara</i>) of Environmental Health and Public Facilities:	• Purification (<i>Tahara</i>) is obligatory in Islam, and effective waste management is essential for environmental health and human safety. • Maintaining cleanliness is praised in the Quran and Sunnah, with cleanliness considered half of faith
9.	Responsibility to Protect and Ensure the Unity (<i>Tawheed</i>) of God's Creation:	• Protecting the environment, including minimizing waste, is essential for safeguarding the unity (<i>Tawheed</i>) of God's creation in Islam. • Tawhid defines the relationship between humans, God, and different manifestations in the universe.
10.	Prevents Degradation and Destruction (<i>Tafsid</i>):	• Muslims must prevent environmental degradation and destruction caused by waste mismanagement, as it is considered a great sin in Islam.

	• Environmental contamination violates God's commandments and leads to imbalance and lack of harmony between humans and the environment.
11. Prevent Extravagance (<i>Israf</i>) and Pollution (<i>Talwith</i>):	• Islam prohibits wasteful consumption (<i>Israf</i>) and pollution of natural resources, emphasizing responsible resource use. • Overconsumption and waste lead to environmental problems, and Islam calls for preventing extravagance and protecting the environment from pollution.

The conceptual framework of waste management practices in Islam, as outlined in Table 4.11 of the paper, is grounded in the *Maqasid al-Shariah*, which upholds environmental stewardship as a reflection of religious duty. This duty is rooted in the Quranic concept of balance or 'hikmah', where Muslims are tasked with preserving 'al-din' (religion) by maintaining ecological balance (Quran 54:49). As stewards or '*khalifah*' of the earth, Muslims are entrusted with the responsibility to safeguard the environment, an obligation that is deeply embedded in the tenets of 'tawheed', 'khalifah', and 'accountability'. Such stewardship is not merely a societal role but is deemed an act of worship ('*ibadah*'), integral to the faith itself and subject to divine scrutiny on the Day of Judgement.

The principles further advocate for responsible waste disposal practices as a manifestation of '*ihsan*' (beneficence) towards all living things, aligning with the Quranic guidance that enjoins justice and goodness while forbidding acts that cause harm and corruption (Surah al-Nahl:90). This extends to the preservation of trust ('*amanah*'), wherein Muslims are called to honor the trust endowed upon them by Allah to manage and protect the environment, a trust that if breached, disrupts the harmony and balance ordained by Allah.

Moreover, the framework emphasizes the importance of embedding Islamic values such as '*Qana'ah*' (contentment and gratitude) in relation to nature's bounty, which fosters a lifestyle of moderation and sustainability. Upholding the purity ('*Tahara*') of the environment reflects the intrinsic Islamic principle that cleanliness is a component of faith, which when integrated into waste management practices,

protects public health, and ensures the well-being of the community. The overarching principle of '*Tawheed*' (the oneness of God) underlines the interconnectedness and unity of all elements of creation, which Muslims are duty-bound to protect from degradation and destruction ('*Tafsid*'), thereby avoiding wasteful consumption ('*Israf*') and pollution ('*Talwith*') that contribute to ecological imbalance. This holistic approach to waste management is not only a practical response to environmental challenges but also a moral and spiritual imperative that aligns earthly actions with celestial accountability, resonating through the paper's narrative and recommendations.

ii. Hifz al-Nafs (Preservation of Life)

From an Islamic viewpoint, the preservation of life (*hifz al-nafs*) is the second most important after the preservation of faith (*hifz al-din*). The importance of the preservation of life has been mentioned and emphasized many times in the Qur'an and hadith of the Prophet Muhammad (PBUH). Past studies proven to have a lot of contributions of *Maqasid al-Shari'ah* to protect our life and promote the wellbeing. For example, some study found that the implementation of *hifz al-nafs* principle at the mosque during the Covid-19 pandemic is regarded as a primary necessity (*daruriyyat*) because it preserves life while offering spiritual continuity of collective religious worship, thereby uniting the community within a paradigm of health and sanctity of life during this challenging time. In the line with waste management, various teachings could be observed from the Holy Qur'an and hadith of the Prophet (peace be upon him) to preserve human life and promote wellbeing for all. Muslims can take the following actions to fulfil the goal of *hifz al-nafs* through practicing sustainable waste management:



Figure 4.13: Healthcare and Wellbeing for Waste Management Practices Based on *Maqasid al-Shariah*

Figure 4.13 illustrates the Islamic perspective on the environmental responsibilities that protect public health and promote a hygienic lifestyle. Central to this framework is the principle of safeguarding public health by minimizing the health risks associated with improper waste disposal, which aligns with the teachings of Islam that emphasize the cleanliness (*Al-Nazafa*) and purity as part of faith. The figure also stresses the importance of responsible waste handling and recycling as an act of stewardship (*khalifah*), which helps prevent harm to human life, a key tenet in Islamic teachings on the preservation of life (*hifz al-nafs*). Furthermore, it touches upon the need to avoid excessive consumption, which is not only an environmental concern but also a moral one, as waste contributes to the degradation of the Earth's resources and human well-being. This holistic approach combines religious duty with practical actions to achieve the greater goal of a sustainable and healthy living environment, reflecting the integrated Islamic principle of ensuring welfare (*maslahah*) in all aspects of life.

Table 4.27: Healthcare and Wellbeing for Waste Management Practices based on *Maqasid al-Shariah*

No.	Principles	Key Points
1.	Safeguarding Public Health	• Poor waste management poses significant risks to public health, leading to increased morbidity and mortality. • Open dumping is a common and hazardous disposal method, emphasizing the need for safe waste management practices. • Key elements for public health protection include waste volume reduction, proper waste segregation, risk awareness, sustainable waste methods, and individual protection during waste handling. • The Prophet's teachings highlight the prohibition of harmful activities to public health, extending to waste management practices. • Emphasis on finding sustainable solutions like reducing, reusing, recycling, or extracting energy from waste.
2.	Maintaining Cleanliness (<i>Al-Nazafa</i>) and Hygienic Lifestyle	• The Prophet's statement, "cleanliness is half of faith," underscores the integral role of cleanliness in one's faith. • Islam promotes cleanliness in various aspects of life, including the body, clothes, home, and personal hygiene. • The Prophet's attention to road cleanliness and the harm caused by waste emphasizes the religious obligation to maintain environmental cleanliness. • Removing harm or waste materials from roads is considered a branch of faith, highlighting the importance of waste management for environmental and personal health.
3.	Highlighting Potential Health Risks of Improper Waste Disposal	• Improper waste disposal poses significant threats to human health, leading to various diseases. • Effective waste management reduces health risks, preventing diseases such as food poisoning, skin infections, and vector-borne illnesses. • Proper waste management aligns with the principle of protecting life (<i>hifzh al-nafs</i>) and promotes health and well-being.

4.	Advocating Responsible Waste Handling and Recycling	• Muslims are encouraged to avoid and reduce waste, aligning with Islamic teachings. • The responsibility includes promoting responsible waste handling and recycling to protect health and well-being. • Government initiatives for waste separation and rewards for proper waste management can reduce health hazards, government expenditure, and promote recycling.
5.	Preventing Harm to Human Life	• The Quran emphasizes the responsibility to protect human life, extending to protecting the environment from pollution. • Proper household waste management is crucial to minimize environmental pollution and prevent harm to human life. • Appropriate and safe solid waste management is essential for maintaining healthy living conditions.
6.	Avoiding Excessive Consumption	• Excessive consumption is identified as the root cause of environmental degradation. • The Quran discourages excess and waste, emphasizing moderation in all behaviors and activities. • Islam promotes minimizing waste by reducing resource use and consumption to protect life and well-being.

Table 4.27 of the paper presents a holistic Islamic framework on healthcare and wellbeing in the context of waste management, as outlined in *Maqasid al-Shariah*. This framework emphasizes the critical role of responsible waste management in safeguarding public health and maintaining cleanliness, deeply anchored in Islamic teachings.

The first principle focuses on safeguarding public health, highlighting the dire consequences of poor waste management on human health, including increased morbidity and mortality (Omar et al., 2018). This principle underscores the necessity of implementing safe waste management practices, such as reducing waste volume, effective segregation, and enhancing awareness of associated risks. It resonates with the teachings of Prophet Muhammad, who advocated against harmful activities to public health, thus extending to waste management practices (Nasir et al., 2022).

Emphasizing sustainable solutions like reducing, reusing, recycling, or extracting energy from waste is crucial to mitigating the risks posed by hazardous disposal methods like open dumping.

Maintaining cleanliness (*Al-Nazafa*) and promoting a hygienic lifestyle form the second key principle. In Islam, cleanliness is an integral part of faith, as highlighted by the Prophet's saying, "cleanliness is half of faith" (Samori et al., 2017). The Prophet's attention to road cleanliness and the removal of waste materials underscores the religious obligation to maintain environmental cleanliness, extending to personal hygiene. This principle emphasizes the removal of harm or waste materials from public spaces as a crucial aspect of faith, underlining the significance of waste management in ensuring both environmental and personal health.

The subsequent principles in Table 4.27 address the health risks of improper waste disposal, the advocacy of responsible waste handling and recycling, the prevention of harm to human life, and the avoidance of excessive consumption. These principles stress the threats to human health posed by improper waste disposal, including the spread of various diseases (Azizah et al., 2021). Effective waste management aligns with the Islamic principle of protecting life (*hifzh al-nafs*) and enhances health and well-being. Additionally, the Islamic teachings encourage responsible waste handling and recycling as a means to protect health and the environment (Nasir et al., 2022). This approach to waste management is in line with Islamic teachings that discourage excess and promote moderation in consumption, thereby protecting life and enhancing overall well-being.

iii. Hifz al-Aql (Preservation of Intellect)

Utilization, protection, and safeguarding the natural resources and environment are firmly connected with the preservation of intellect (*hifz al-Aql*). Allah has ordered that every Muslim should protect the gift of *al-Aql* from Allah by utilizing the benefit of all and not for any kind of evil that might lead to destruction. In the context of waste management, Maqasid al Shariah plays an essential role in formulating order in Muslim thinking and behaviour that leads them to do what is good and avoid what is wrong. Therefore, they will feel obliged to learn 3Rs (reduce, reuse, recycle) that

would assist them to make a good judgment in handling waste at home. This knowledge will carry out good deeds for the benefit of mankind, including devoutly caring for the environment and managing its resources.



Figure 4.14: Useful Knowledge for Waste Management Practices based on *Maqasid al-Shariah*

Figure 4.14 highlights the integral role of education and awareness in shaping sustainable waste management practices in accordance with Islamic principles. It underscores the necessity to promote consumption patterns that are responsible and mindful of resource utilization. The figure also advocates for innovative thinking to foster creative solutions in waste management, while emphasizing the crucial role of proper upbringing in instilling values of environmental stewardship from a young age. Additionally, the provision of knowledge and education in proper waste handling and segregation is presented as key to enabling informed community participation in waste reduction efforts. By incorporating these educational and behavioral principles, the framework aims to guide Muslim communities towards a more sustainable and ethically aligned approach to waste management, reflecting the holistic view of conservation and resource efficiency encouraged by *Maqasid al-Shariah*.

Table 4.28: Useful Knowledge for Waste Management Practices based on *Maqasid al-Shariah*

No.	PRINCIPLES	KEY POINTS
1.	Promotion of Rational Resource Use	• Islamic teachings emphasize rational and efficient use of natural resources, encouraging Muslims to acquire knowledge for responsible utilization. • The Quran and Sunnah advocate understanding and intellect to prevent waste and misuse, signifying appreciation to Allah and respecting the rights of other creatures for ecological balance.
2.	Encouragement of Balanced Consumption	• Economic growth and urbanization increase disposable income, leading to higher consumption and waste generation. • Islam prohibits excessive consumption, promoting a moderate lifestyle that aligns with Shariah principles to protect the environment.
3.	Fostering Innovative Thinking	• Islam encourages Muslims to use their intellect for sustainable waste management, aligning with Quranic verses emphasizing seeking knowledge. • Innovative thinking is essential to reduce waste, minimize environmental pollution, and contribute to a sustainable future.
4.	Role of Proper Upbringing	• Proper upbringing in Islam aims to instill awareness of responsibility towards Allah, including the duty to manage waste and protect the environment. • Early education on waste management for children helps cultivate awareness and responsibility in addressing waste-related issues.
5.	Importance of Knowledge in Waste Handling	• Providing knowledge and education about various waste management methods is crucial for promoting eco-friendly practices. • Environmental education, supported by Shari'ah principles, enhances intellectual well-being and contributes to sustainable development by addressing environmental crises.

Table 4.28 of the paper delineates an Islamic framework for imparting useful knowledge in the realm of waste management, as per *Maqasid al-Shariah*. This

framework emphasizes the importance of education and awareness in fostering sustainable waste management practices.

The first principle highlights the promotion of rational resource use, rooted in Islamic teachings that advocate for the judicious and efficient utilization of natural resources. This principle is supported by Quranic and Sunnah teachings, which encourage understanding and intellect to avoid waste and misuse, thereby showing appreciation to Allah and maintaining ecological balance (Nasir et al., 2022). This principle signifies the importance of respecting the rights of other creatures and maintaining the ecological balance that is integral to Islamic teachings.

The second principle, the encouragement of balanced consumption, addresses the challenges posed by economic growth and urbanization, which typically lead to increased disposable income and consequently, higher consumption and waste generation. Islam's stance against excessive consumption is clear, advocating for a moderate lifestyle that is in harmony with Shariah principles to protect the environment. This approach is crucial in minimizing waste generation and promoting environmental sustainability (Azizah et al., 2021).

The third and fourth principles focus on fostering innovative thinking and the role of proper upbringing. Islam encourages the use of intellect in sustainable waste management, aligning with Quranic verses that emphasize the pursuit of knowledge. This innovative thinking is essential for reducing waste and minimizing environmental pollution, contributing to a sustainable future. Additionally, proper upbringing in Islam plays a vital role in instilling a sense of responsibility towards Allah, including the duty to manage waste and protect the environment. Early education about waste management for children is crucial for developing awareness and responsibility regarding waste-related issues (Samori et al., 2017).

The fifth principle underscores the importance of knowledge in waste handling. Providing education about various waste management methods is critical for promoting eco-friendly practices. Environmental education, grounded in Shari'ah principles, not only enhances intellectual well-being but also contributes significantly to sustainable development by addressing environmental crises. This comprehensive

approach to waste management education, as outlined in the table, is instrumental in guiding both current and future generations towards responsible and sustainable waste management practices.

iv. Hifz al-Nals (Preservation of Lineage)

The Shariah provides deterministic rewards and incentives for favorable action towards promoting positive externalities in the environment. Regarding this, the Prophet Muhammad (SAW) said, *“Whoever plants trees, God will give him reward to the extent of their fruit”*. This objective is rightly addressed in *Hifz al-Nasl*, which is the fourth dimension of *Maqasid al-Shariah*. The Prophet Muhammad (SAW) also mentioned that *“If the Resurrection were established upon one of you while he has in his hand a sapling, then let him plant it”*. During our limited lifetime, we must utilize and protect the given resources of the planet as trustees and the benefit we are getting should pass it to our next generation. Therefore, Muslims are obliged to save the resources and manage the waste as a form of responsibility and practice the following principles so that our children (offspring) can grow up in a healthy natural environment:

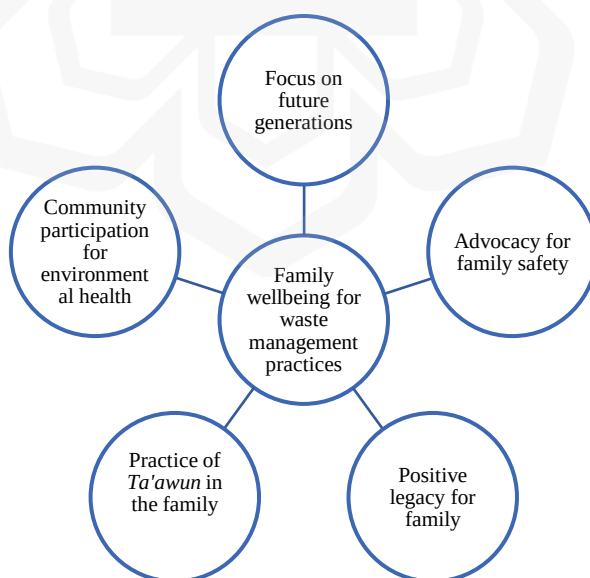


Figure 4.15: Family Wellbeing for Waste Management Practices based on *Maqasid al-Shariah*

Figure 4.15 presents a conceptual map linking family wellbeing with sustainable waste management in the light of Islamic principles. It emphasizes the importance of safeguarding the environment for future generations, advocating eco-friendly practices for family safety, and fostering community participation. The figure also highlights the need to inculcate the Islamic value of cooperation (*ta'awun*) within the family unit, which plays a critical role in enhancing environmental awareness and action. Moreover, it stresses the significance of leaving a positive legacy that upholds the teachings of Islam related to environmental stewardship, ensuring that waste management contributes to the overall wellbeing of the family and the wider community. This framework serves as a guide for integrating religious values with practical environmental actions, promoting a collaborative and intergenerational approach to preserving the earth's resources.

Table 4.29: Family Wellbeing for Waste Management Practices based on *Maqasid al-Shariah*

No.	Principles	Key points
1.	Focus on Future Generations	- Managing waste is crucial to protect human life and ensure the well-being of future generations. - Islamic teachings emphasize appreciation and preservation of natural resources for the continuity of life, necessitating the development of sustainable waste management practices.
2.	Advocacy for Family Safety	- Islam emphasizes safeguarding both the environment and human beings from destructive effects like waste. - Eco-friendly waste disposal practices are obligatory for Muslims, contributing to family safety and well-being.
3.	Positive Legacy for Family	- Leaving a positive legacy in Islamic teachings is essential, emphasizing the responsibility to contribute positively to society. - Muslims are encouraged to spread true Islamic teachings, knowledge, and skills related to waste management, aiming to leave a lasting impact on future generations.

4. Practice of <i>Ta'awun</i> in the Family	• Providing awareness to the family about environmental care aligns with the Islamic value of <i>ta'awun</i> (cooperation). • Teaching family members to preserve the environment, reduce natural resource usage, and participate in conservation campaigns reflects the Islamic principle of preventing evil through capacity and advice.
5. Community Participation for Environmental Health	• Involvement in community activities is essential for addressing environmental issues, especially waste management. • Community participation in waste management contributes to creating awareness and a sense of responsibility for a clean and healthy environment, aligning with Islamic teachings on cooperation and responsibility.

Table 4.29 in the paper outlines a framework for family wellbeing in the context of waste management, guided by the principles of *Maqasid al-Shariah*. This framework highlights the integral role of families in promoting environmental sustainability and the well-being of future generations through responsible waste management practices.

The first principle emphasizes the importance of focusing on future generations. Managing waste effectively is essential for protecting human life and ensuring the well-being of future generations. Islamic teachings advocate for the appreciation and preservation of natural resources, emphasizing the need for sustainable waste management practices. This approach is rooted in the Islamic belief that the continuity of life depends on the responsible stewardship of the environment (Nasir et al., 2022).

Advocacy for family safety forms the second principle, where Islam underscores the need to safeguard both the environment and human beings from the destructive effects of waste. Eco-friendly waste disposal practices are not just encouraged but considered obligatory for Muslims, contributing significantly to family safety and well-being. This principle aligns with the Islamic view of environmental conservation as an integral part of preserving human life and health (Samori et al., 2017).

The third and fourth principles focus on leaving a positive legacy for the family and the practice of *Ta'awun* (cooperation) within the family unit. Islamic teachings emphasize the importance of contributing positively to society, encouraging Muslims to impart true Islamic teachings, knowledge, and skills related to waste management to their families. This approach aims to leave a lasting positive impact on future generations, ensuring the continuation of responsible environmental practices (Azizah et al., 2021). Additionally, raising family awareness about environmental care and teaching family members to preserve the environment, reduce natural resource usage, and actively participate in conservation campaigns are seen as reflections of the Islamic value of *Ta'awun*. This principle emphasizes the role of family in preventing environmental harm and promoting sustainable practices.

The fifth principle highlights the importance of community participation in environmental health. Active involvement in community activities, particularly in waste management, is crucial for addressing environmental issues. Community participation not only fosters awareness but also instills a sense of responsibility for maintaining a clean and healthy environment. This principle aligns with Islamic teachings on cooperation and collective responsibility, underscoring the communal aspect of environmental stewardship (Omar et al., 2018).

Together, these principles present a comprehensive Islamic approach to family wellbeing in waste management, emphasizing the collective responsibility of families and communities in environmental conservation and sustainable practices.

iv. Hifz al-Mal (Preservation of wealth)

In Islam, the word wealth (*al-mal*) refers to all the resources that Allah has made devoted to man including all rights and rewards of ownership. Allah (s.w.t) made human as *Khalifah* to protect and manage the resources wisely without causing harm on earth by promoting *Ihsan* (benevolence) and *Adl* (justice). According to Al-Shatibi the preservation of wealth demonstrates the prohibition against injustice, wastefulness, inefficiencies, and corruption on earth (Zailani et al., 2022).

The principle of *hifz al-mal* could be line in achieving a sustainable solid waste management system by preventing wastage, unnecessary expenditure, promoting recycling, encouraging responsible consumption habit and advocate cost effective waste management system that will ultimately reduce landfill wastes, reduce the government expenditure, create job employment, enhance economic growth, and improve the quality of life among Muslim countries.

One study confirmed that the waste segregation policy in Malaysia has contributed significantly to the increased segregated waste volume and waste reduction in landfills, enhances the recovery of recyclable materials at the source. The policy has significantly contributed to reducing waste management costs in the landfills at 61 thousand USD per year through the waste segregation program in the states under Act 672. The program could also generate profits through recyclable trading at 130 thousand USD per year (Rangga et al., 2022). Therefore, we should practice more the following principles to meet the goal of *hifz al-mal* and provide more economic benefits to the country.

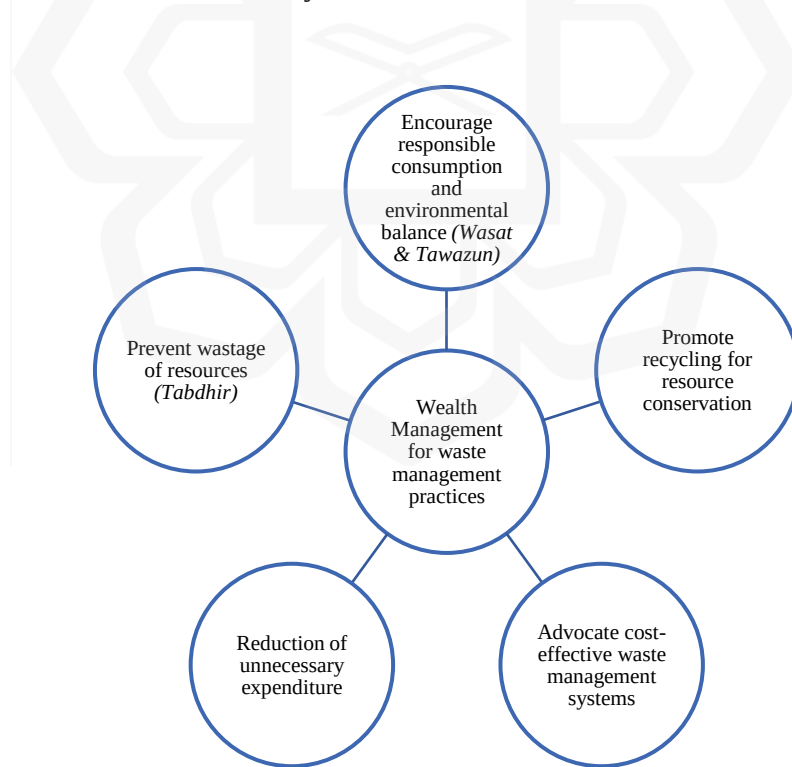


Figure 4.16: Wealth Management for Waste Management Practices based on *Maqasid al-Shariah*

Figure 4.16 encapsulates the Islamic principles that advocate for a responsible and sustainable approach to environmental stewardship through waste management. It underscores the necessity of adopting cost-effective systems that emphasize recovery, recycling, and conservation of resources to prevent extravagance (*Israf*) and wastage (*Tabdhir*). It also highlights the importance of promoting recycling as a means to conserve resources, encouraging responsible consumption habits that align with the Islamic principles of balance (*Wasat*) and moderation (*Tawazun*). These interconnected concepts form a holistic approach that not only seeks to minimize unnecessary expenditure and the environmental impact of waste but also aligns with the broader objectives of preserving wealth in the context of Islamic ethics and ensuring a sustainable future for all.

Table 4.30: Wealth Management for Waste Management Practices based on *Maqasid al-Shariah*

No.	Principles	Key Points
1.	Encourage Responsible Consumption and Environmental Balance (<i>Wasat & Tawazun</i>)	• Islam promotes responsible consumption to mitigate risks associated with overconsumption. • Excessive consumption, especially wasting food, negatively impacts the environment and goes against Quranic teachings. • Emphasis on order, balance (<i>tawazun</i>), and cleanliness (<i>Taharah</i>) to minimize waste aligns with Islamic principles of justice and moderation (<i>wasat</i>).
2.	Promote Recycling for Resource Conservation	• Muslims are encouraged to be stewards of the earth, emphasizing the responsibility to promote recycling. • Recycling benefits the environment by reducing the need for new production, preventing deforestation, saving energy, and contributing to a more sustainable future.
3.	Advocate Cost-Effective Waste Management Systems	• The Malaysian government spends a significant amount on solid waste management annually. • Advocating cost-effective waste management through segregation can reduce disposal costs and enhance the recovery of recyclable materials at the source.
4.	Reduction of Unnecessary Expenditure	• Islamic principles discourage wasteful or excessive spending, promoting moderation. • Quranic verses and teachings of Prophet Muhammad encourage moderation, applicable to

			both worldly resources and environmental protection.
			• Minimizing unnecessary expenditure is advocated to reduce overall waste generation.
5.	Prevent Wastage of Resources (Tabdhir)	of	• Islam strongly condemns wastage (<i>Tabdhir</i>) of resources, considering it as disliked by Allah. • Wasting wealth or property is equated with the behavior of Satan's brothers in Quranic verses. • Muslims are obligated to manage waste productively, avoiding acts of <i>Tabdhir</i> and contributing to a clean environment.

Table 4.30 in the paper provides a framework for wealth management in waste management practices, guided by the principles of *Maqasid al-Shariah*. This framework emphasizes the Islamic approach to environmental stewardship through responsible consumption, recycling, and efficient waste management.

The first principle, encouraging responsible consumption and environmental balance (*Wasat & Tawazun*), reflects Islam's promotion of moderation to mitigate risks associated with overconsumption. Excessive consumption, particularly in the context of food waste, is highlighted as having a negative impact on the environment, going against the Quranic teachings. Islam places emphasis on order, balance (*tawazun*), and cleanliness (*Taharah*) as means to minimize waste, aligning with the principles of justice and moderation (*wasat*). This approach underscores the importance of responsible consumption as a key element in sustainable waste management and environmental conservation (Nasir et al., 2022).

The second principle underscores the promotion of recycling for resource conservation. In Islam, Muslims are encouraged to act as stewards of the earth, responsible for promoting recycling. This practice is beneficial for the environment as it reduces the need for new production, prevents deforestation, saves energy, and contributes to a more sustainable future. Recycling aligns with the Islamic values of stewardship and responsibility towards the earth, ensuring that resources are used efficiently and sustainably (Azizah et al., 2021).

The framework also advocates for cost-effective waste management systems, emphasizing the significant expenditure by governments, such as the Malaysian

government, on solid waste management. By advocating for cost-effective strategies, such as waste segregation, it is possible to reduce disposal costs and enhance the recovery of recyclable materials at the source. Additionally, the framework highlights the importance of reducing unnecessary expenditure, in line with Islamic principles that discourage wasteful or excessive spending. Quranic verses and the teachings of Prophet Muhammad encourage moderation in both consumption of worldly resources and environmental protection, advocating for minimizing unnecessary expenditure to reduce overall waste generation (Omar et al., 2018).

Finally, the principle of preventing wastage of resources (*Tabdhir*) is emphasized. Islam strongly condemns the wastage of resources, considering it as behavior disliked by Allah. Wasting wealth or property is equated with the behavior of Satan's brothers in Quranic teachings. Muslims are obligated to manage waste productively, avoiding acts of *Tabdhir* and contributing to a clean environment. This principle underlines the importance of efficient resource use and waste management as an integral part of Islamic environmental ethics and wealth management.

Together, these principles present a comprehensive Islamic approach to wealth management in waste management, emphasizing responsible consumption, recycling, cost-effectiveness, and the prevention of resource wastage as key components in sustainable environmental practices.

The framework presented in Study 4 based on *Maqasid al-Shariah*, offers a significant and comprehensive Islamic perspective on waste management, encompassing the principles of public health, family wellbeing, wealth management, and more. This framework is instrumental in illustrating how Islamic teachings can be effectively integrated into contemporary environmental management practices. By emphasizing the importance of responsible consumption, recycling, balanced lifestyle, and sustainable practices, it aligns ecological stewardship with religious duties, providing a moral and ethical impetus for Muslims and the broader community to engage in environmentally responsible behaviors. Therefore, identifying these principles of sustainable WM practices within the framework of *Maqasid al-Shari'ah* mark the research objective of Study 4. In next Study 6, these principles of Maqasid al Shariah will be integrated with the selected persuasive design principles (Study 5)

to design a medium-fidelity prototype using *Justinmind* prototyping tool and will be validated in a second round of Fuzzy Delphi technique by an expert review.

4.4.3 Study 6 Determination of Persuasive Principles of Waste Management Framework Based on Maqasid Al-Shari'ah

The Study 6 presents a revised persuasive design framework for waste management practices. In the framework, the five dimensions of *Maqasid al-Shari'ah* has been implemented to increase awareness from Shariah Perspective and persuade more to adopt green practices of waste management. Later, the components and features of persuasive design framework for waste management practices were validated using fuzzy Delphi method (FDM) via experts' review.

4.4.3.1 Revised Persuasive Design Framework

The Figure 4.17 shows the revised persuasive design framework for waste management application. There are 12 persuasive components selected for waste management application from 1st round of fuzzy Delphi analysis that are marked as C1 to C12 as shown in Figure 4.17. The five dimensions of *Maqasid al-Shari'ah* was applied with each persuasive components and all the components together with its user interface design was evaluated as a model validation to help in achieving the goal of influencing and motivating and increasing awareness towards WM practices.

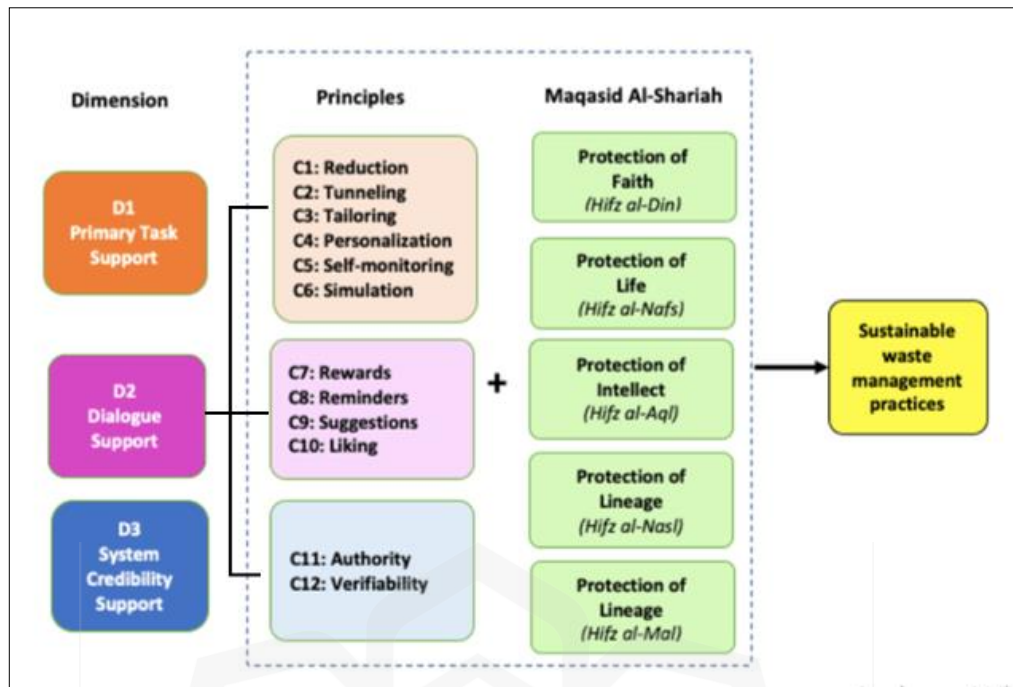


Figure 4.17: Revised Persuasive Design Framework for Waste Management Application Based on Maqasid al-Shariah

4.4.3.2 Design Principles Integrated with Maqasid al-Shariah

The following design principles integrated with *Maqasid al-Shari'ah* to guide the design of the application to ensure that it will increase awareness of importance of waste management practices. The researcher used *Justinmind* prototyping tool to design a medium-fidelity prototype that employed *Maqasid al-Shari'ah* perspective.

Reduction: Reduction principle indicates the use of technology to reduce difficult behavior to facilitate the tasks and influence end-users to achieve the target behavior. Islam has clearly distinguished reduction on Muslim acts and making it easier of performing any action to worship Allah, as Allah (S.W.T.) stated in the Quran:

“And Allah wants to lighten for you [your difficulties]; and mankind was created weak” [Surah an Nisa:28].

In our prototype design, the reduction principle was used to display the color-coding calendar for a garbage collection schedule making it easier for people to know specific day or date for specific type of waste collection. This color-coding calendar makes the waste management practices easy, simple, persuasive and contributes to meet the goal of higher objectives of protecting din, life, intellect, lineage, and property. Allah (swt) tells us that He loves those who show *ihsan* (doing good). Allah also mentioned in Surah Al-Imran, verse 134

“Allah loves the doers of good (al-Muhsineen)” [Surah Al-Imran: 134]

Therefore, reduction principle will make ‘*Ihsan*’ easier to dispose the waste properly and make the world greener and clean. Further, in Surah Al-Anfal verse 53 Allah mentioned that

“Verily! Allah will not change the condition of a people unless there is a change of what is in themselves.” [Surah Al-Anfal: 53]

The example of user interface design using reduction strategy for waste management shows below:

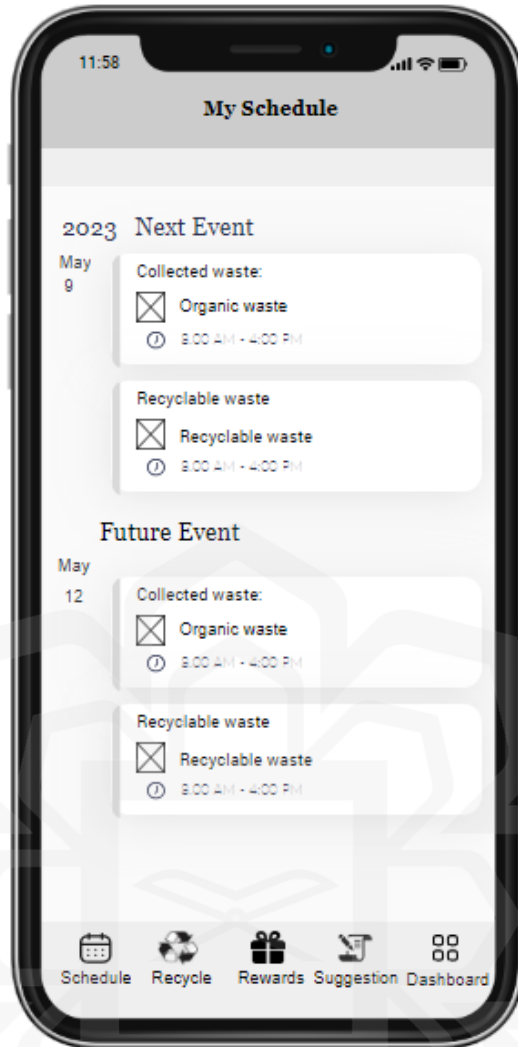


Figure 4.18: Prototype Displays Garbage Collection Schedule (*Reduction*)

Tunnelling: Tunnelling refers to the use of system to guide end users through a procedure or experience that provides the opportunity to persuade along the way. The system guides end users in their mind set change process by providing steps which consequently bring them towards any targeted behaviour. Form Islamic perspective, tunnelling was the way that Allah (S.W.T) and the Prophet (PBUH) taught the whole mankind how to perform particular action such as perform ablution in proper manner by providing series of actions and steps that persuade people to perform the behaviour.

In our waste management prototype, the tunnelling guides user on how to achieve goal in five core dimensions under *Daruriyyah*, emphasizing religiosity,

healthcare, useful knowledge, family wellbeing, and wealth management. For example, tunnelling guides user based on Quran and Sunnah in their maintaining cleanliness, proper upbringing, prevent wastage of resources, prevent extravagance and so on. The example of user interface design using tunneling strategy for waste management shows below:

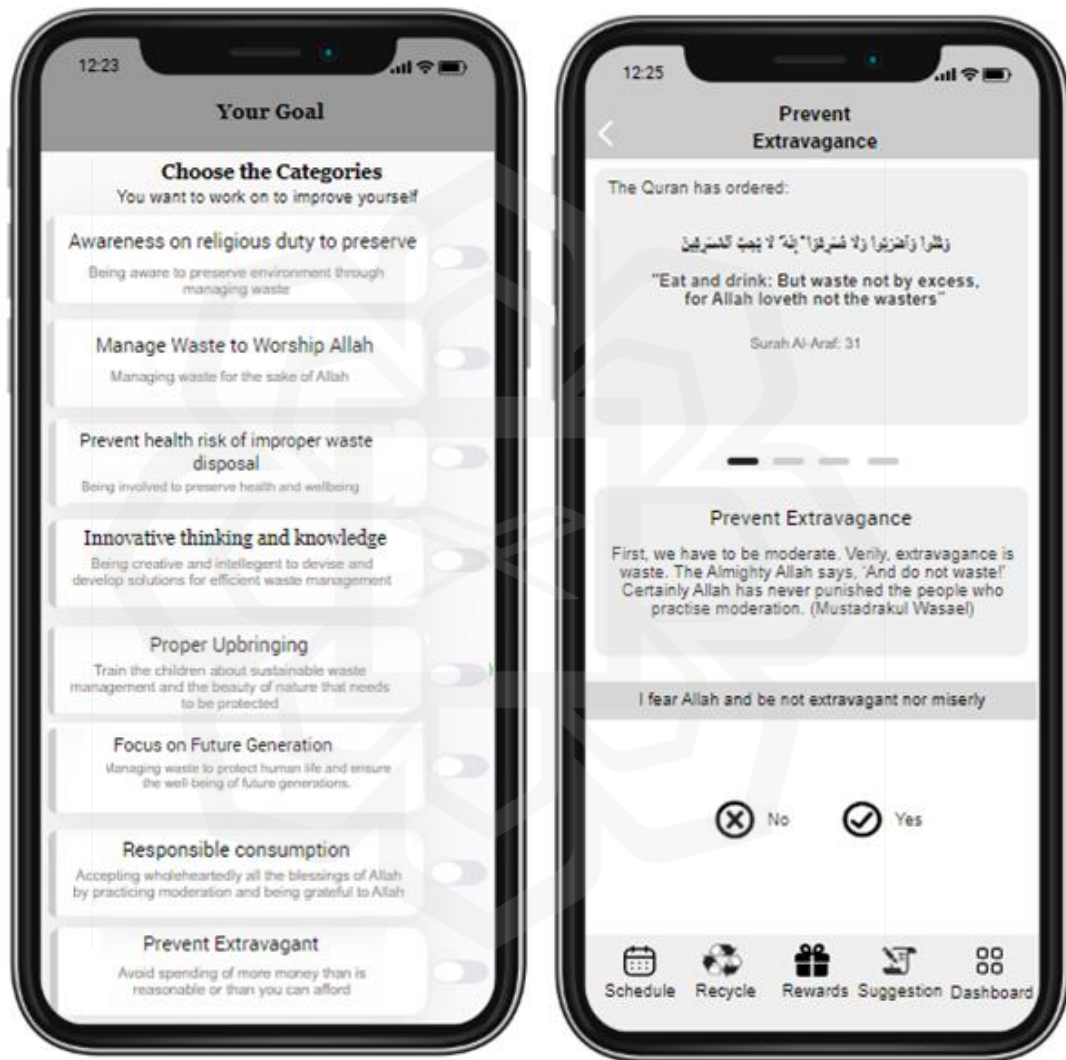


Figure 4.19: Prototype Provides Series of Actions (*Tunnelling*)

Tailoring: tailored to the end users' needs, interests, personality, usage context, or other factors related to the end user to change their attitudes or behaviors. In the regards of waste management prototype, the tailoring principle persuade users by providing information about garbage and recycling items collection schedules based

on user home address. The collection schedule makes the life simpler for users who usually prefer not to struggle through amounts of generic information to discover what is related to them.



Figure 4.20: Prototype Schedule based on User Home Address (*Tailoring*)

Personalization: In waste management prototype, the personalization offers personalized users' preferred languages, upload personal photos in user profile, addresses and set reminders settings. Islam gives the importance of beauty in words, deeds, garments, and outward appearance as Prophet (PBUH) has mentioned in hadith that Allah is beautiful, and He loves beauty. Therefore, from Islamic perspective, making the user profile beautiful with content and services is considering needed to

enhance the engagement in sustainable waste management practices. Figure 4.21 displays the personalization interface design.

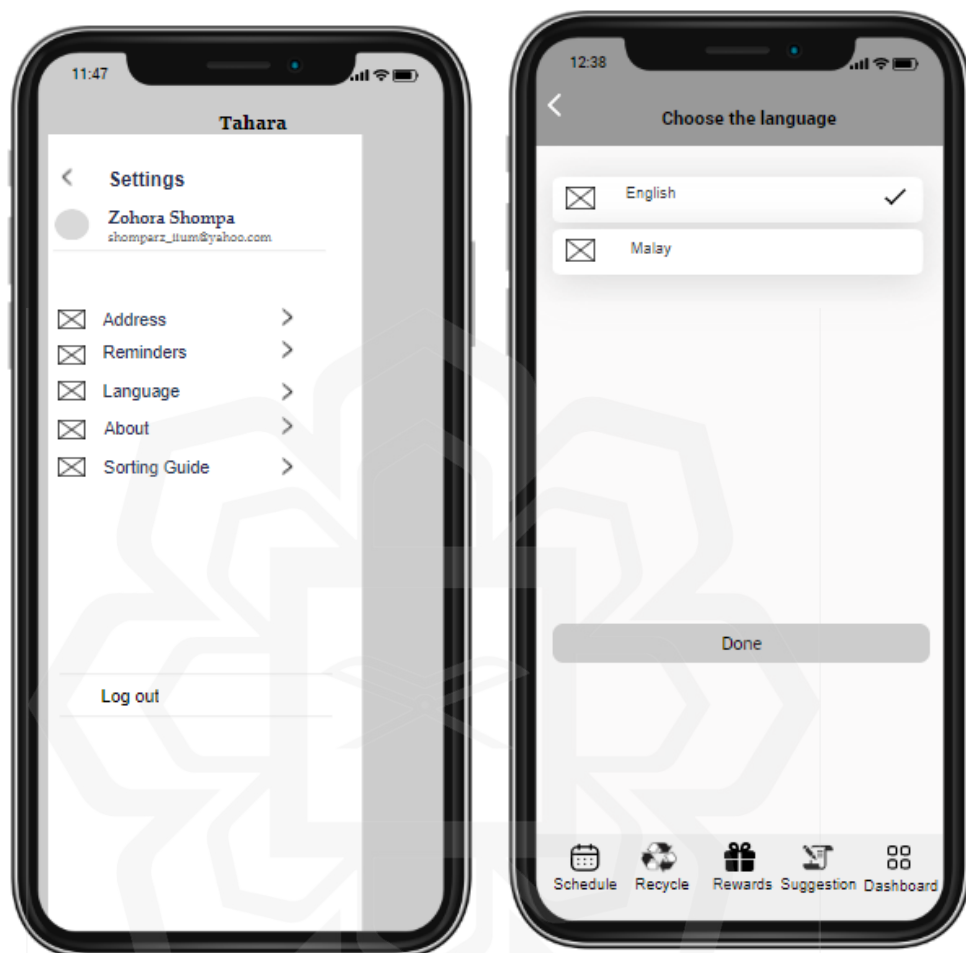


Figure 4.21: Prototype provides Personalized Content and Services (*Personalization*)

Self-monitoring: Self-monitoring technology enables people to monitor themselves to change their attitude or behavior to achieve the goal. Using this principle in waste management prototype (Figure 4.22) shows different types of garbage recycled by each month and shows the user's performance on different categories on waste disposal to achieve the goal. Self-monitoring is the basic principle in Islamic faith. From Islamic perspective, the practice of religious self-examination (*muhāsabah*) led to the action of avoiding evil and doing good and influenced mystical attitudes in Islam. When a Muslim realize that they have to monitor themselves of their every

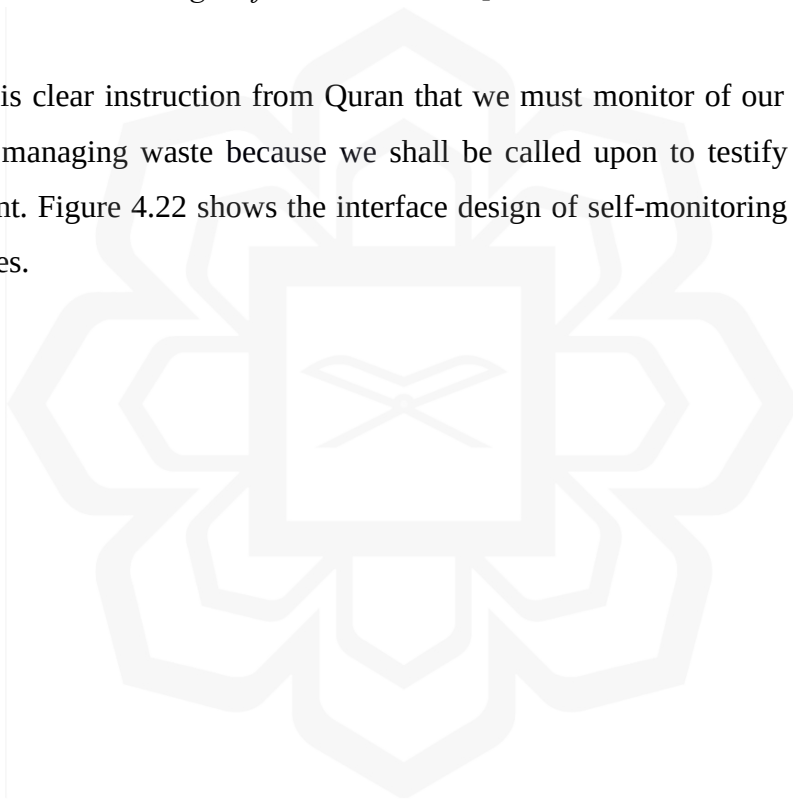
action and will be a witness against himself in the Day of Judgment then their attitude and behavior will be changed to refrain from committing sins and continues to perform good deeds. Allah mentioned in Surah Qiyamah verse,14 that

“Rather, man, against himself, is well aware of himself” [Surah Qiyamah:14]

Further, Allah mentioned in surah Surah Zalzalah verse 7 and 8

“So, whoever does an atom’s weight of good will see it. And whoever does an atom’s weight of evil will see it.” [Surah Zalzalah: 7 and 8]

It is clear instruction from Quran that we must monitor of our own actions as well as managing waste because we shall be called upon to testify on the Day of Judgment. Figure 4.22 shows the interface design of self-monitoring and simulation principles.



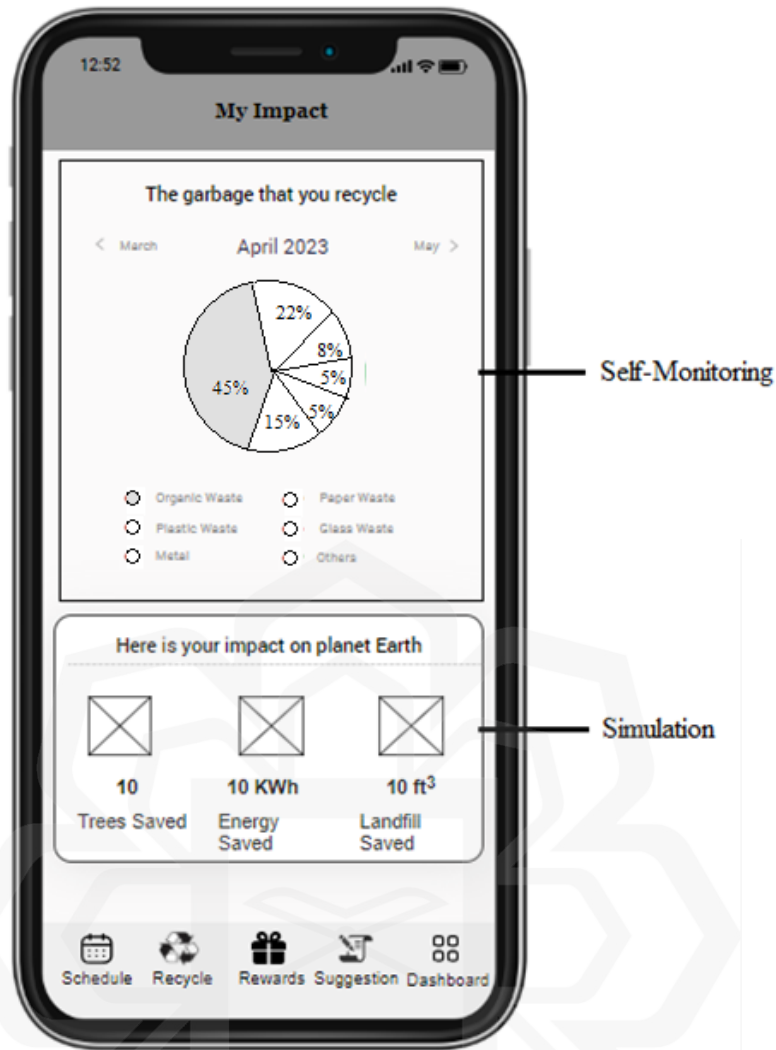


Figure 4.22: Prototype displays User- Performance (*Self-Monitoring*) and Contribution (*Simulation*)

Simulation: Simulation persuade user to change their attitudes or behaviors by enabling them to observe immediately the link between cause and effect. Simulation in the prototype shows the impacts of waste being recycled on the environment (Figure 4.22). For example, the application informs that the user has saves 10 trees, 10KWh energy and 10 ft³ landfills by recycling of the waste generated cause and effect. Simulation contributes to preserve the life by keeping the environment pure and clean through practicing sustainable waste. From Islamic perspective, the simulation principle contributed to preservation of life by persuading Muslims to get renewable reward of planting trees as mentioned in a hadith

“If a Muslim plant a tree or sows seeds, and then a bird, or a person or an animal eats from it, it is regarded as a charitable gift (sadaqah) for him.” [Imam Bukhari].

Muslims are encouraged to plant a tree even in their last deed. Anas (May Allah be pleased with him) reported that the Prophet (peace and blessings be upon him) said

“If the Hour (the day of Resurrection) is about to be established and one of you was holding a palm shoot, let him take advantage of even one second before the Hour is established to plant it.”

Accordingly, knowing the cause and effect of our actions and behavior would be very effective and persuasive to change our attitude and behavior to carry out appropriate waste management practices.

Rewards: Systems that use rewards may have great persuasive powers to shape complicated behavior or transfer current behaviors into habits. The waste management prototype offers rewards point after completing a certain level of recycling. Rewards have been noticeably mentioned in many verses in Quran and Hadith which encourage people to strengthen their behavior that will later transfer to be habit by offering positive feedback. Allah said:

“And (remember) that Allah is aware of whatever good you do (and you shall be rewarded for it) [Surah Al-Baqarah: 215]”.

The meaning of this verse is that Muslim who conducts good deeds will be rewarded in the hereafter. Islam also encouraged Muslims of giving rewards by removing harmful objects from road. The Prophet said that removing harmful things from the road is charity. He also mentioned that

“There is a reward in doing good to every living thing.” (Saheeh Al-Bukhari)”.

Prophet Muhammad (PBUH) mentioned in a hadith that

“When a person intends to do a good deed, and then does it, ten good deeds will be recorded for him”. [Sahih al-Bukhari:6491]

Hence, giving rewards persuades Muslim to follow the religiosity in waste management. Further, it will change and reinforce their behavior when they are aware of the connection between target behavior and rewards. Figure 4.23 shows the interface design of rewards principles in the prototype.

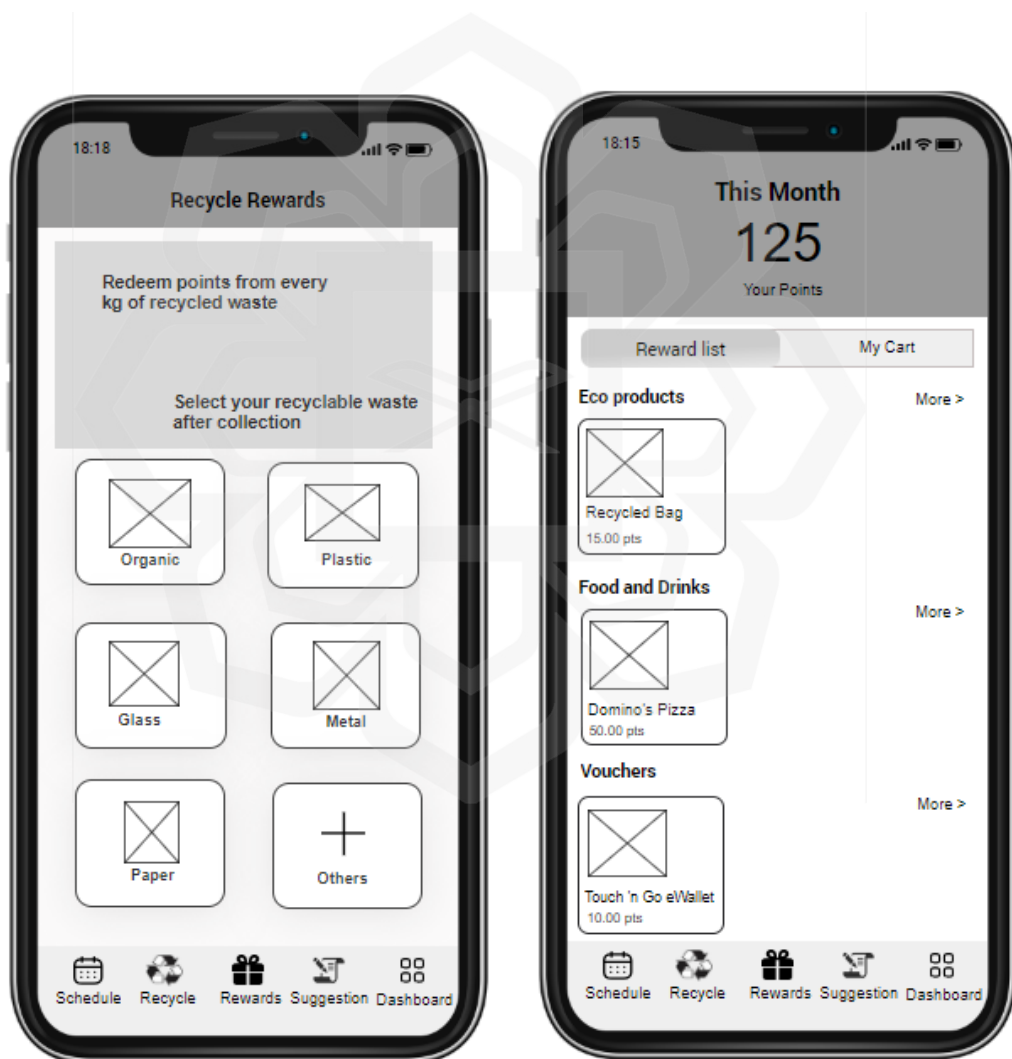


Figure 4.23: Prototype displays Recycle Rewards (Rewards)

Reminder: If a system reminds users of their targeted behavior, the users are more likely to achieve their goals. From Islamic perspective, the guidance laid out in the Quran (Surah al-An'am verse 165) reminded Muslims that they will be accountable for their every action and will be judged in the day of judgement for any injustice or misconducts done to other elements of the environment, not only because it is a "sign" of Allah, but also it is ultimately divine property. Further, Allah also reminds Muslims about the mischief on the earth by saying

"And cause not corruption upon the earth after its reformation. And invoke Him in fear and aspiration. Indeed, the mercy of Allah is near to the doers of good". (Surah al-Araf: 56).

Further, Islam also reminds Muslim about the danger of throwing harm in the street. Sa'd ibn Abi Waqqas said:

"Beware of action that will incur cursing: that a person throws his garbage in the street. So no one passes the street except he says: may Allah curse the one who did this" [al-Musaawi ul-Akhlaaq of Kharaaiti no. 800 with the a Saheeh chain].

Further, Ibn ul-'Uthaymeen rahimahullah said

"The conclusion is that everything that harms should be removed from the street. You will be rewarded for that deed. Therefore, if removing harm from the street is an act of charity, then throwing harm in the street is a sin. Amongst those who are sinful are those who throw their garbage in the middle of the street." [Sharh Riyaadul-Saliheen (1/290) no. 248].

Therefore, reminder benefits the believers by saying in Quran

"And remind, for indeed, the reminder benefits the believers" (Surah-Dharyat: 55).

In Figure 4.24, reminder plays an important role in protecting our religion (*al-din*) by sending notification from Quran and sunnah to manage the waste and track the user's progress.

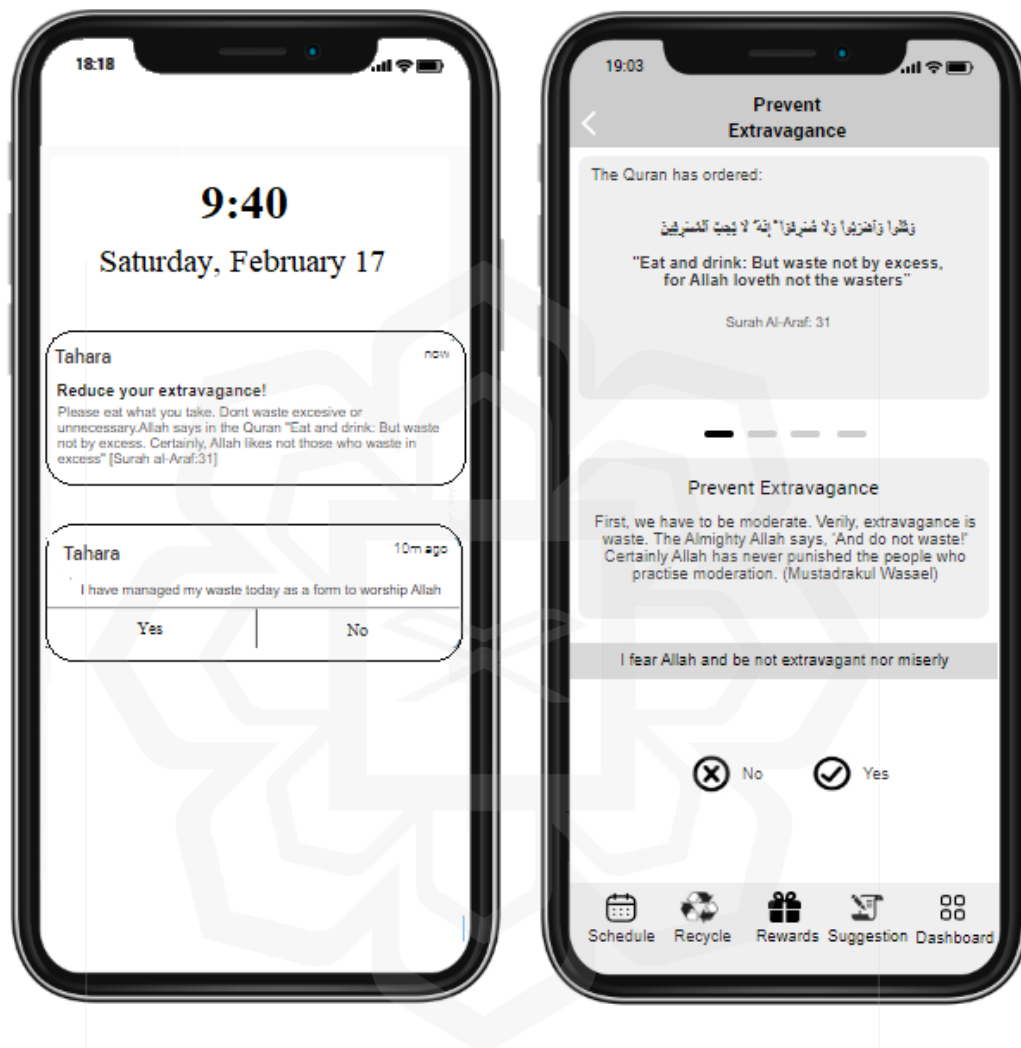


Figure 4.24: Prototype displays Reminder from Quran and Sunnah and provides notification (*Reminder*)

Suggestion: Systems that offering fitting suggestions will have greater persuasive powers. The prototype integrating with suggestion principle plays an important role in protecting our religion and wealth by providing suggestion on alternative ways to reduce, reuse and recycle waste and encourage them to do efforts to practice 3Rs (Figure 4.25). Allah said in Quran

“As for those who struggle in Our cause, we will surely guide them along Our Way. And Allah is certainly with the good-doers” (Surat Al-Ankabut :69).

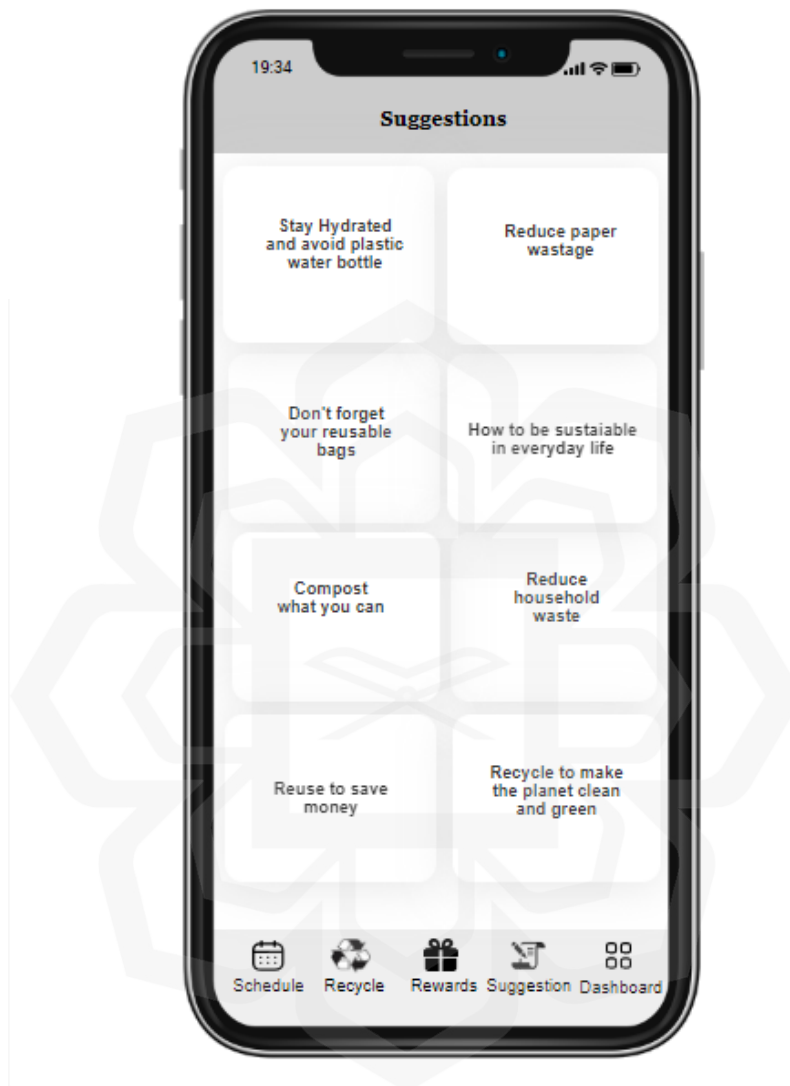


Figure 4.25: Prototype provides Suggestion about Waste Management (*Suggestion*)

Liking: A system that is visually attractive for its users is likely to be more persuasive. From Islamic perspective, the liking feature is a part of beauty and Ihsan. It is mentioned in Hadith that

“Allah is indeed beautiful and loves beauty” [Muslim].

Therefore, the liking feature implemented in prototype persuade user by providing good usability and positive user experience - user friendly (Figure 4.26).

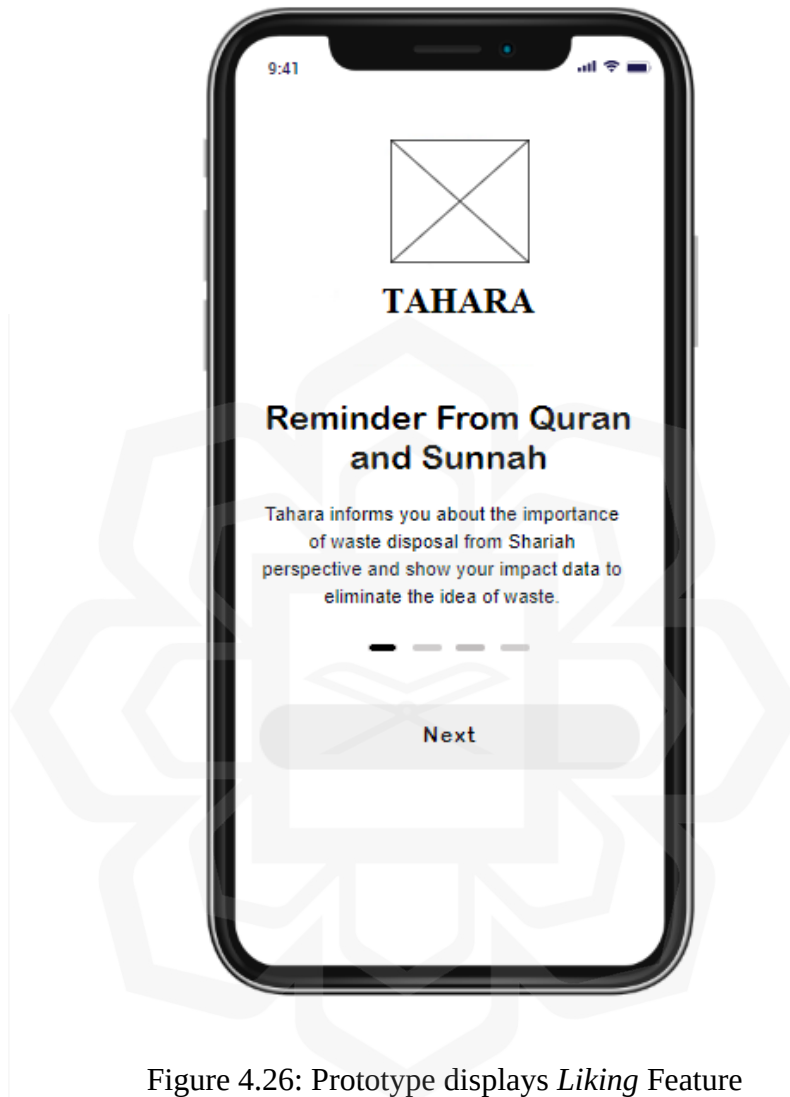


Figure 4.26: Prototype displays *Liking* Feature

Authority: The Authority feature in waste management app persuade users by facilitating residents to submit their waste collection and public cleansing complaints to Waste Management authority. Figure 4.27 shows the authority feature in prototype.

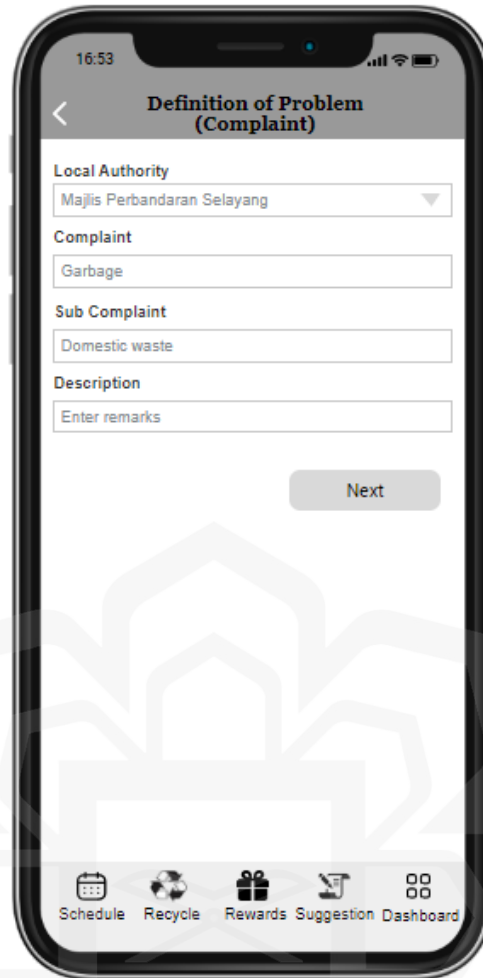


Figure 4.27: Prototype displays Complaint Feature (*Authority*)

Verifiability: Credibility perceptions will be enhanced if a system makes it easy to verify the accuracy of site content via outside sources. The application provides the name of waste management organization such as KDEB Waste Management Sdn. Bhd., a link to their website and contact information to verify the accuracy. Figure 4.28 shows the verification feature in prototype.



Figure 4.28: Prototype provides the Address and Contact Information (*Verifiability*)

4.4.3.3 Conduct of Fuzzy Delphi Method (Round 2)

4.4.3.3.1 Expert Invitation

After analysis of our 1st round result of initial framework validation, an invitation email was sent to the experts to our 2nd round of expert review to validate our revised persuasive design framework. Experts were given time to reply to the email with their specific available date and time. In our 2nd round analysis, seven experts were contributed to validate the framework from the field of *Maqasid al-Shariah*, Human Computer Interaction, Solid Waste Engineering and Waste Management Corporations including KDEBWM and SWCorp. Table 4.31 shows the experts demographic information of the experts.

Table 4.31: Experts Demographic Information

No	Experts	Positions	Areas of Expertise	Years of Experience
1.	Expert 1	Assistant Professor	Shariah sciences, Maqasid al shariah, Islamic economics	5
2.	Expert 2	Associate Professor	Information Retrieval, Semantic Technology, Knowledge Management, Bibliometrics, Maqasid Methodology	30
3.	Expert 3	Assistant Professor	Fiqh & Usul al-Fiqh, Maqasid Shariah, Islamic social finance	10
4.	Expert 4	Assistant Professor	Human-Computer Interaction, Persuasive Technology, Interaction Design, User Experience	5
5.	Expert 5	Assistant General Manager of Corporate Communications Community Education Division, (SWCorp)	Solid waste and public cleansing management	6
6.	Expert 6	Assistant General Manager of Corporate Communications (KDEBWM)	Corporate Communication, Human resource and administration, Innovation Practice	25
7.	Expert 7	Assistant Professor	Human Computer Interaction, Multimedia Learning	9

4.4.3.3.2 Questionnaire for Experts

Based on our revised WM framework, we have designed a medium-fidelity prototype integrating with twelve persuasive principles based on *Maqasid al Shariah*. During an invitation, our revised Persuasive Design Framework and an expert review form (See appendix VI) was given to experts. The data was collected through questionnaires and were later calculated in a quantitative form to create an empirical study (Jamil, 2021). In expert review form, the twelve persuasive principles integrating with *Maqasid al-Shariah*, and the example of user interface design for each persuasive principle given to the experts. The researcher administered 5-point Likert scale in the questionnaire from 1 "very unimportant " to 5 " very important" to obtain the agreement and consensus on each item. Besides, based on the UIs, the participants were also asked to respond to the following query: " *In your opinion, how important is this persuasive principle [x] to persuade people towards sustainable waste management practices*

based on *Maqasid al-Shariah*?” The online survey was conducted over two months, August, and September 2023.

4.4.3.3.3 Results

The threshold value (d), expert consensus percentage, defuzzification and item position for the persuasive principles are shown in Table 4.32.

Table 4.32: Findings of Expert Consensus on Waste Management Interface Design

Item	Average Likert Score	Triangular Fuzzy Numbers		Defuzzification Process				Position	Experts Consensus
		Threshold Value, d	Percentage of Experts Group Consensus, %	M1	M2	M3	Fuzzy Score (A)		
C1	4.6	0.187	85.7%	0.514	0.714	0.914	0.714	3	Accepted
C2	4.6	0.187	85.7%	0.514	0.714	0.914	0.714	3	Accepted
C3	4.6	0.187	85.7%	0.514	0.714	0.914	0.714	3	Accepted
C4	4.6	0.187	85.7%	0.514	0.714	0.914	0.714	3	Accepted
C5	4.9	0.075	85.7%	0.571	0.771	0.971	0.771	2	Accepted
C6	4.7	0.125	100%	0.543	0.743	0.943	0.743	1	Accepted
C7	4.6	0.187	85.7%	0.514	0.714	0.914	0.714	3	Accepted
C8	4.4	0.239	85.7%	0.486	0.686	0.886	0.686	4	Accepted
C9	4.7	0.125	100%	0.543	0.743	0.943	0.743	1	Accepted
C10	4.7	0.125	100%	0.543	0.743	0.943	0.743	1	Accepted
C11	4.4	0.239	85.7%	0.486	0.686	0.886	0.686	4	Accepted
C12	4.6	0.187	85.7%	0.514	0.714	0.914	0.714	3	Accepted
Condition: Triangular Fuzzy Numbers 1) Threshold Value (d) ≤ 0.2 2) Percentage of Experts Consensus $> 75\%$ Defuzzification Process 3) Fuzzy Score (A) $\geq \alpha$ – cut value = 0.5									

Based on the findings in Table 4.32 above, all items recorded a value of Threshold (d) ≤ 0.2 . This result indicates that all these items have gained an expert consensus (Chen & Lin, 2002). The expert agreement percentage shows that all items

are above 75% and all defuzzification values for items also exceed the value of α - cut = 0.5. The result shows that the persuasive strategies in waste management application based on *Maqasid al-Shari'ah* have gained consensus from the experts. The persuasive principles were prioritized by the experts in Table 4.32.

4.4.3.4 Discussions

In brief, the Fuzzy Delphi finding indicates that seven experts, including *Maqasid al-Shariah*, Human Computer Interaction, Solid Waste Engineering and Waste Management Corporations from KDEBWM and SWCorp, all conformed that all the persuasive principles from the framework need to be applied in designing the waste management application. This finding aligns with past studies emphasizing key persuasive principles to enhance user-friendly routines, adaptability, automated notifications, and performance tracking in sustainable waste management apps for greater persuasiveness and effectiveness (Nkwo et al., 2021). Persuasive principles include reduction, personalization, tailoring, reminders, rewards, suggestions, and self-monitoring effectively encourage sustainable waste management practices. Furthermore, on the aspects interface design, all the experts provided feedback and suggestions to each persuasive principle to encourage sustainable behavior. In addition, the experts also highlighted that the connection between the persuasive principles and the supporting Islamic teachings (*Maqasid al-Shari'ah*) is clear and purposeful.

In terms of **Reduction** principle, all the experts agreed that the importance of reduction principle to perform an activity and focus on the intended waste management practices. One of the experts provided suggestion to improve the usability in schedule to increase the application's persuasive. According to the experts:

“This is good practices. It helps consumer’s awareness to do waste separation on the systematic way”. (E6, KBEDWM expert)

“The principle of reduction is significantly important, as simplifying waste-related tasks and enhancing the benefit/cost ratio can effectively encourage

sustainable behavior and the link between the persuasive principle of reduction and the ayah from Surah al-Anfal is insightful, emphasizing the need for inner transformation to bring about change” (E1, Maqasid expert)

“Color-coding is a good way of making people notice the type of waste collection. However, the date is kind of hard to differentiate because it is not color-coded too”. (E7, HCI expert)

Tunnelling is another important principle particularly in the context of *Maqasid Shariah*. As stated by the experts:

“Yes. This is a persuasive principle based on Maqasid Shariah”. (E3, Maqasid expert)

“The on/off slider allows for a user to choose the type of waste management practice that he/she wants to practice. Having the definition together with terms allows them to understand more of what they are going to practice.” (E7, HCI expert)

“Tunneling, while moderately important, can guide users through the process of waste management, offering persuasive opportunities along the way and the reference to change as mentioned in Surah al-Anfal: 53 captures the concept of tunneling, where incremental changes lead to overall transformation”. (E1, Maqasid expert)

Tailoring principle enhances waste management practices by providing personalized schedules based on user home address, while integrating Islamic principles adds a meaningful persuasive element.

“It would be better if the user needs to always allow notification, location and there a pop-ups notification during collection day.” (E5, SWCorp expert)

“Tailoring holds substantial importance, as providing personalized waste collection schedules based on users' needs can effectively drive sustainable waste management practices. The connection drawn from the Hadith about Allah's love for beauty is a creative way to address tailoring”. (E1, Maqasid expert)

Personalization principle is another important principle that improves user experience by ensuring clarity, customization, and engagement. It enhances persuasion by allowing users to tailor content to their preferences, fostering sustained app usage. According to the experts, integrating Islamic principles adds a meaningful dimension to personalization. As per the expert's evaluation:

“Excellent layout because everything was shown clearly, place accordance and user-friendly”. (E5, SWCorp expert)

“Allowing users to personalize information according to their preferences makes the user to liking the app more and this will encourage them to continue using the app”. (E10, HCI expert)

“Personalization is notably important, offering a higher capability for persuasion by customizing content and services to enhance user engagement in sustainable waste management. And the connection drawn from the Hadith about Allah's love for beauty is a creative way to address personalization”. (E1, Maqasid expert)

According to the experts, **Self-monitoring** is crucial for tracking waste management performance, promoting accountability. Integrating Islamic principles reinforces its persuasive impact.

“This principle is very important as it enable users to monitor their waste management performance and how their doing in achieving the Maqasid al-Shari'ah practice”. (E7, HCI expert)

“Self-monitoring ranks very high in importance, as keeping track of individual waste disposal performance significantly supports users in achieving their

sustainable waste management goals. *“The emphasis on personal accountability through the ayah from Surah Zalzalah reflects the persuasive principle of self-monitoring”*. (E1, Maqasid expert)

All the experts gave their feedback that **Simulation** principle enhances user understanding by demonstrating the cause-and-effect of waste management practices. It strengthens persuasion by visualizing environmental impact, with Islamic principles adding deeper motivational value.

“Yes. It will assist user to see the cause and effect in better ways”. (E6, KBEDWM expert)

“Simulate a contribution that a user makes to the earth in practicing the waste management has giving understanding to the user on how his/her behavior may bring effect to the environment and how much contribution user have made from his/her justified behavior”. (E7, HCI expert)

“Simulation holds considerable importance, enabling users to immediately observe the positive effects of waste recycling on the environment, which can enhance persuasive impact. The inclusion of the Hadith regarding planting trees as a renewable reward provides a strong link to simulation”. (E1, Maqasid expert)

Rewards enhance user motivation by reinforcing the value of waste management, promoting recycling habits, and supporting waste reduction. Integrating Islamic principles strengthens the persuasive impact of incentives. As highlighted by the expert:

“The prototype that offers reward will have better choice and provide attraction. That the end user will understand that waste is wealth and waste is not dirty but waste is money”. (E6, KBEDWM expert)

“Crucial to persuade households and waste producers to reuse and recycle more, helps prevent the generation of waste and can help contribute to financing

waste management activities. To encourage user to adapt recycle as their habits". (E5, SWCorp expert)

"Rewarding user after achieving their goal will encourage more determination in performing the waste management". (E7, HCI expert)

"The ayah from Surah al-Tawba: 108 and the Hadiths concerning rewards reinforce the persuasive principle of Rewards" (E1, Maqasid expert)

According to the expert's observations, **Reminder** principles play a vital role in encouraging waste segregation and sustainable practices by keeping users accountable and motivated. Integrating Islamic principles enhances their persuasive impact.

"This is an extra privilege and attract user to practice waste segregation as way of life to result harmonious and greener living style". (E6, KBEDWM expert)

"Since people may easily forget, the use of reminder is very useful in helping people to remember of their duty or task about waste management. Getting a word of encouragement when completing the task giving the sense of relief and happiness". (E5, HCI expert)

"Reminder holds great importance, as notifying users of their waste reduction goals can significantly enhance the likelihood of achieving sustainable waste management practices. The incorporation of Hadiths that highlight the benefits of reminders and the importance of doing good aligns well with the persuasive principle of Reminder" (E1, Maqasid expert)

Experts highlighted that **Suggestion** principle enhance efficiency, safety, and user knowledge while promoting sustainable waste management practice. Allowing users to acknowledge and implement suggestions aligns with *Maqasid al-Shariah*, reinforcing its persuasive impact.

"Important because can help increase efficiency, eliminate waste, improve safety, and improve the user knowledge". (E5, SWCorp expert)

“Besides giving suggestion, system should enable user to remark the suggestion as a form of noticing and implementing the suggestion that will become one of the way to show the practicing the Maqasid al Shariah”. (E7, HCI expert)

“The principle of suggestion is notably important, as offering fitting suggestions for waste reduction methods can effectively encourage sustainable behavior. The ayah from Surah al-'Ankabut: 69 complements the persuasive principle of Suggestion, emphasizing guidance for those who strive”. (E1, Maqasid expert)

Liking principle is also important as highlighted by experts:

“User experience is important to meet user expectations and support the effective functionality of your system”. (E5, SWCorp expert)

“Professional looking interface will attract user to like and have confidence in using the app” (E5, HCI expert).

“Liking is of utmost importance, as an attractive interface is likely to have a substantial persuasive impact on users, encouraging them to adopt sustainable waste management practices”. (E7, HCI expert)

Authority plays an important role in sustainable waste management practices by ensuring compliance, resolving issues efficiently. In light of the expert's feedback:

“Very Important. Sustainable waste management practices must be observed”. (E6, KBEDWM expert)

“User should bring any waste collection related problem to the attention of the local authority immediate as soon as possible using this system so the problem may be resolved straight away by the responsible parties”. (E5, SWCorp expert)

“This principle immediately enable user to contact the right authority in-charged whenever a problem occurred or persists”. (E3, Maqasid expert)

“Authority holds significant importance, leveraging roles of authority to enhance persuasive powers, especially when facilitating interactions with waste management authorities”. (E7, HCI expert)

Based on expert opinions, **Verifiability** principle enhances user trust by providing accurate data, ensuring direct communication with responsible authorities, and increasing confidence in waste management practices.

‘Yes correct. For example, KDEB Waste Management is having iClean Selangor Application for complaint management’. (E6, KBEDWM expert)

‘Very important, through accurate data site, user can quickly get in touch with person in charge if they need advice or whether they have a complaint that needs to be addressed or just want more information about their services’. (E5, SWCorp expert)

‘This will show who own app and manage the waste and therefore increase the user’s trust towards the app and have confidence in performing the waste management practice’. (E7, HCI expert)

The validation of revised persuasive design framework therefore marked the achievement of our third research objectives (RO3). The following Table 4.33 summarizes the findings of all six (6) studies.

Table 4.33: Summary of Findings from Study 1 until Study 6

Study#	Findings
<i>Study 1:</i> Investigating urban community awareness based on <i>Maqasid al-Shariah</i>	– Most of the households have moderate awareness of waste disposal from the perspective of Shariah but they do not integrate their religious values into their actual behavior to adopt environmentally friendly practices.
<i>Study 2:</i> Identify the barrier of adopting green practices	– 10 factors identified at each socio-ecological level: - Microsystem: lack of awareness and knowledge, lack of personal responsibility, lack of motivation, negative attitude (e.g., garbage is still garbage; people do not want to try new things; lazy to adopt green practices; time constraints to separate waste) - Mesosystem: lack of community participation in waste separation and recycling activities, insufficient and inaccessibility of information regarding 3rs, not enough facilities; unavailability of waste separation facility; no separate bins: recycle center is very far from residency) and the infrequency of waste collection. - Macrosystem: lack of enforcement, lack of financial initiatives (reward and penalty)
<i>Study 3:</i> Investigate end-user perspectives on effective persuasive design principles	– Based on the outcome of this study, 25 relevant persuasive design principles were identified – These principles informed to propose an initial framework.
<i>Study 4:</i> Identify the principles within the framework of <i>Maqasid al-shari'ah</i>	– The outcome of the study provides an approach to harmonize <i>Maqasid al-Shari'ah</i> with sustainable WM practices, encompassing essential dimensions of religiosity, healthcare and wellbeing, useful knowledge, family wellbeing, and wealth management in the context of <i>Jalb al-Masalah</i> (Serve interest) and <i>Daf'al-Mafsadah</i> (Protect from harm and corruption). – These essential principles incorporate with persuasive principles in <i>Tahara</i> application
<i>Study 5:</i> Initial framework validation	– Based on expert review approach, 12 relevant persuasive design principles were selected. – These principles integrate with <i>Maqasid al-Shari'ah</i> and informed the design of medium fidelity prototype <i>Tahara</i>.
<i>Study 6:</i> Determination of persuasive principles of WM framework based on <i>Maqasid al-Shariah</i>	– Based on expert review approach, the twelve persuasive principles based on <i>Maqasid al-Shari'ah</i> were verified as an important principle to design an application. – The revised framework informed the design of high-fidelity prototype <i>Tahara</i>.

4.4.3.5 Summary of Study 6

In summary, the Study 6 illustrated the validation of revised persuasive design framework for waste management application based on *Maqasid al-Shari'ah* using the FDM. This study found that the twelve persuasive principles based on *Maqasid al-Shari'ah* are most important in designing the waste management application. The next phase 4 will describe the development of a a high-fidelity prototype for persuading sustainable waste management practices.

4.5 TAHARA APPLICATION

In the research phase 4, this study presents the *Tahara* app - a waste management application prototype that persuade users to perform appropriate waste management practices. Besides, this prototype increase the awareness on the importance of appropriate municipal solid waste disposal based on *Maqasid al-Shariah*. In this study, an iterative design process was employed to achieve our goals. Iterative design is a cyclic process of prototyping, testing, evaluation, and refinement of new products, where users are always involved (Dix et al., 1998). This process enhances the quality and functionality of the final interface design. In this research, an iterative design process begin with the identification of persuasive principles and principles of *Maqasid al-Shariah* (Study 3 and Study 4) and then validation of the components of persuasive design framework for waste management practices based on *Maqasid al-Shari'ah* (Study 5 and Study 6), the result of the review is then used to design a high-fidelity prototype named *Tahara* using *Justinmind* (<https://www.justinmind.com/>). In the following subsection, the study will describe the *Tahara* application, and its persuasive feature which had been incorporated with selected persuasive design principles and *Maqasid al-Shariah*.

4.5.1 The High-Fidelity *Tahara* Application

In this study, we have chosen the word “*Tahara*” (طهارة), an Arabic term meaning purity or cleanliness, which is highly emphasized in Islam. A Muslim is encouraged to maintain both spiritual and physical cleanliness. The application *Tahara* integrates waste management with Islamic teachings on cleanliness and environmental

responsibility. The term purification is not only representing cleanliness but also symbolizes renewal, emphasizing that waste management is not just about disposal but also it involves recycling, reusing, and purifying the environment. Our application promotes cleanliness, hygiene, and sustainability, and reminds users that proper waste disposal is a moral and ethical duty. In *Tahara* application, a total of 12 persuasive design principles were implemented. The persuasive design principles integrated with the principles of *Maqasid al-Shari'ah* encompasses five key dimensions of preservation (*hifz*) of religion (*al-din*), life (*al-nafs*), intellect (*al-aql*), progeny (*al-nasl*), and wealth (*al-mal*) in the context of *Jalb al-Masalah* (Serve interest) and *Daf'al-Mafsadah* (Protect from harm and corruption). The importance of integrating these principles into human behavior is to ensure that practicing waste management aligns with the Shari'ah viewpoint and contributing to the environmental conservation efforts. The following Table 4.34 summarizes the design principles integrated with *Maqasid al-Shari'ah* implemented in *Tahara* application.

Table 4.34: Persuasive Design Principles Implemented in *Tahara* Application

Persuasive Principle	Description of the principle	<i>Tahara</i> app features
Primary Task Support		
Reduction	The use of technology to reduce difficult behaviour to facilitate the tasks and influence end-users to achieve the target behaviour.	<i>Tahara</i> app displayed the color-coding garbage collection schedule and make ' <i>ihsan</i> ' easier to know specific day/date for specific type of waste collection schedule.
Tunnelling	Using the system to guide the user progresses through a procedure.	Users were presented with proper interfaces in <i>Tahara</i> app that helped them to concentrate on their tasks and follow the principles of waste management from Maqasid al -Sharaih while being persuaded in the process. The objective of the persuasion was for the user to read the instruction at Dashboard and indicate their goal.
Tailoring	A system that offers information that is more compelling when it is tailored to the potential needs, interests, personalities, context of use, or other aspects of a particular user group.	<i>Tahara</i> app persuade user by providing information about garbage and recycling items collection schedules based on their home address.
Personalization	A system's capacity to convince users is greatly enhanced when it	Personalization is used in the settings part of the <i>Tahara</i> app, where users can make the user profile beautiful by

	offers personalized content or services.	adding their personal photos, modify their username or password, and select the language to use the app.
Self-monitoring	Allow people to monitor themselves in a great way to change their attitudes or behaviors in order to achieve a certain goal	Enables monitoring of waste management performance. This practice will change the attitude and behavior to refrain from committing sins and continues to perform good deeds.
Simulation	Systems that offer simulations can persuade by allowing users to see the connection between cause and effect.	Enables user to observe their contribution of waste being recycled on the environment. This way users feel more open towards persuasion and contribute to preserve life.
Dialogue Support		
Rewards	Systems that reward targeted behaviours may have great persuasive powers.	Offers points as a reward, which the user may redeem for food and drink items, eco-friendly products, and vouchers for their progress and achievement of goals. Giving rewards persuades Muslim to follow the religiosity in waste management.
Reminder	Users are more likely to succeed in their goals if a system constantly reminds them of their desired behaviour	Sends notification that frequently reminds Muslim to use the app and track progress. Besides, this app reminds them about the importance of practicing sustainable waste management from Quran and Sunnah to succeed in this world and next.
Suggestion	Systems offering fitting suggestions will have greater persuasive powers.	Persuade Muslims to reduce their usage of waste materials like plastic bags and water bottles by educating them about sustainability, health, and wellbeing, as well as how to live a cleaner, greener lifestyle.
Liking	A system that is visually attractive to its users is probably more persuasive.	The app presents information for sustainable waste management activities based on Shariah that are visually appealing to the user.
System Credibility Support		
Authority	A system that influences roles of authority will have stronger persuasive abilities.	<i>Tahara</i> app facilitates residents to submit their waste collection and public cleansing complaints to the waste management authority.
Verifiability	If a system makes it simple to verify the accuracy of site material through external sources, credibility perceptions will improve.	In order to verify the accuracy, the application provides the names of recycling centres and their contact information.

4.5.2 The Persuasive Features of *Tahara* Application

Tahara application comprised of the following persuasive main features. The presentation of the digital prototype is divided into twelve sections:

- Welcome page (presents information that are visually appealing to the user)
- Schedule (provides color-coding garbage collection schedule based on user home address)
- Recycle (collecting recyclables waste)
- Complaints to authority (sending a report towards any mismanagement or problem)
- Drop off location (show the nearest recycling center near and verify the accuracy of recycling center).
- Impact (shows user performance and contribution towards environment)
- Rewards (giving rewards after disposing recyclable waste)
- Suggestion (which provides information regarding green practices),
- Dashboard (practice sustainable waste management from Shariah perspective)
- Progress (shows user performance of following the principle of waste management from shariah perspective).
- Reminders Notification (Reminds user to complete the task)
- Language (allow user to choose the language)

The following sections would describe in detail about the specific user interface design of *Tahara* application and how persuasive principles had been applied. A wireframe overview of the *Tahara* prototype (including all twelve sections) can be seen in Figure 4.29 to Figure 4.44 (*Please refer to Appendix VII for detailed screenshots of persuasive principles implemented in Tahara prototype*).

1. Welcome Page

Description: When a user accesses the application for the first time, they are given a short overview of *Tahara* application. In these pages, *liking* feature is implemented to present the information about Shariah-based sustainable waste management practices that are visually appealing and *Ihsan* (perfection, or excellence).

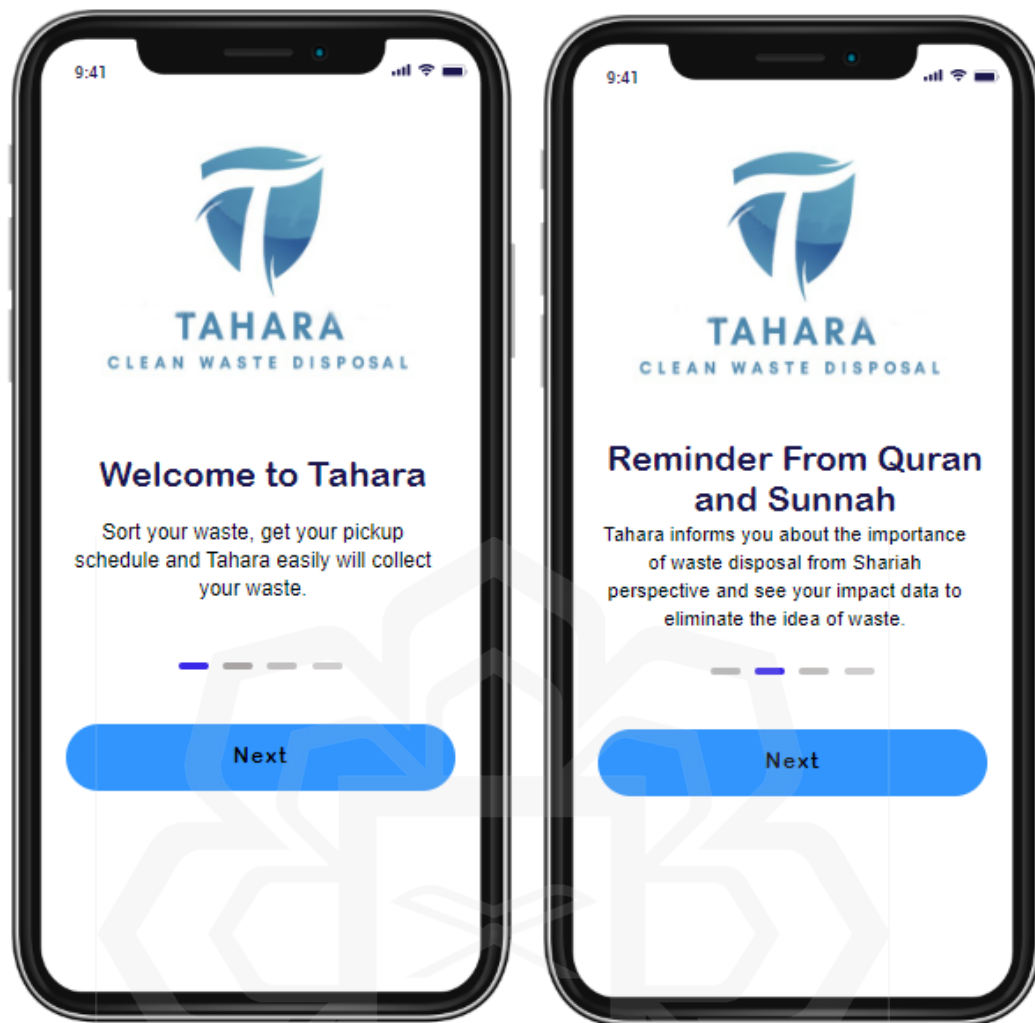


Figure 4.29: Tahara Prototype Displays Welcome Messages (*Liking*)

2. The Schedule

Description: In this page we applied the *tailoring* principle where the user can indicate the home address that they live in by typing the name of their home address from a SEARCH button. After that, the color-coding waste collection schedule will be displayed in their schedule page (*reduction principle*). It will benefit the user from knowing the precise day and time for a particular kind of waste collection plan.

Based on the advice of expert ((E7, SWCorp expert, (FDM- round 1)) the schedule page is designed in accordance with Malaysia's recycling guideline such as collecting organic waste twice a week, recycle and bulky waste once a week. Besides,

the expert suggested integrating with other community programs like school recycling programs or fabric collection. Additionally, another expert ((E7, HCI expert (FDM-round 2)) pointed out that using date in schedule is hard to differentiate because it is not color-coded. Therefore, the schedule is adjusted in terms of days in response to expert advice. The following Figures 4.30 shows the user interfaces of schedule page based on user home address.



Figure 4.30: *Tahara* Prototype Displays Color-Coding Garbage Collection Schedule Based on User Home Address (*Tailoring (Left), Reduction and Hifz Al-Din, Nafs, Nasl, Aql, and Mal (Right)*)

3. Recycle

This page can be accessed by clicking on the 'recycle' button in the tab bar menu at the bottom of the screen. This page presents five important aspects such as 1) start a pickup waste, 2) collection history, 3) drop off location, 4) impact, and 5) complaints to authority (Figures 4.31-4.36). Each section is described below:

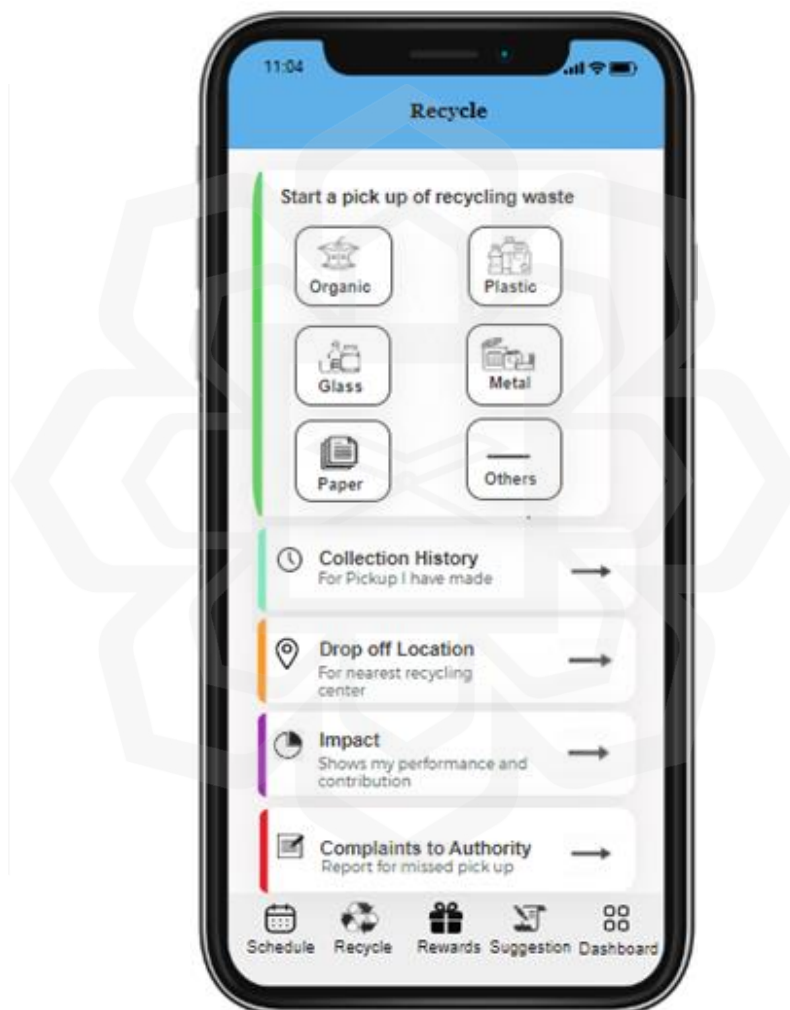


Figure 4.31: *Tahara* Prototype Displays the Recycle Page

4. Pickup recycle waste

In the recycle page, at first the user will see the “Start a pickup of recycling waste” option with different kinds of recycling waste. The user can click on each of the waste that they are interested in. For example, user can click on the ‘Plastic’ waste then it will be redirected to confirm location page. User are requested to confirm their location and then input an estimate of the amount of rubbish they would like picked up. Ultimately, the user will receive confirmation that the request has been sent and waiting to be approved. *Reduction* principle is implemented to collect our recyclable waste by sending our own location for own service.

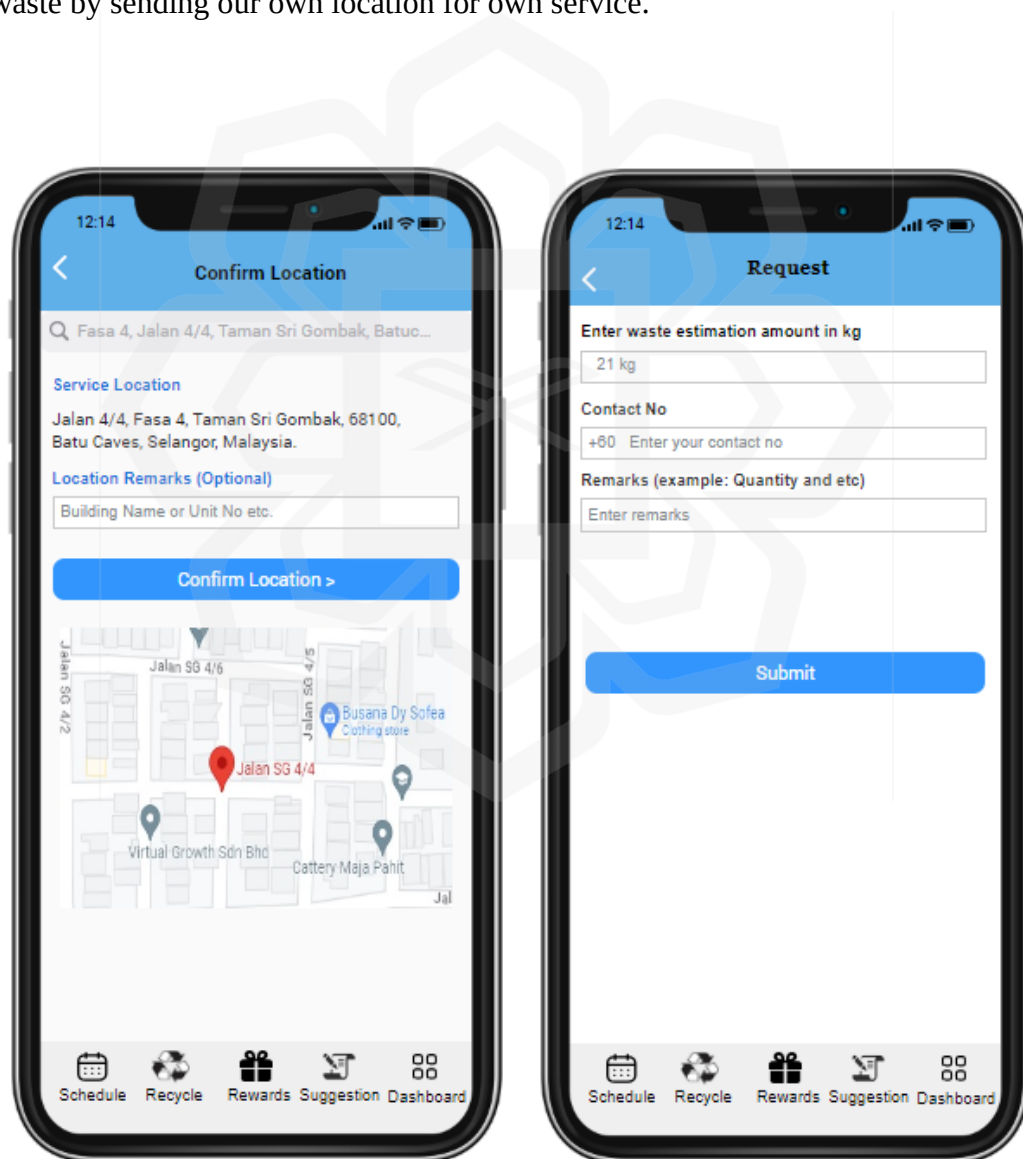


Figure 4.32: Tahara Prototype Displays the Request to Pick up Recyclable Waste

5. Collection History

Below the pickup waste, user can click 'Collection History' to see which pick up request has been accepted or pending.

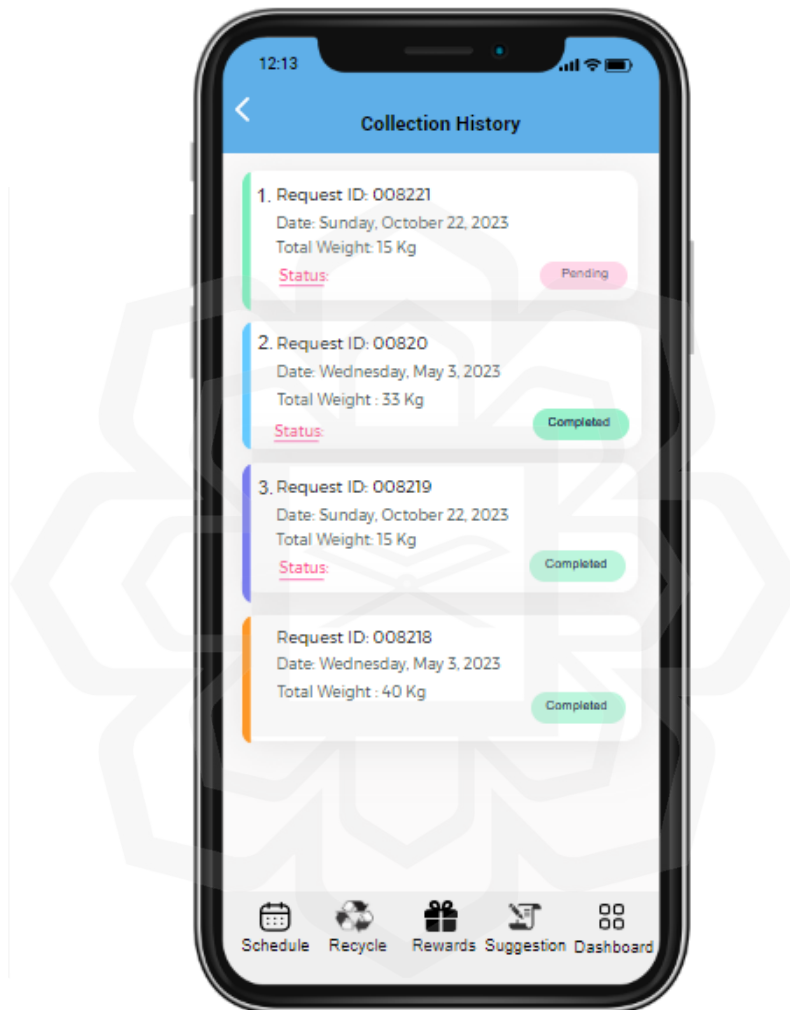


Figure 4.33: *Tahara* Prototype Displays the Collection History

6. Drop off Location

Description: At the 'Drop off Location' page, user can see the list of possible addresses of the nearest waste drop off locations to the user (reduction). This allows the user to reduce the time spent in finding the closest one. Besides, user will get the best option to recycle or dispose of it. Further, user can choose the any of the recycling

center and it will be shown a link to their website and contact information and operation hours to verify the accuracy.

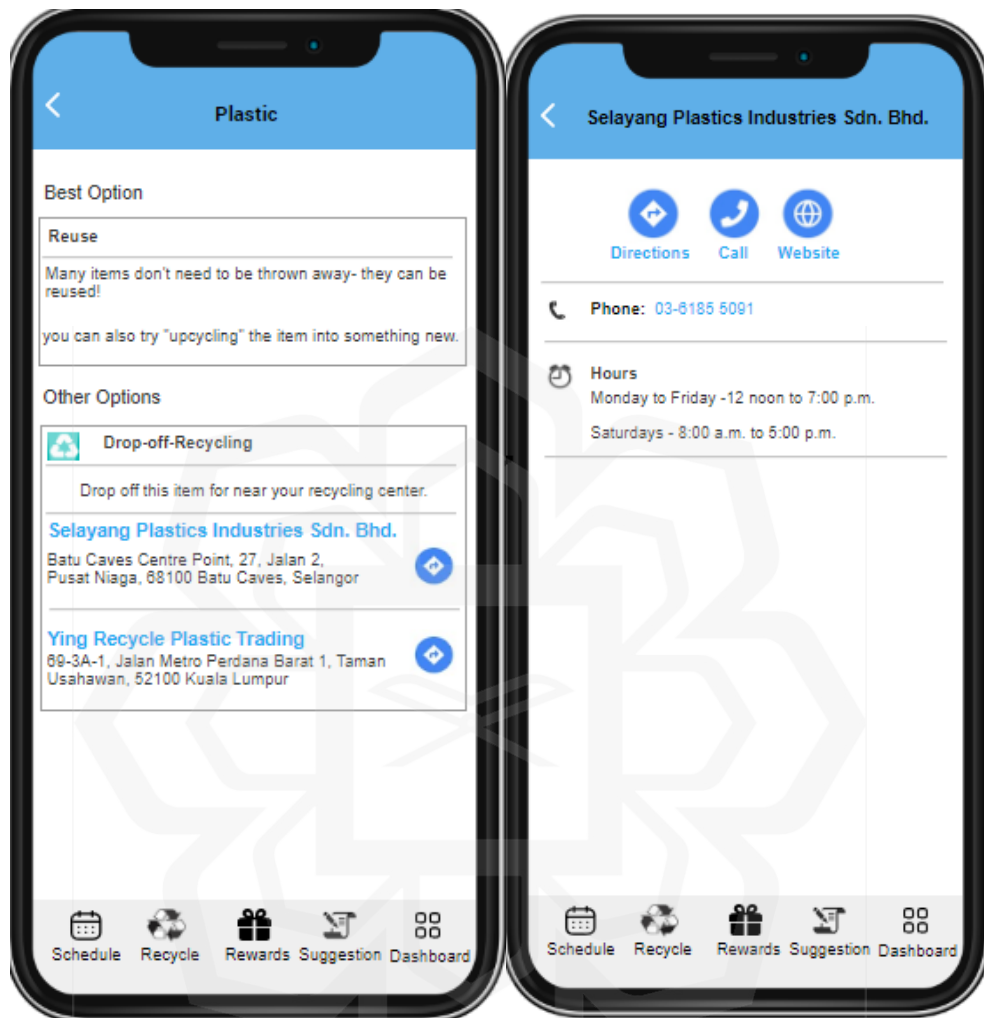


Figure 4.34: *Tahara* Prototype Displays Nearest Waste Drop Off Locations (*Reduction and Hifz al-Din, Nafs, Nasl, Aql, and Mal (right) and Verification(left)*)

7. Impact

User can click the 'impact' button in recycle page and monitor themselves on different categories of waste being recycled by each month and see their contribution to the environment and human life such as saving trees, energy, and landfills by recycling of

the waste generated. This practice will change their attitude and behavior to refrain from committing sins and continues to perform good deeds.

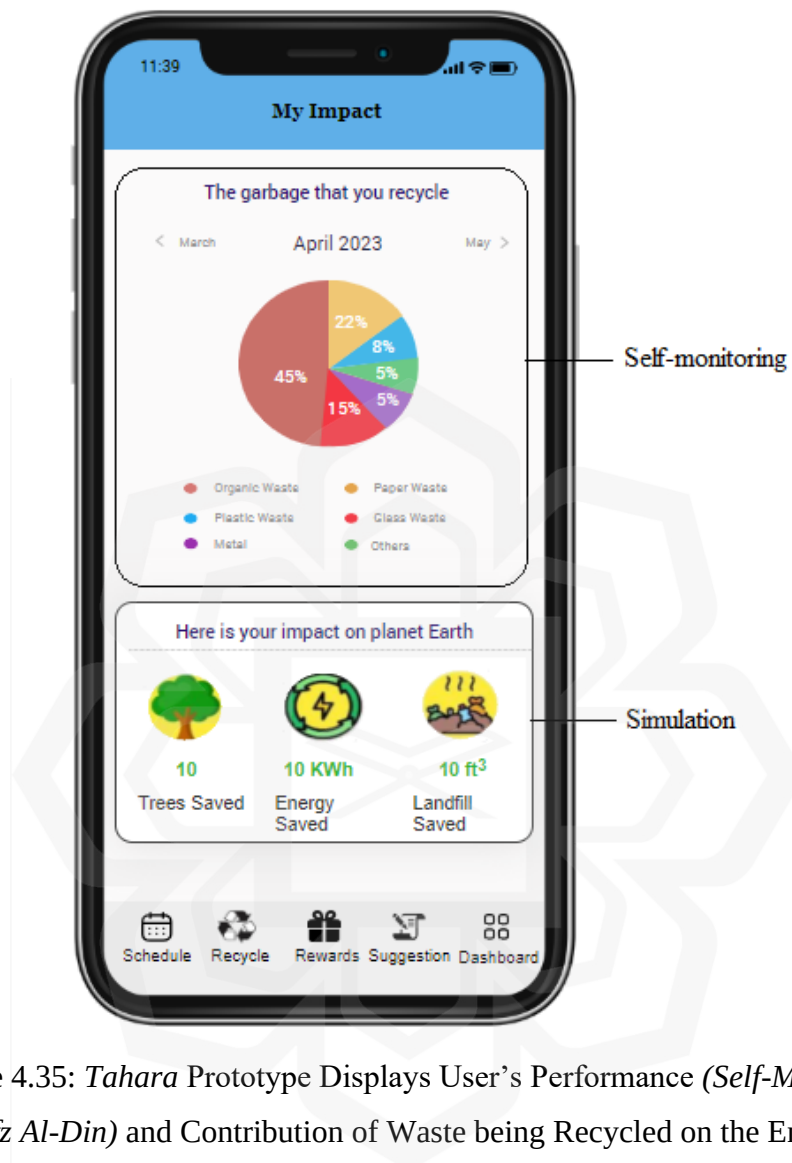


Figure 4.35: *Tahara* Prototype Displays User's Performance (*Self-Monitoring and Hifz Al-Din*) and Contribution of Waste being Recycled on the Environment (*Simulation and Hifz Al-Nafs*)

8. Complaints to Authority

When user click on the 'Complaints to Authority' button, they will be redirected to the complaint page to make a report about the garbage problem in their area. The user can select the local authority from a drop-down menu and fill up the complaints form

and click 'next' button. Then user will see the confirmation that their request has been submitted successfully.

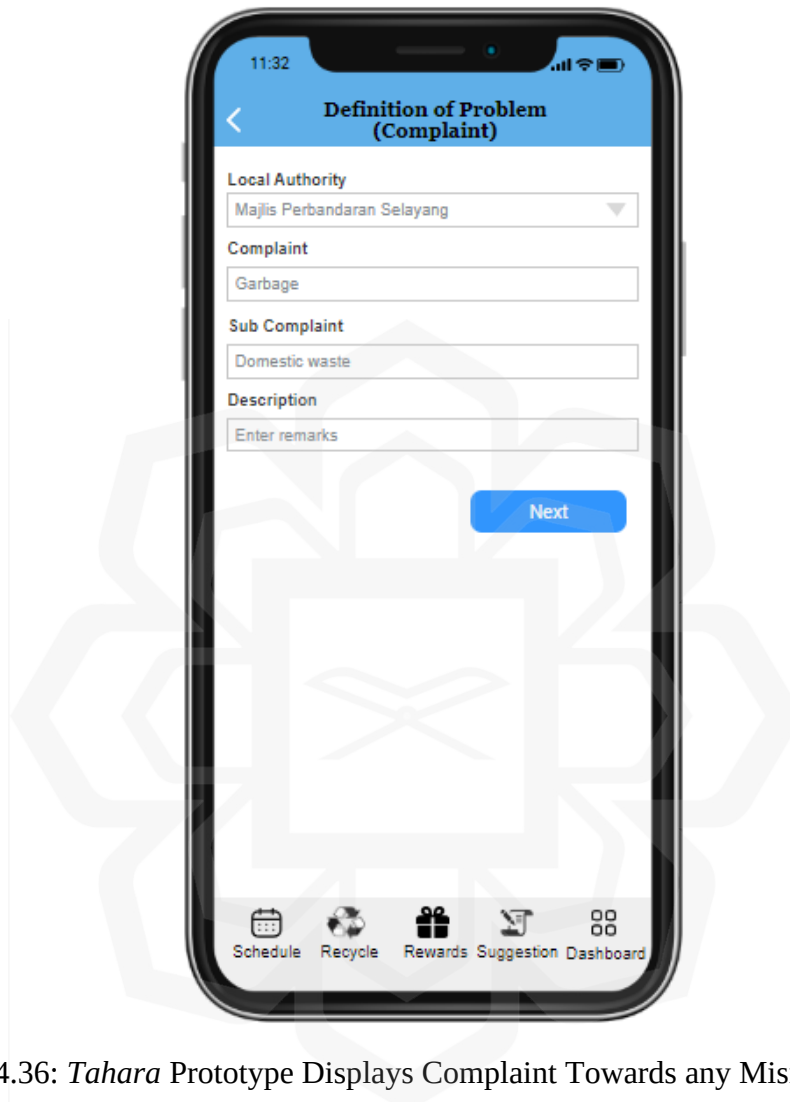


Figure 4.36: *Tahara* Prototype Displays Complaint Towards any Mismanagement or Problem (*Authority*)

9. Rewards

The “rewards” page can be accessed from the tap bar menu. At the rewards page, the user may see their total monthly points as well as the other kinds of rewards like eco-products, foods and drinks, and vouchers. The user can click on any of the incentives

to purchase the product. Giving these rewards through *Tahara can* persuade Muslims to follow the religiosity in waste management.

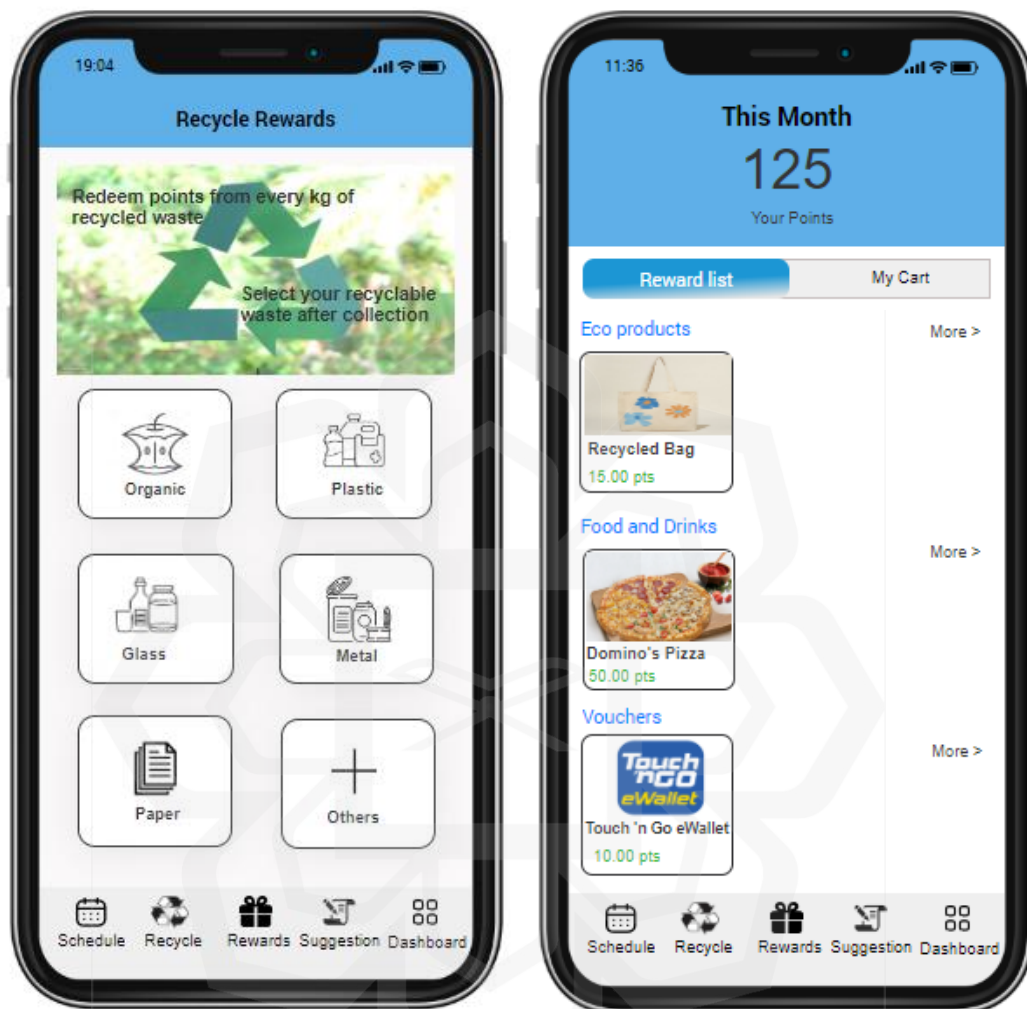


Figure 4.37: *Tahara* Prototype Rewards after Disposing Recyclable Waste (*Rewards and Hifz Al-Din*)

10. Suggestion

This page can be accessed by clicking on the suggestion icon in the horizontal menu at the bottom of the screen. In this page user can get many suggestions about the managing waste that makes the world better and green. User can click on the content

about the respective topic to gain information and knowledge. Figure 4.38 shows the suggestion page in the prototype.

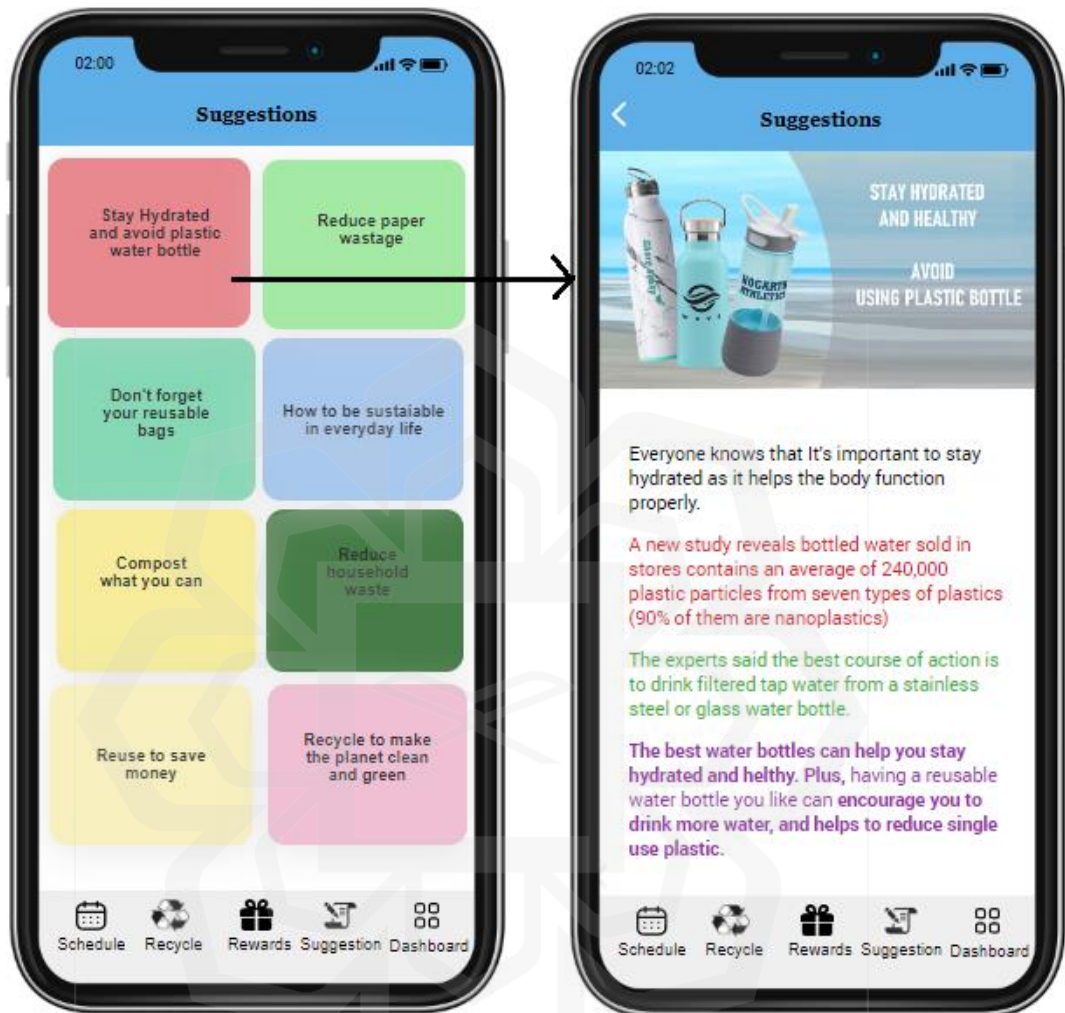


Figure 4.38: *Tahara* Prototype Provides Suggestion about Sustainability, Health, and Wellbeing, as well as how to Live a Cleaner, Greener Lifestyle (*Suggestion and Hifz Al-Din and Mal*)

11. Dashboard

Dashboard can be accessed by clicking on the dashboard icon in the horizontal menu at the bottom of the screen. On this page, user will see the calendar, the 'ALL' and 'PROGRESS' button and a message of Allah's love and blessing of managing waste. User can click on '+' button on dashboard. Then the principles of managing waste

from the *Maqasid al-Shari'ah* perspective will appear in next page. This page addresses five core dimensions under *Daruriyyah*, emphasizing religiosity, healthcare, useful knowledge, family wellbeing, and wealth management. The principles for responsible waste management practices, such as promoting religious duty awareness, safeguarding public health, encouraging rational resource use, considering family impact, and advocating responsible consumption. (See Section 4.4.2.3).

After that, user can choose any categories of waste management practices to work on to improve themselves by clicking the toggle switch button. This is how we try to persuade users to be aware about the waste management practices from Shariah perspective. Thus, this feature works as follows: after selecting the categories user needs to click the 'close' sign button at the top of left side. Then user will be redirected to 'All' page in dashboard. All selected categories will be displayed on this page. After this, user can click any of the categories such as 'PREVENT EXTRAVAGANCE' button.

Each category has its own reminder from Quran and Sunnah, and instruction that motivate user to be moderate. After reading the instruction user can indicate if they can achieve their goal or not by clicking the "YES" or "NO" button. After clicking the yes button, the application will congratulate user by saying Alhamdulillah and no button will ask user to keep striving.

This is an important feature that need to be practiced and translated into human behaviour so that they manage waste management practices in accordance with the Shari'ah viewpoint and contribute to environmental sustainability efforts. Figures 4.39-4.42 presents the dashboard screen including categories of WM from shariah, reminder from Quran and sunnah and progress features in the prototype.

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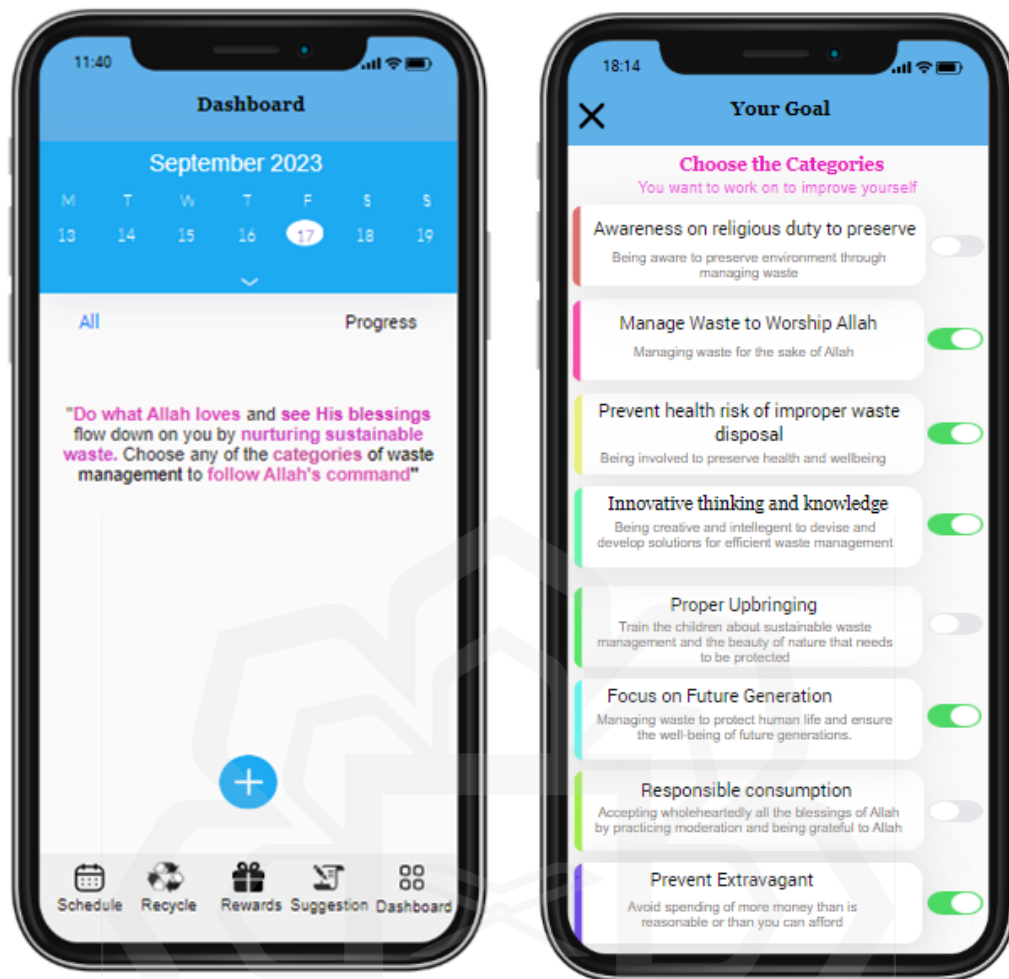


Figure 4.39: *Tahara* Prototype Displays Dashboard Screen and Category of Principles of Waste Management Practices from *Maqasid Al-Shari'ah* ((*Tunnelling, and Hifz Al-Din, Nafs, Aql, Nasl, and Mal*)

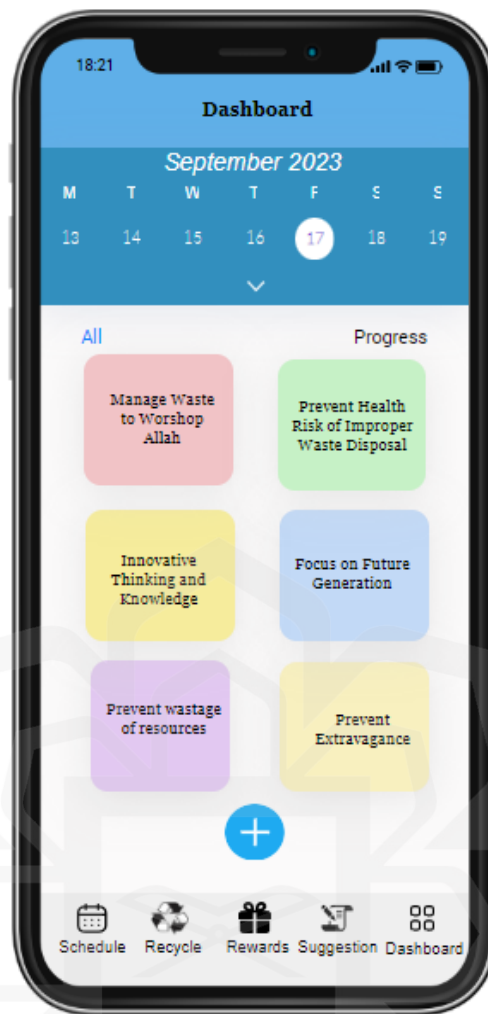


Figure 4.40: *Tahara* Prototype Displays Current Practices to Improve on
(*Tunnelling, and Hifz Al-Din, Nafs, Aql, Nasl, and Mal*)

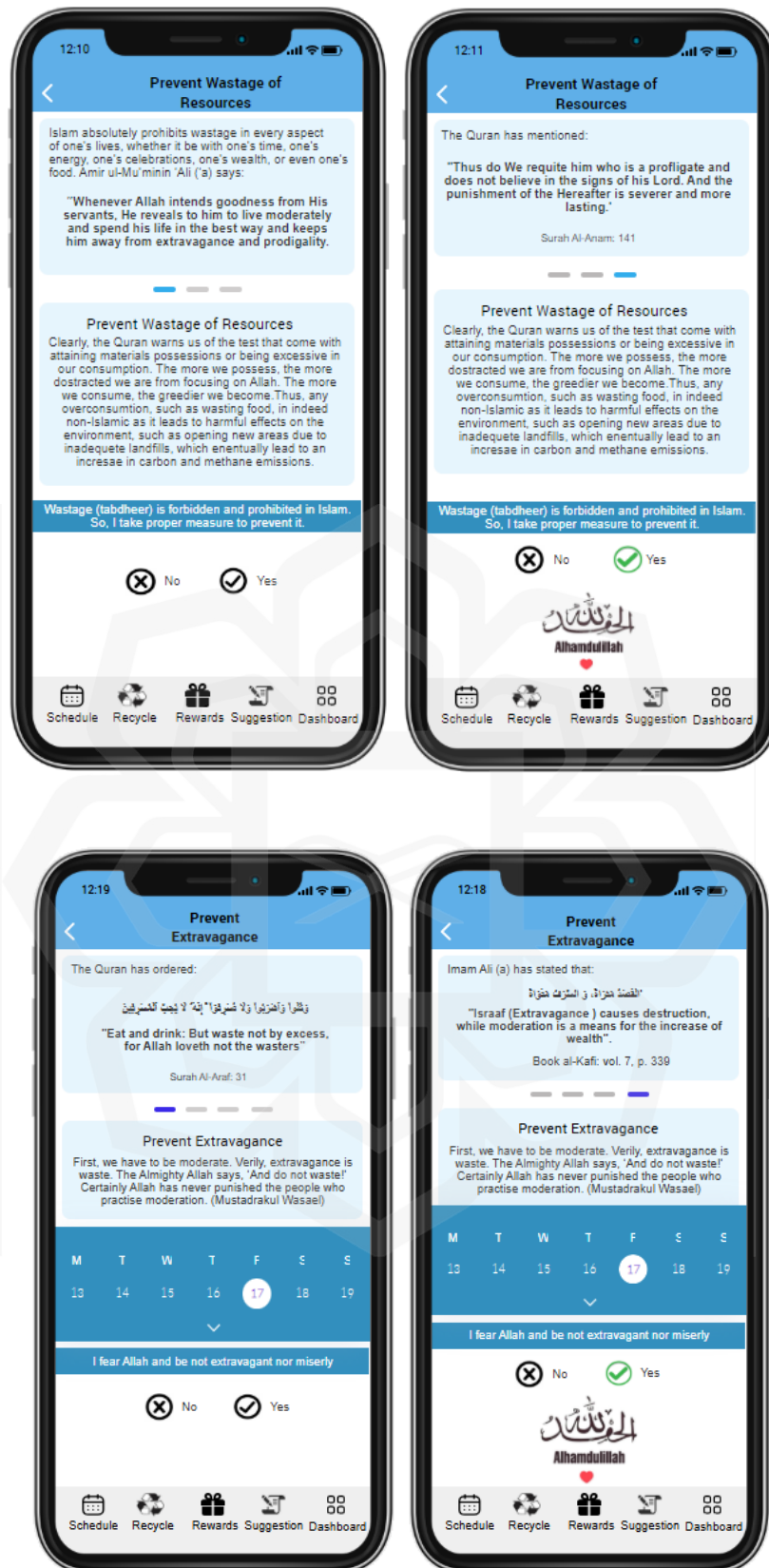


Figure 4.41: *Tahara* Prototype Guides and Reminds user based on Quran and Sunnah of Managing Waste (*Tunnelling, Reminder, and Hifz Al-Din, Nafs, Aql, Nasl, and Mal*)

12. Progress

Finally, all the users progress will be displayed in PROGRESS button at the top of right button on dashboard page. User will see their progress of each week or last 10 days of following the principle of waste management from shariah perspective.



Figure 4.42: *Tahara* Prototype Displays Individual Progress of Managing Waste from Shariah Perspective (*Self-Monitoring and Hifz Al-Din*)

13. The Reminders Notifications

The REMINDERS item lets the user specify how they would like to receive the reminders they set - either as an alarm, text message or email. The reminder notifies

and reminds users on phone about their task of managing waste from shariah perspective to achieve the goal such as “Reduce your extravagance” and “I have managed my waste today as a form to worship Allah”.

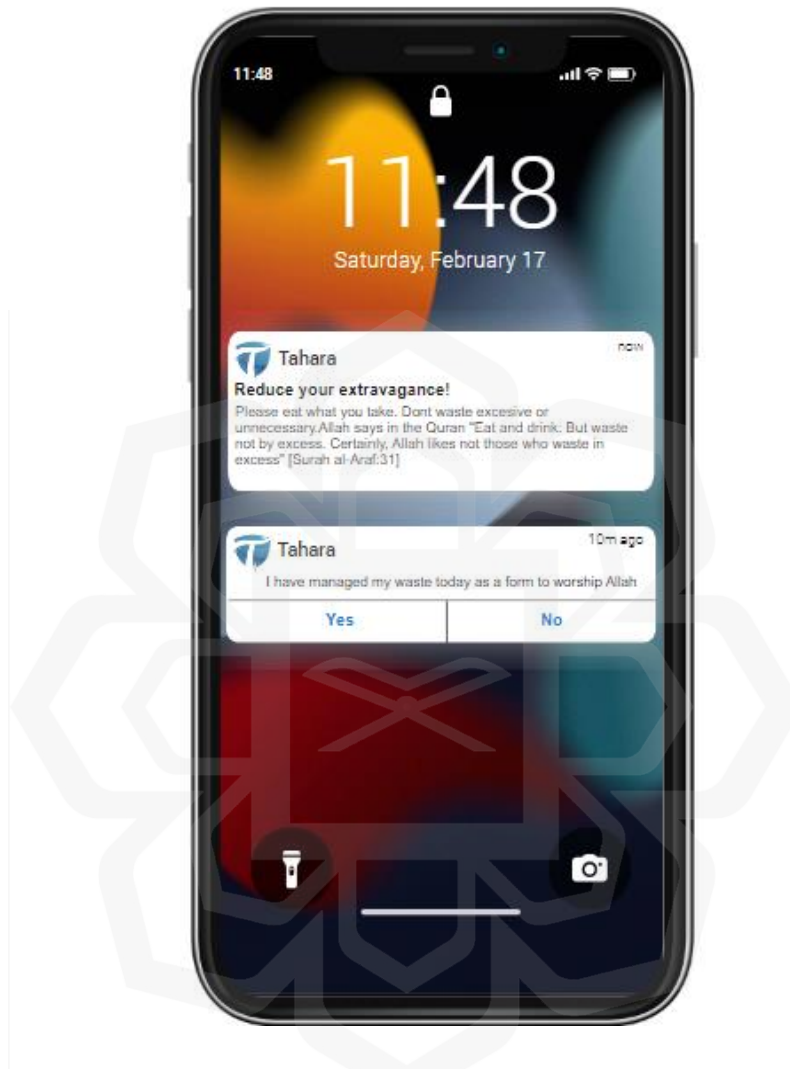


Figure 4.43: *Tahara* Prototype Reminds user about their task of Managing Waste from Shariah Perspective (*Reminder and Hifz al-Din*)

14. Language

In *Tahara* prototype, the personalization offers personalized users' preferred languages, upload personal photos in user profile, addresses and set reminders settings. For example, Preferred language used through the prototype is designed to motivate user to achieve the tasks.

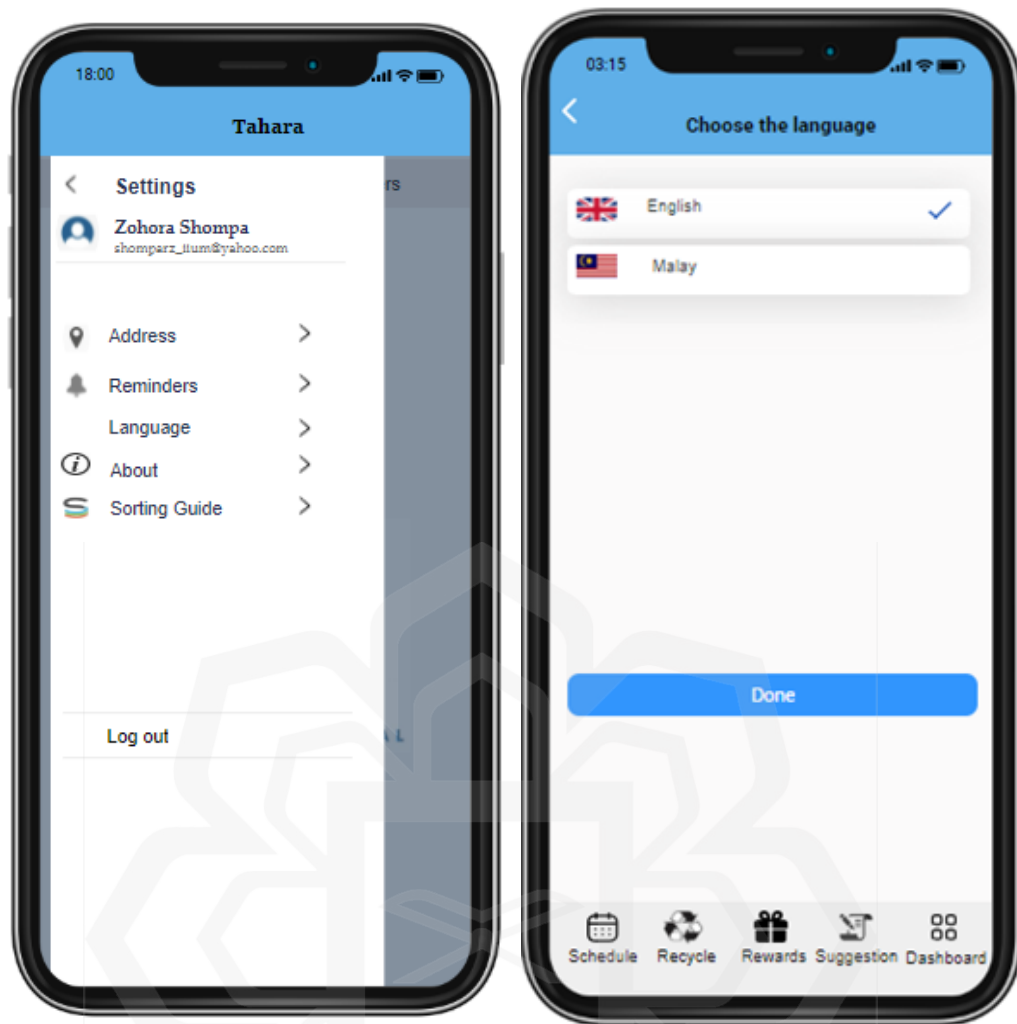


Figure 4.44: *Tahara* Prototype allow user to Choose the Language (*Personalization*)

4.5.3 Summary

In this chapter, we have described six studies (Study 1 to Study 6) that had been conducted to design a persuasive application aiming to encourage green practices among Malaysian community. Study 1 involved investigating the level of awareness of waste management practices based on *Maqasid al-Shariah*. Study 2 involved identifying what are the barriers that hinder waste management practices. In Study 3 and Study 4, effective persuasive design principles and principles of Shariah for waste management practices were identified. The Shariah principles integrated with design principles formed an initial framework and were later validated by an expert review in Study 5 and Study 6. The result of the review is then used to design a high-fidelity

prototype named *Tahara* - a waste management application that persuade users to perform appropriate waste management practices. In the next chapter, we would describe the details of our research objective (4), to evaluate the effectiveness of the framework at encouraging green practices of municipal solid waste disposal through the design of persuasive *Tahara* application prototype among the Malaysian Muslim community.



CHAPTER FIVE

EVALUATION

5.1 INTRODUCTION

This chapter begins with Study 7 to evaluate the effectiveness of *Tahara* application at encouraging sustainable waste management practices for Malaysian households. In order to evaluate the perceived persuasiveness of the prototype, a case study using pre-post within-subject design was conducted. During the evaluation, *Tahara* was presented to the participants, where they were requested to complete several tasks, and afterwards were asked to give their feedback. Only one iteration was carried out including pilot study. In the pilot study, two participants provided feedback in an evaluation session and in the last iteration, eleven participants took part in a prototype evaluation to determine the perceived effectiveness of the application at encouraging sustainable waste management practices.

5.2 STUDY 7: THE CASE STUDY

The objective of this Study 7 is to evaluate the effectiveness of the prototype developed based on the validated framework at encouraging appropriate waste management practices. A think a loud approach was adopted in assessing the effectiveness of the *Tahara* application.

5.2.1 Study Design

In order to evaluate the effectiveness of *Tahara* application, a case study approach is chosen. According to Benbasat et al. (1987), a case study is referring to a study that “examines a phenomenon in its natural setting, employing multiple methods of data collection to gather information from one or a few entities (people, groups, or organizations)”. In fact, it was stated that the case study approach was especially helpful for research involving the assessment of a tool, system, or application in an uncertain real-life setting (Balbach, 1999). In this Study, as the *Tahara* will be utilized

by Malaysian Muslim community, a case study with pre-post within-subject design will be employed to evaluate the effectiveness of the *Tahara* application. The study would be conducted over two (2) months for baseline data collection. This study consists of four parts as described below:

- i. Consent form
- ii. Pre-study questionnaire
- iii. List of Tasks
- iv. Post-study interview
 - Questions regarding system design
 - Questions regarding the user's persuasion level and behaviour
 - Feedback and suggestion from participants/users' opinions

The pre-study questionnaire comprised eleven items, and the post-study interview consists of twenty-four items with a combination of quantitative system design metrics and the following open-ended questions. The principle of persuasion is taken into consideration when creating the questions. The personal data and response regarding the participants' overall degree of persuasion level of the user have been collected through a questionnaire. The post-study questionnaire has been addressed using the Likert-scale mechanism. After completing the post study questionnaire, participants were debriefed about their liking or disliking towards specific feature or aspects of the interfaces and overall degree of persuasion. The very last question aimed to get suggestions or feedback from users as their suggestions or feedback will be helpful to improve the usability of *Tahara* app.

5.2.2 Study Participants

Purposive sampling method was applied by selecting participants that meet the inclusion criteria. The inclusion criteria for the participant in this study includes, a) Malaysian Muslim community residing in Klang Valley, Malaysia; b) already have years of experience of using smartphones; c) willing or have interest to adopt sustainable waste management practices through the use of smartphone applications; d) owned a smartphone with at least 6 months of usage experienced.

Since, the study aimed to evaluate the participants' level of persuasion towards *Tahara* app, we have selected well-educated participants purposefully from diverse age groups who are familiar with the use of technology and smartphones applications. Besides, we have purposefully selected participants who adopt environmentally friendly waste management practices at home and are willing to use a waste management app to improve their waste management behavior. All these criteria collectively contribute to a well-informed and engaged participant group that ensure insightful information about their perspectives and responses toward waste management application.

We invited our participants at eco-friendly booth conducted at IIUM mosque. From the events three participants were agreed to participate in the study. Two participants were recruited from previous study that investigated urban community awareness on MSW disposal based on *Maqasid al-Shariah*. They were re-invited to participate in this study via email. The remaining six participants was personally invited by the researcher due to their interest of managing waste of using smartphone application.

5.2.3 Procedures

There were three (3) main phases involved for data collection which are:

a) Phase 1: Participant Fill up consent form and Pre-Study Questionnaire

In the first phase, firstly the respective participant was asked to feel comfortable to be recorded and signed the consent form (See Appendix IX). If they agreed to be recorded, a voice recorder was used. After that, participants were asked about their demographic information regarding their gender, age, education, occupation, experience of smartphone usage, types of waste generated in their household, usages different bins for different type of waste, how they dispose their household waste, difficulties of practicing 3Rs, usage of waste management app to manage household waste etc. (see Appendix X, part A).

b) Phase 2: Participant perform a list of tasks on *Tahara* application

Afterwards, participants were asked to install *Tahara* application in their smartphone. They were given tasks as per instructed by the researchers. As they were doing the tasks, they were asked to do think aloud technique by uttering or voice-out loud what they were doing (see Appendix X, part B). *Tahara* application allows at least the following high-level tasks:

Task 1: Read the instructions	These are the welcome messages about the app. Please click “next” button to continue.
Task 2: Registration	You are new user. Please sign in with your account.
Task 3: Type of home address	This is the home page of <i>Tahara</i> app. Type of your home address and then search. Then find out your waste collection schedule based on your home address.
Task 4: Pick up recycle object	At the main Menu select “Recycle”. At first, you will see the type of recycle waste materials to be collected. Click any waste material and find out how to request a pickup your recycling waste.
Task 5: Find nearest recycling center and verify the accuracy	Next, click on the “Drop off Location” by selecting a name of waste item and find out the best option to dispose of waste, and name of recycling center near your house and their contact information.
Task 6: User’s progress and contribution towards environment	Further, at the Recycle page click “Impact” button and monitor your performance and your contribution towards the environment.
Task 7: Claim rewards	Go to “Rewards” button. And find out more how to claim your redeem points and get rewards.
Task 8: Read suggestion regarding waste management and environmental aspects	Go to “suggestion” page and find out more an alternative way to reduce your waste.
Task 9: Manage waste from Shariah	Next go to “Dashboard” and click “+” button to select any of the categories of waste disposal to follow Allah’s command and to improve yourself. Select any of the categories and find out the reminder and importance of practicing waste management from Quran and sunnah. And find out how you can improve your behavior in waste management practices.
Task 10: user’s progress and accomplishments	At the Dashboard click the “progress” button and see your progress about the selected categories of waste disposal.

Task 11: change language settings, reminder, and a lot more At the settings, select your preferred languages, reminders, profile, and addresses options.

c) Phase 3: Participant answer a post-study interview

Afterward, in phase 3, the participants were asked to give feedback about the application and share their points of view regarding the application design and how does it affect their waste management behaviour (see Appendix X, part C). At the end of session, an incentive of RM30 was given for their participation.

5.2.4 The Pilot Study

Prior to the actual study, a pilot study was conducted to ensure that the usability testing of the prototype will be successfully conducted. The pilot study provided the researcher with an opportunity to review the prototype, focusing specifically on the methods used for data collection, the accuracy of documentation, and the effectiveness of the tasks list. The pilot study was taking place on October 2023. The pilot study was conducted with two participants, involving both genders (male and female), ages 23 and 25 years old, and with 8 and 20 years of experience of using smartphone, respectively. The two participants have experienced separating their household waste at home and were willing to use smart phone to adopt green practices.

During the pilot study, participants were briefed about the research and asked participants to filled up their demographic information in a given questionnaire. Then, they were asked to perform the eleven tasks that had been assigned to them on the prototype. They were asked to verbalise their thoughts according using think aloud technique. After the task, participants were given the post-study questionnaires and open-ended questions about their experiences, motivation, and any suggested improvements of the prototype. At the end, they received an appreciation and gift. After the first prototype test, the prototype reviewed and modified to avoid the problems.

5.2.4.1 Result from Pilot Study Evaluation

Based on the post-test interview session, the two (2) pilot study participants considered the high-fidelity prototype – *Tahara* application to be useful. Their feedback on the persuasive system design questions were all positive (where all the scores were above 4.0) indicating that persuasive principles and *Maqasid al shariah* applied in the *Tahara* application are potentially effective to persuade people towards sustainable waste management behaviour.

The most favourable feature by the pilot study participants was the redeem points and reminder from Shariah perspective. Another helpful feature of the application was the impact feature on recycling page as they can monitor themselves how much they have recycled and their contribution to the environment. They believed that this feature could improve their waste management behavior. Regarding the design of the *Tahara* application, two (2) participants positively mentioned that the design as “*the design of the app is simple, easy to use and very user-friendly*” and “*the app is helpful for giving idea and encouraging to manage waste.*”

The participants also made valuable suggestions for improvement which includes to solve some usability issues on a few user interfaces and to rectify some buttons that were not functioning properly which lead to negative user experience. These problems had been fixed before actual user evaluation was conducted.

5.2.5 Data Analysis

A transcription of the recorded sessions was carried out. The transcriptions were used to identify perceptions but most importantly to understand how persuaded they are towards *Tahara* app and how they likely to change their waste management behaviour based on their experience interacting with the prototype.

5.2.6 Results

5.2.6.1 Demographic of the Participants

As shown in Table 5.1, a total of 11 participants (2 male and 9 female) participated in this user study. In terms of their education level, 6 out of 11 participants hold a master's and Ph.D., 4 have a bachelor's degrees and 1 had a Diploma. Majority of the participants were aged between 21–30 years old (n=6), followed by 31–40 years (n=3) and 61 years and above (n=2).

In terms of occupation, two participants are PhD students, one is housewife, one is retired, while the remaining six participants work in a variety of professions, including tutoring, administrative support, assistant IT officer, and clerk.

Table 5.1: The Demographics of the Participants

Participant no.	Gender	Age	Education Level	Occupation	Smartphone experiences
P1	Male	24	Bachelor's Degree	Tutor	6 years
P2	Female	29	Masters	Administrative staff	10 years
P3	Male	68	Masters	Retired	20 years
P4	Female	25	Bachelor's Degree	Admin	10 years
P5	Female	39	PhD	Student	15 years
P6	Female	64	Diploma	Housewife	18 years
P7	Female	24	Bachelor's Degree	Clerk	9 years
P8	Female	37	PhD	Student	15 years
P9	Female	28	Masters	Assistant IT Officer	10 years
P10	Female	23	Bachelor's Degree	Clerk	8 years
P11	Female	31	Masters	Teacher	15 years

In terms of familiarity with smartphone usage, all the participants are regular smartphones users and have experienced using smartphones for more than six. Three (3) of the participants have more than 15 years' experience, while remaining participants have 6 years, 10 years, 12 years, 13 years, and 20 years of experience. Nearly majority of the participants use their smartphone regularly (see Figure 5.1).

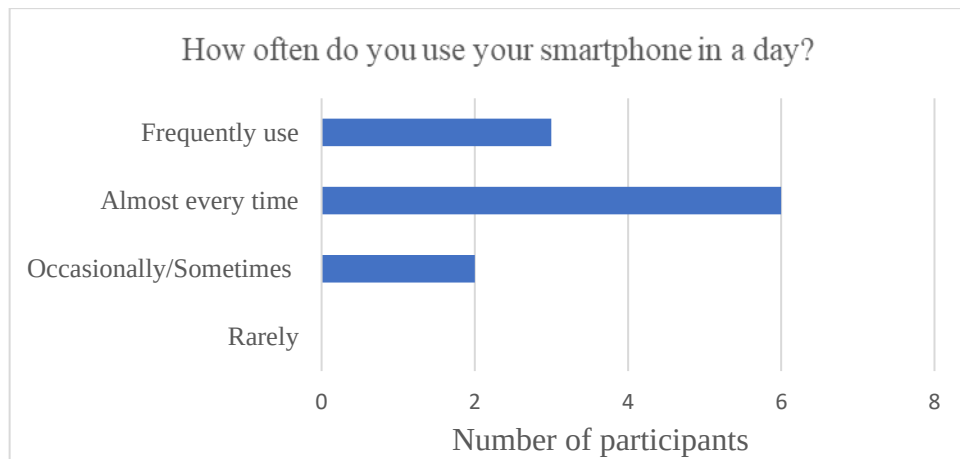


Figure 5.1: Participants' Smartphone Usage Level

In terms of the type of household waste generated, all of the participants reported they generated plastic waste (n=11, 32%), food (n=10, 29%), paper (n=5, 15%), clothing materials (n=4, 12%) and glass (n=4, 12%) at their household. Figure 5.2 shows the types of waste produced by participants. More than half of the respondents (73%) reported that they separated their garbage into bin before disposal.

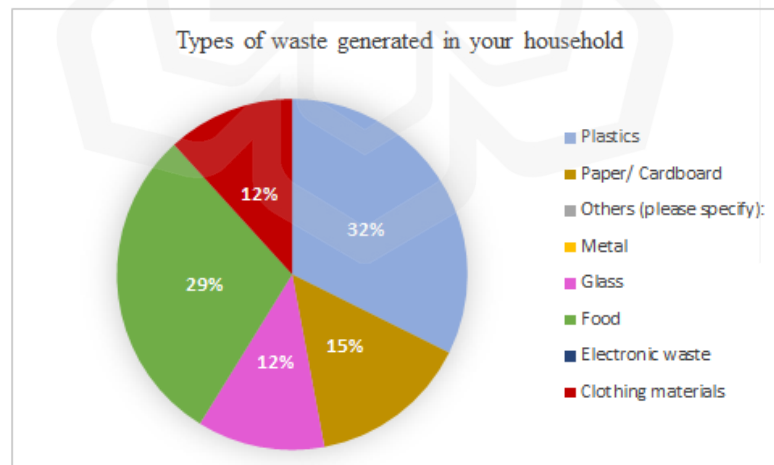


Figure 5.2: Types of Waste Produced by Participants

Besides, in terms of waste disposal, Figure 5.3 revealed that (n = 8, 38%) of the participants disposed their garbage using pick-up truck whereas 19% (n=4) used a

community bin, 19% (n=4) composted and 19% (n=4) burned their waste. In the meantime, only a minority of the respondents reported to use recycling method (n=1, 5%) and no one was found throwing their waste at open place.

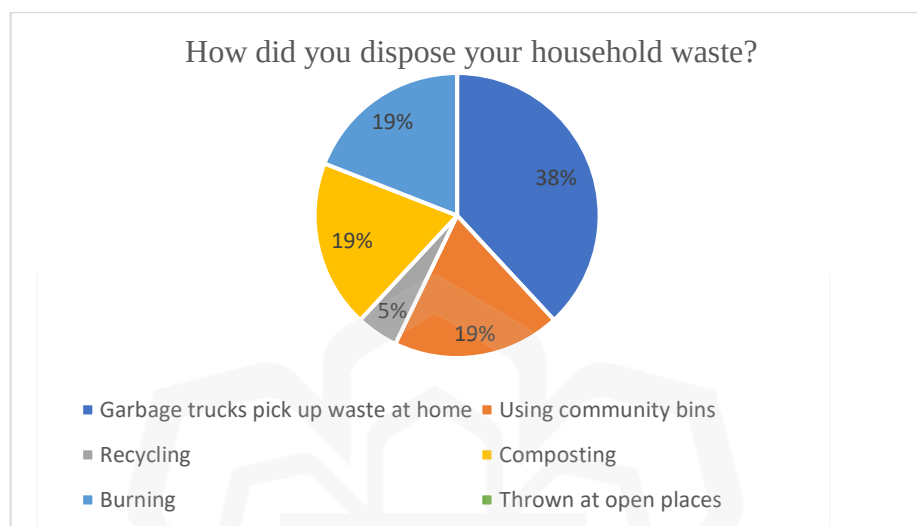


Figure 5.3: Methods of Disposing Waste by Participants

In terms of the difficulties or challenges that the respondents experienced in order to reduce, reuse and recycle household waste, the result shows that, 23% of the respondents (n=7) reported they have lack of time to sort waste and send it to the recycling centre and 19% reported (n=6) they did not have enough space at home to store reusable and recyclable waste. Besides, lack of knowledge about reducing waste (n=2, 6%), reusing waste (n=5, 16%) and recycling waste (n=3, 10%) and inconvenient recycling facilities or recycling bins near the residential area (n=5, 16%), and recycling requires too much effort (n=3, 10%). were the main reasons why people did not adopt environmentally friendly waste disposal practices at home. Figure 5.4 shows the difficulties or challenges the participants face to practice 3Rs at home. Further, Figure 5.6 illustrates that all the participants are unaware of waste management app to manage their household waste.

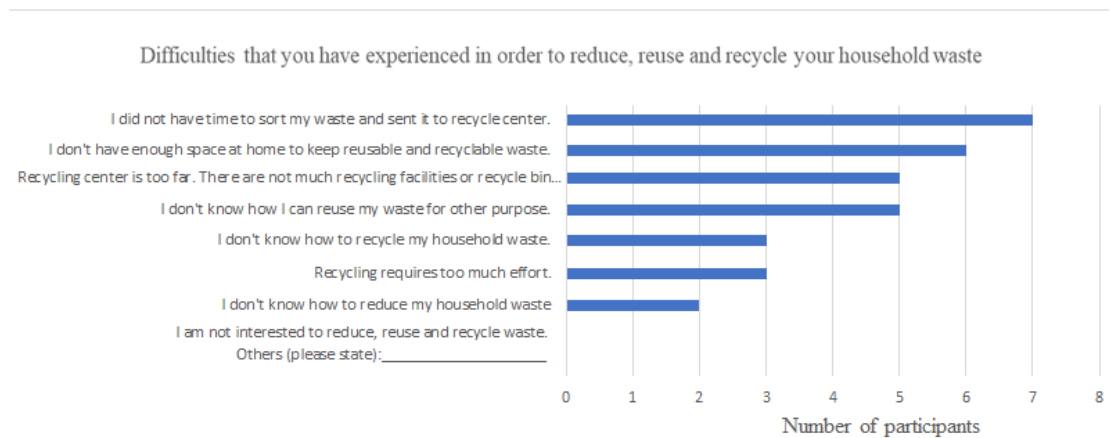


Figure 5.4: Difficulties of Managing Waste by Participants

In terms of waste separation behaviour, majority of the participants ($n = 9$, 82 %) were separating their garbage into different bin before disposal and only 18% ($n=2$) did not separate their waste (Figure 5.5).

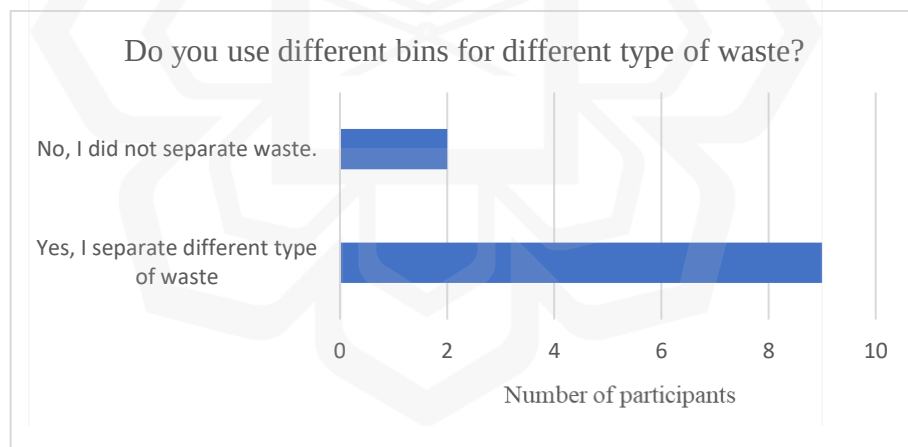


Figure 5.5: Participants' Usage Bin for Different type of Waste

In terms of their experience in using waste management application, majority of the participants ($n=10$, 91%) had never used any waste management app. Only one participant is already aware of waste management app. The following Figure 5.6 shows participants' usage of waste management app to manage their household waste.

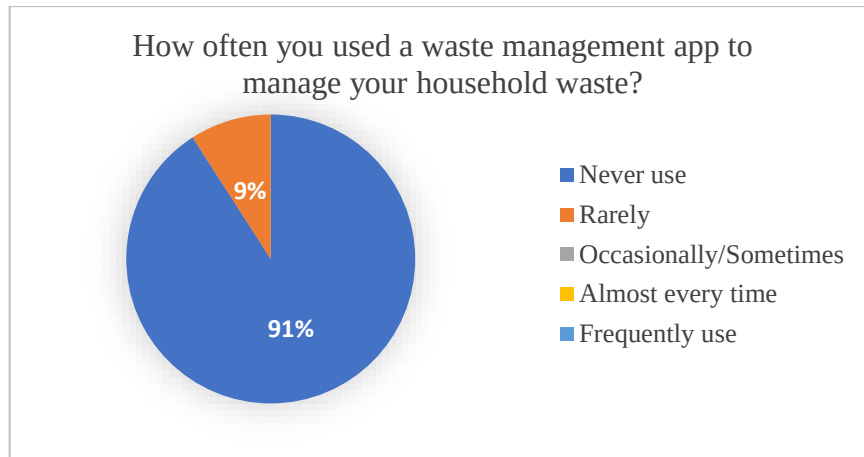


Figure 5.6: Participants' Usage Waste Management App

5.2.6.2 Post-Study Results

7.5.6.2.1 Results of Questions Regarding System Design

The first two questions show the response of participants regarding the general aspects of the design of *Tahara* app using the Likert scale. In these questions, the user feedback was very positive, demonstrating that users liked to use *Tahara*, and the information provided by app was clear and easy to understand. This survey was inspired by a work by Lund (2001) that describes a tool (USE Questionnaire) that may be used to determine whether an interface is well-designed. USE, which stands for Usefulness, Satisfaction, and Ease of Use that most strongly emerged in the early development of questionnaire.

The next 12 questions had been designed by implementing the twelve principles from PSD based on *Maqasid al-Shariah*. In this case, the user feedback was also quite positive (all the scores were above 4.0). These 12 questions were intended to evaluate the *liking, reduction, tunnelling, tailoring, self-monitoring, simulation, rewards, reminder, suggestion, personalization, authority, and verification* persuasive concepts from PSD, and the results showed that the objectives of improving the unsustainable waste management behaviour were greatly met.

The last two questions reflect that the knowledge and awareness provided by the application were informative, useful, and persuasive towards sustainable waste management behavior. On the following Figure 5.7 presented the average rate of *Tahara*- specific features by participants. The graph of design principles with respective Likert scales is also shown below in Figure 5.8.

- **Liker-Scale Graph of System Design**

The average mean score in Figure 5.7 shows that the system has been designed by following the principles of PSD model. Figure 5.8 (Likert-Scale Graph of System Design) also illustrates that the system design seems to be effective with respect to the PSD model. The *rewards* and *reminder* principles from Dialogue Support have high performance. Additionally, 100% participants showed a greater positive response to the *authority* and *verifiability* principles from system credibility support questions. This indicates a 100% certainty on the credibility of the system. Besides, *simulation* features from primary task support greatly encouraged them to enhance their waste management practices. Finally, the majority of users highlighted that *Tahara* app is very persuasive towards sustainable waste management behavior because *Tahara* was designed exactly to encourage the audience to participate in it.



Figure 5.7: Average Rate of System Design

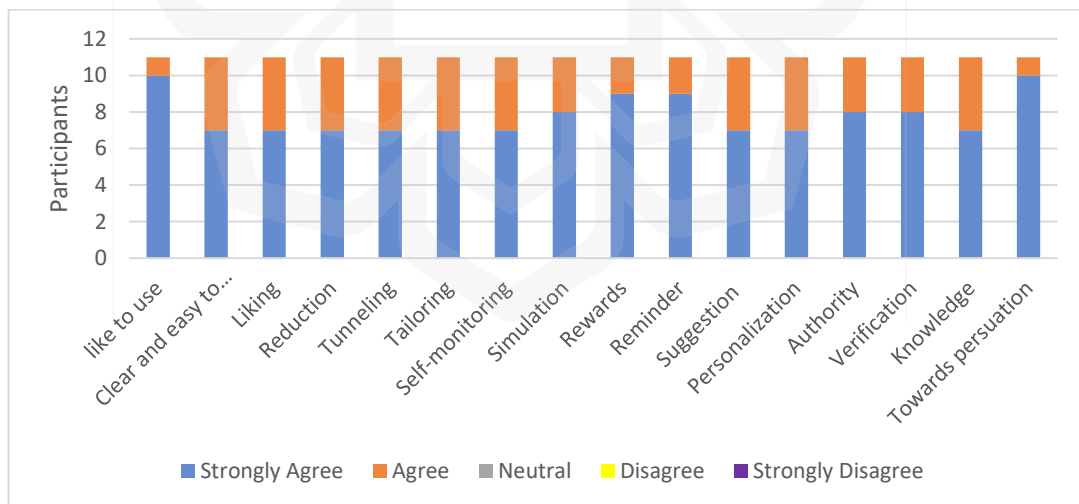


Figure 5.8: Likert-Scale Graph of System Design

7.5.6.2.2 Results of Post Test Interview

During user study, we discovered that the application had a great influence on the user's behaviour of managing their waste. Results of questions regarding participants' behaviour levels after using the application are described below:

- *User Perceptions towards the Use of Tahara application for Waste Management*

All 11 participants in our user evaluation study agreed to use *Tahara* app to manage their household waste. The reason is because they felt that this was the first waste management app from a shariah perspective, which motivated them to manage their household waste more mindfully. They found the app to be very helpful, educational and convenient.

"Yes, the app is very useful, user friendly and convenient." (P2)

"Yes, because I think this is the first app regarding the waste management from Islamic perspective." (P6)

"Yes, the app is quite manageable for different types of recyclable waste. So, I can differentiate what I want to throw into bin." (P11)

"Yes, because it helps me manage my household waste more consciously". (P4)

Besides, participants were also asked about features of the application that they liked most. Most of the participants mentioned about the *reminder* feature from Quran and Sunnah followed by *rewards* points.

"Mostly, I liked the reminder from Quran and sunnah. It increases my knowledge. Besides, it motivates and encourages me to manage my waste from Islam." (P1)

"I love the reminder feature in Tahara app because it helps me to understand how important it is to manage waste in order to safeguard the environment." (P2)

“Personally, I liked the most in Tahara app is the reward system, when we will dispose our waste by the app will get rewards.” (P6)

“This is the first app I have found it and we can get redeem points so it will motivate me.” (P10)

Meanwhile, some other participants also liked the ‘schedule’ and ‘drop off’ location where they can find the recycling center near their house.

“I liked the drop off location where we can find recycling center near our house.” (P11)

“I liked the schedule. Because we have different categories of waste. And when I want, I can send my waste. In my residential area, only one person is to remind us to collect recycling things. So, if I have this app so I can remind myself earlier and when they will come and collect the waste. So, I do not need waiting for others to remind us.” (P8)

In general, the majority of participants responded that they liked the app. However, one participant highlighted that she is not interested in the feature of the app that helps to manage the behavior. Her main area of interest is garbage sorting at home.

“It’s not dislike about it. May be its not my main concern. I know the reminder about Quran and Sunnah its important. But I think maybe I am not interested in the features of the app that how it helps us to manage our behavior. I am more interested on how to sort the household waste. I want to know which items need to sort.” (P11)

- *User Perceptions towards the Persuasiveness of Tahara Application for Waste Management Behaviour*

In terms of persuasiveness of the application, all 11 participants reported that the app had a strong influence on them to adopt sustainable waste management practices. They

said that *Tahara* app broadened their knowledge of waste management and made them conscious of their responsibility towards environment and waste management from the Islamic perspective. While some participants believed that reminder from Quran and sunnah could change our behaviour towards sustainable waste management practices. In addition, they reasoned that by utilizing this app, they can see the impact of our recycling and therefore inspire the community or society to recycle more frequently. This suggests that the app is highly convincing to improve or change the user's behaviour towards sustainable waste management practices. Some of their comments are shown below:

"Yes, I can learn more about waste management from Quran and sunnah."
(P8)

"Yes, because I think by using this app we can see the impact of our recycling so, the society or community will be encouraged to do recycling more often."
(P9)

"Yes, because it makes aware about our duty towards environment and waste management from Islamic perspective. (P3)

"Yes, because the system gives the notification to remind us. In the future if we use this app then we can change our behavior" (P10)

In terms of persuasive features of the *Tahara* app, users were delighted with the self-monitoring and simulation features in app which allows user to see the cause-and-effect relationship of their behavior -i.e., how their waste management behavior had changed as a result of the waste they had recycled. Some participants appreciated the reminder feature on the dashboard, the schedule, and the option to request their waste be picked up for recycling.

"Yes, it shows my performance (self-monitoring). So, I will aware more about the environment and waste management." (P4)

“I think impact (simulation) could improve our waste management behavior because if I see the effect of my contribution towards environment, then I will be more motivated.” (P2)

Additionally, we also asked participants for additional suggestions to enhance the persuasive power of the application. One participant suggested adding a ranking for user performance.

“Add another feature. Example: Consider other user performances to encourage people doing waste management.” (P1)

Besides, another participant suggested to add the hotline number (e.g., WhatsApp number) to contact to the recycling center instead of using office number:

“No, but if we want to contact to the recycling center in their office number. Maybe they will no response or may be take long time to response. So, I think they should put some WhatsApp number.” (P2)

Besides, we also asked participants for any feedback or suggesting improving the app. Some of the participants suggested to add the user guide before using the app while one participant recommended using affirmative language such as "Allah loves it more if you encourage to do it compared who do not" to make the app more causal in our day-to-day lives. As mentioned by the participants:

“You can add the guidelines how to use the app for older people. (P8)

“Maybe we can improve more. let’s consider for the people didn’t have knowledge for it, maybe we can have the guideline before to use the app.” (P10)

“It has the component of behavior management, which is good, but I think in terms of reminding people using the qur’anic verse. I think we need to make it more casual. I mean how it can affect our daily life. Like Allah loves it more if you encourage to do it compared to use do not.” (P11)

In addition, it was shown that majority of participants were felt motivated to use *Tahara* application to improve their waste management practices. They are excited to wait for the real application to be launched because they believed it will be helpful for people to manage garbage from a Shariah perspective.

“In future, when the app will release, I think it will be quite useful for the people.” (P10)

“It is helpful for giving idea and encouragement to manage waste from Shariah perspective.” (P2)

“I think it’s quite good. I wait for the real app to use it.” (P5)

“I don’t have suggestion because this app is really good to new user and simple design, and we can find anything.” (P4)

Furthermore, regarding the usability of the *Tahara* app, in general the majority of participants noted that it was very easy to use, user friendly, colorful and convenient.

“Yes. This is very easy to use, very convenient, user friendly and the app is not very complicated.” (P6)

“Yes, it is colorful and convenient.” (P4)

“Yes, the function of the Taharah app is user friendly.” (P8)

5.2.7 Summary of Study 7

The evaluation of the prototype was presented in this chapter. *Tahara*- clean waste disposal is a persuasive mobile application that persuaded the Muslim community to increase their awareness and improve their waste management behaviors by integrating *Maqasid al-Shari’ah* into the design of a mobile phone application. During user tests, all users felt excited and had a good experience with *Tahara*. The most

helpful feature of the application were the rewards points after completing recycling, reminder from Quran and Sunnah, and self-monitoring and simulation feature to see their performance and contribution towards waste management. Lastly, all participants considered the application to be useful, user friendly, would use it if available and found the app to be highly persuasive and capable of motivating desired behavior change towards sustainable waste management practices. In the next chapter, we will conclude our research by presenting our approach to achieving the goal, our contribution, limitations, and our recommendations for further research.



CHAPTER SIX

CONCLUSION

6.1 INTRODUCTION

This chapter reviews the research that has been carried out. First, an overall summary of the study is presented. In this part, the research questions, research objectives, and research methodology are briefly discussed. Afterward, the contribution of the study is discussed. Finally, the discussion on the limitations and direction for future research are presented.

6.2 SUMMARY OF THE STUDY

Generally, the main objective of this study is to design a persuasive mobile application prototype, *Tahara-clean waste disposal*, which integrates Shariah principles to motivate behavioral change among Malaysians towards responsible waste disposal and better environmental consciousness. The study aimed to achieve the following research objectives:

1. **RO1:** To investigate awareness on MSW disposal Based on *Maqasid al-Shariah*.
2. **RO2:** To identify persuasive behaviour change strategies that could encourage behavioural change towards green practices of municipal solid waste disposal.
 - a) Identify effective persuasive design principles to encourage green practices of MSW Disposal based on the Persuasive System Design (PSD) model.
 - b) Identify the principles of waste management practices within *Maqasid al-Shari'ah* framework namely protection of faith, life, intellect, lineage, and wealth.

3. **RO3:** To propose a new integrated framework to design a persuasive system to encourage green practices of municipal solid waste disposal based on *Maqasid al-Shariah*.
4. **RO4:** To evaluate the effectiveness of the framework at encouraging green practices of municipal solid waste disposal through the design of persuasive application prototype.

To achieve these objectives (RO1–RO4), the research was carried out through five iterative phases: Phase 1 (Problem Identification), Phase 2 (Identifying Design Principles), Phase 3 (Framework Development), Phase 4 (Prototype Development), and Phase 5 (Evaluation). These phases were conducted in an iterative manner, as illustrated in Figure 6.1. The design and evaluation process were guided by the Persuasive System Design (PSD) model introduced by Oinas-Kukkonen and Harjumaa (2009), with the *Maqasid al-Shariah* framework integrated into the persuasive design to ensure alignment with Islamic ethical values.

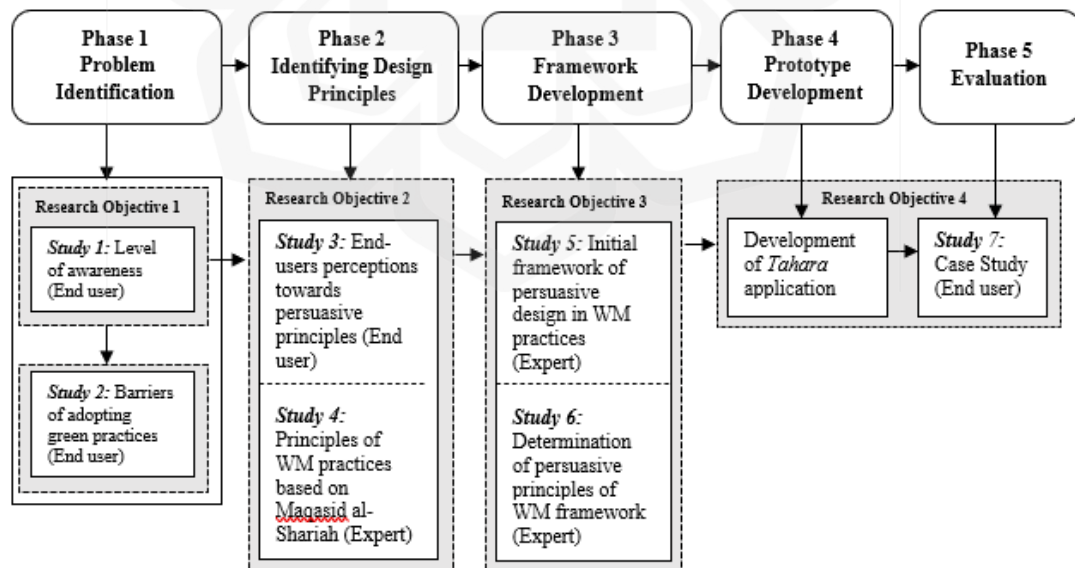


Figure 6.1: Research Phase of the Study

In order to achieve the first research objective (RO1), the study commenced with **Phase 1: Problem Identification**. This phase involved a comprehensive literature review and the conducting **Study 1**, which aimed to assess the level of awareness regarding Municipal Solid Waste (MSW) disposal from the perspective of *Maqasid al-Shariah*. Data were collected through an online survey involving 200 respondents, focusing on their behaviors and practices related to solid waste disposal in light of the five dimensions of *Maqasid al-Shariah*—protection of faith, life, intellect, lineage, and wealth.

The findings revealed that while most households demonstrated a moderate level of awareness of waste disposal guided by Islamic principles, this awareness did not consistently translate into environmentally responsible behavior. Participants generally did not integrate their religious values into practical waste management practices. These findings successfully addressed and fulfilled the first **Research Objective (RO1)**.

To further explore the barriers to adopting environmentally friendly practices, **Study 2** was conducted. This study utilized an in-depth, semi-structured interview method involving seven participants to investigate the challenges Malaysian households face in implementing green practices related to MSW disposal. Thematic analysis was employed to analyze the interview transcripts, with themes categorized as barriers to sustainable waste management.

The results indicated several key obstacles, including lack of awareness and knowledge, lack of personal responsibility and motivation, and negative attitude toward waste separation, lack of community participation, insufficient and inaccessibility of information regarding 3Rs, lack of facilities, and the infrequency of waste collection, lack of enforcement and lack of financial initiatives.

These findings provided deeper insights into the practical challenges hindering the integration of Shariah-based environmental consciousness into daily waste disposal practices.

The second phase (**Identifying Design Principles**) of study comprised **Study 3**, and **Study 4** aimed at fulfilling Research Objective 2 (RO2)—to identify persuasive behavior change strategies that encourage environmentally responsible municipal solid waste (MSW) disposal practices.

Study 3 focused on exploring user perceptions towards the persuasive design principles implemented in waste management application. In-depth interviews were conducted with seven participants, aged between 31 and 47 years, residing in various locations within the Klang Valley. During the sessions, participants were presented with multiple user interface (UI) designs demonstrating the application of different persuasive design principles. Thematic analysis was employed to examine participants' positive and negative responses to these UI elements, helping to determine which persuasive strategies were most effective.

The analysis revealed 20 positive, 3 negative, and 5 mixed (both positive and negative) user perceptions of the persuasive design principles. The positive perceptions are *reduction, tailoring, personalization, self-monitoring, simulation, praise, rewards, reminders, liking, social role, trustworthiness, expertise, surface credibility, real-world feel, verifiability, social learning, normative influence, and cooperation* principles. The negative perceptions were associated with *rehearsal, similarity, and recognition* principles. Meanwhile, *tunnelling, suggestion, authority, third-party endorsement, competition, social comparison, and social facilitation* principles with mixed views (positive and negative) perceptions.

These insights provided a clearer understanding of which persuasive principles are positively or negatively perceived by users, offering valuable input for the design of effective persuasive systems.

Study 4 aimed to investigate the principles of sustainable waste management practices within the framework of *Maqasid al-Shari'ah*. This was conducted using a qualitative content analysis guided by an inductive approach. After identifying relevant principles, the conceptual framework was validated through the literature of *Maqasid al-Shari'ah* scholars. The findings revealed that the principles of *Maqasid al-Shari'ah* provide a foundation for guiding responsible waste management behavior.

The study identified five key dimensions aligned with the objectives of Shariah—*Jalb al-Masalah* (promoting benefits) and *Daf'al-Mafsadah* (preventing harm):

1. Religiosity – promoting awareness of waste management as a religious duty.
2. Healthcare and Well-being – protecting public health through hygienic waste practices.
3. Useful Knowledge – encouraging informed and rational resource use.
4. Family Well-being – considering the impact of waste management on household welfare.
5. Wealth Management – advocating responsible consumption and resource conservation

These dimensions contain specific indicators and principles that can be directly applied to household waste management, promoting behavioral change that aligns with Shari'ah viewpoint.

The completion of **Study 3** and **Study 4** marked the achievement of **Research Objective 2 (RO2)**. The findings from this phase 2 contributed to the development of a persuasive design framework for sustainable waste management, grounded in the principles of *Maqasid al-Shari'ah*.

The third phase of the study focused on **Framework Development**, and involved **Study 5** and **Study 6**, aiming to achieve Research Objective 3 (RO3)—to propose an integrated framework for designing a persuasive system that encourages green practices in Municipal Solid Waste (MSW) disposal based on *Maqasid al-Shari'ah*.

In **Study 5**, the initial framework was validated through expert review using the Fuzzy Delphi Method (FDM). A total of twelve experts were selected via purposive sampling, representing diverse areas of expertise including Shariah Sciences, Maqasid al-Shari'ah, Islamic Economics, Islamic Jurisprudence, ICT and Islam Foundation, Human-Computer Interaction (HCI), Solid Waste Engineering, and Waste Management Corporations such as KDEBWM and SWCorp.

Data collection for the expert review involved a combination of face-to-face interviews, virtual interviews via Google Meet, and questionnaire method. The expert review form used a 5-point Likert scale to obtain consensus on each item of the proposed framework.

The results of Study 5 indicated that twelve persuasive design principles from the Persuasive System Design (PSD) model were considered essential for inclusion in the waste management application. The twelve principles are reduction, tunnelling, tailoring, personalization, self-monitoring, simulation, rewards, reminders, suggestion, liking, authority, verifiability. These validated principles provided the basis for designing a medium-fidelity prototype named *Tahara*, which was further evaluated in Study 6 through a second round of the Fuzzy Delphi technique.

In **Study 6**, the revised framework was validated by seven experts from the field of Maqasid al-Shari'ah, Human-Computer Interaction, Solid Waste Engineering, and key stakeholders from KDEBWM and SWCorp. This second round of expert review confirmed the relevance and importance of the twelve persuasive principles that need to be applied in designing the WM application. Additionally, experts offered constructive feedback on user interface (UI) design elements corresponding to each principle to effectively encourage sustainable behavior. Moreover, the experts emphasized the clarity and alignment between the persuasive principles and supporting Islamic teachings (*Maqasid al-Shari'ah*). They acknowledged that the integration of *Maqasid al-Shari'ah* within the persuasive design framework was both meaningful and purposeful, reinforcing ethical and religious motivation for behavior change.

The completion of **Study 5 and Study 6** marked the successful achievement of **Research Objective 3 (RO3)**. The validated framework served as the foundation for the development of the high-fidelity mobile application prototype, *Tahara*, in the next phase of the study.

In phase 4 (prototype development) In *Tahara* application, a total of 12 persuasive design principles were implemented with the principles of *Maqasid al-Shari'ah* such as preservation (*hifz*) of religion (*al-din*), life (*al-nafs*), intellect (*al-*

aql), progeny (*al-nasl*), and wealth (*al-mal*) in the context of *Jalb al-Masalah* (Serve interest) and *Daf' al-Mafsadah* (Protect from harm and corruption).

In **Phase 4: Prototype Development**, a high-fidelity mobile application named *Tahara* was developed by integrating twelve persuasive design principles with the five key dimensions of *Maqasid al-Shari'ah*—preservation (*hifz*) of religion (*al-din*), life (*al-nafs*), intellect (*al-'aql*), progeny (*al-nasl*), and wealth (*al-mal*). These were incorporated within the ethical framework of *Jalb al-Masalah* (Serve interest) and *Daf' al-Mafsadah* (prevention of harm and corruption). The prototype operationalized both persuasive system design elements and Islamic ethical values to encourage behavioral change toward sustainable waste disposal practices.

To achieve the **fourth research objective (RO4)**, **Phase 5: Evaluation** was conducted through a case study—**Study 7**—to assess the effectiveness of the *Tahara* application. A think-aloud protocol was adopted to capture participants' real-time reactions and reflections while interacting with the application. A total of 11 participants were involved in this user study, providing feedback on usability, relevance, and behavioral influence.

The findings from Study 7 revealed that the *Tahara* application, designed using persuasive design principles and grounded in *Maqasid al-Shari'ah*, effectively influenced users' awareness and behavior concerning Municipal Solid Waste (MSW) disposal. Participants demonstrated increased understanding of the ethical and religious dimensions of waste management and showed positive changes in their practices.

The completion of **Study 7** signifies the achievement of the **fourth and final research objective (RO4)**—to evaluate the effectiveness of the proposed framework through the *Tahara* application. Furthermore, this phase marked the completion of iterative research process, encompassing: Phase 1 (Problem identification), Phase 2 (Identifying design principles), Phase 3 (Framework development), Phase 4 (Prototype development) and Phase 5 (Evaluation). Together, these phases represent a holistic and methodologically rigorous approach to designing and evaluating a

persuasive system for green practices in municipal solid waste management through the lens of Islamic values and behavioral science.

6.3 RESEARCH CONTRIBUTION

This research makes six significant and incremental contributions to the design and development of a persuasive mobile application aimed at encouraging Malaysians to adopt sustainable waste management practices. Each study was designed to address specific gaps in the literature and practical implementation, systematically building towards the development of the *Tahara* mobile application, which integrates persuasive system design principles with Islamic values derived from *Maqasid al-Shari'ah*.

1) Urban Community Awareness on Municipal Solid Waste (MSW) Disposal based on *Maqasid al-Shari'ah* (Study 1)

This study explored the level of awareness among urban Malaysian communities regarding proper Municipal Solid Waste (MSW) disposal, through the lens of *Maqasid al-Shari'ah*—protection of faith (*din*), life (*nafs*), intellect (*'aql*), lineage (*nasl*), and wealth (*mal*). Five hypotheses were tested to examine how these five dimensions of *Maqasid al-Shariah* influence behavioral intention toward waste management practices.

Findings indicated moderate awareness of Islamic teachings on waste disposal. However, despite recognizing the religious importance of protecting the environment, participants showed limited integration of these values into their actual behavior. Regression analysis showed that the dimensions of faith (*hifz al-din*), life (*hifz an-nafs*), and wealth (*hifz al-mal*) significantly influenced behavioral intentions, whereas intellect (*hifz al-'aql*) and lineage (*hifz al-nasl*) did not. This highlights a gap between religious understanding and environmentally responsible behavior.

2) Barriers to Green Practices Based on the Socio-Ecological Model (Study 2)

This qualitative study explored the barriers faced by residents of Klang Valley in adopting sustainable waste disposal behaviors. The problems and challenges are identified by conducting in-depth interviews involving 7 participants. Through the use of socio-ecological model, barriers were identified at multiple levels: personal level (lack of awareness and knowledge, lack of personal responsibility, motivation, and negative attitude), community level (Limited community involvement in waste separation initiatives), organizational level (Inaccessibility of 3R (Reduce, Reuse, Recycle) information and inadequate facilities, and the infrequency of waste collection), policy level (lack of enforcement, and lack of financial initiatives). These barriers provided essential context for the selection of relevant persuasive strategies in the subsequent study and informed the user-centered design of the application.

3) User Perceptions of Persuasive Design Principles in Waste Management Application (Study 3)

To develop an effective persuasive application for sustainable waste management, this study examined end-user perceptions towards persuasive design principles based on the Persuasive System Design (PSD) model proposed by Oinas-kukkonen and Harjumaa (2008). In this thesis, understanding end-user perceptions as the end user of the application are very imperative, to ensure that the selected design principles implemented on the persuasive application are indeed effective and useful to encourage them to practice waste management. In order to understand their perceptions, in-depth interview sessions were conducted with seven (7) participants, aged 31 to 47 years residing in Klang Valley. During interview sessions, participants were presented with several user interfaces (UIs) of waste management applications showing how each persuasive design principle had been applied. Thematic analysis uncovered: Positive principles (*reduction, tailoring, personalization, self-monitoring, simulation, praise, rewards, reminders, liking, social role, trustworthiness, expertise, surface credibility, real-world feel, verifiability, social learning, normative influence, and cooperation principles*), negative perceptions (*similarity, rehearsal, and recognition*) and mixed views (*tunnelling, suggestion, authority, third-party endorsement, competition, social comparison, and social facilitation*). This evaluation

guided the selection of culturally and contextually suitable persuasive strategies for Malaysian users.

4) Principles Guiding Waste Management Based on *Maqasid al-Shari'ah* (Study 4)

This study developed a conceptual framework to guide waste management practices in accordance with *Maqasid al-Shari'ah*, addressing the gap between Islamic environmental ethics and practical waste disposal behaviors. Using qualitative content analysis and expert validation (five Islamic scholars), the study identified key sub-dimensions and indicators within the five *Maqasid* domains. The framework highlights how Islamic values promote sustainability through protection of faith (*Hifz al-din*): treating waste management as a form of worship; protection of life (*Hifz an-nafs*): reducing health risks through hygienic practices; protection of intellect (*Hifz al-'aql*): encouraging thoughtful decision-making based on the recognition of Allah's signs in nature; protection of lineage (*Hifz al-nasl*): preserving the environment for future generations and; protection of wealth (*Hifz al-mal*): preventing wastage, encouraging recycling, and promoting cost-effective consumption. The Figure 6.2 shows the framework of the principles of *Maqasid al-Shari'ah* into various sub-dimensions, indicators, and principles related to sustainable waste management practices. This holistic framework bridges Islamic ethical values with practical environmental actions, offering a spiritually driven model for behavioral change.

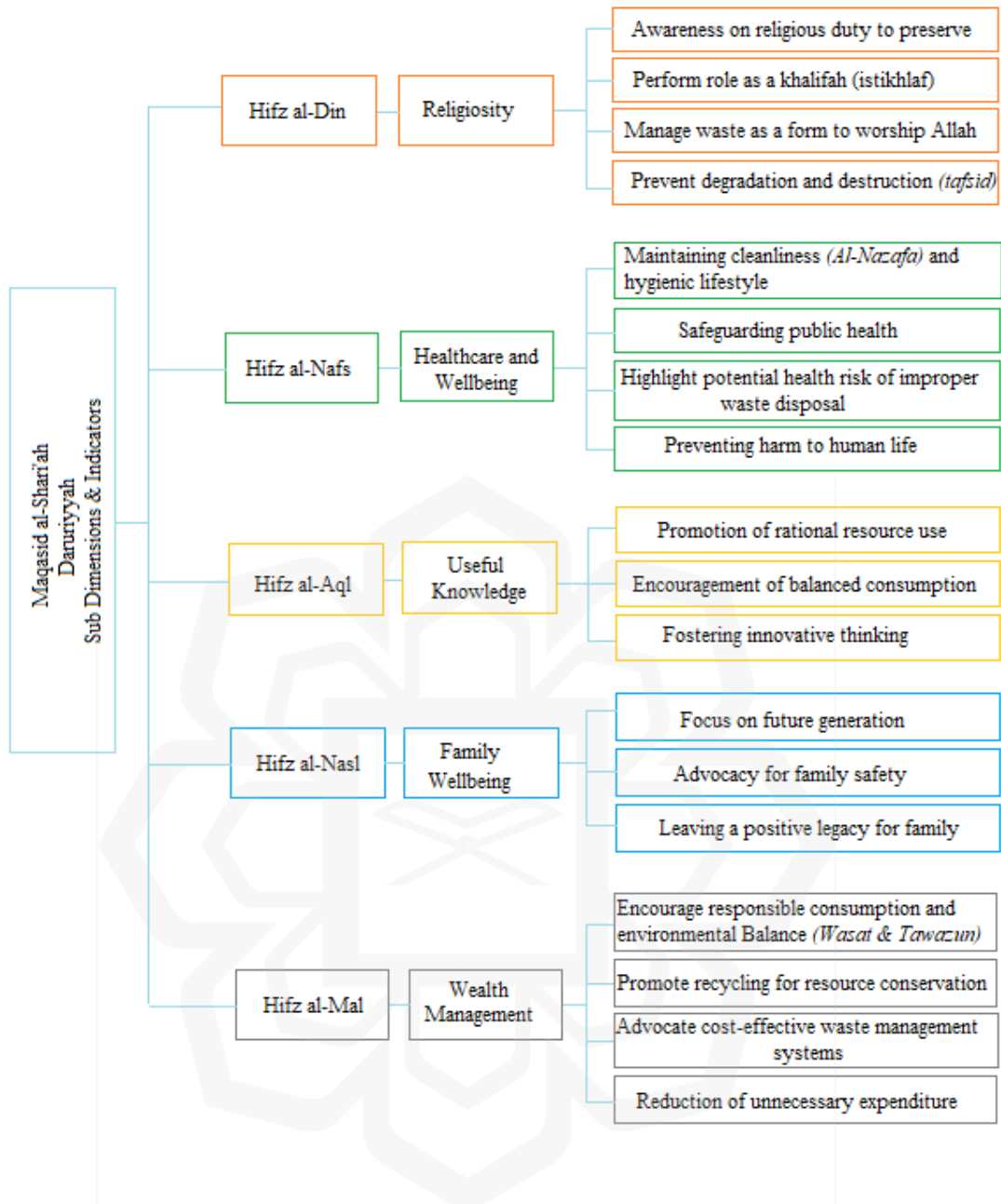


Figure 6.2: *Maqasid al-Shari'ah* Framework for Sustainable Waste Management

These important principles of *Maqasid al Shariah* will be integrated with the persuasive design principles to ensure that waste management aligns with the Shari'ah viewpoint and contribute to the environmental conservation efforts.

5) Integration of Persuasive Principles with *Maqasid al-Shari'ah* in a Waste Management Application Framework (Study 6)

Based on the findings of Studies 3 and 4, a persuasive framework was constructed by integrating selected persuasive design principles with corresponding *Maqasid al-Shari'ah* elements. The resulting framework was validated through expert reviews involving twelve experts from diverse domains including *Shariah Sciences, Maqasid al-Shari'ah, Islamic Economics, Islamic Jurisprudence, ICT and Islam Foundation, Human-Computer Interaction (HCI), Solid Waste Engineering, and Waste Management Corporations* (e.g., KDEBWM, SWCorp). The framework validation was conducted in two iteration rounds until consensus or stability is reached. The results indicated that the twelve persuasive principles based on *Maqasid al-Shari'ah* as highly relevant to design waste management application. The twelve persuasive principles are *reduction, tunnelling, tailoring, personalization, self-monitoring, simulation, reminders, suggestion, liking, authority, and verifiability*. These principles were implemented into a high-fidelity prototype of the *Tahara* app using the Justinmind prototyping tool. This study addressed critical limitations in existing PSD frameworks, particularly the lack of consideration for religious and cultural contexts in persuasive technology research. Consequently, this thesis demonstrated the detailed process and methods involved in designing, developing, and evaluating persuasive application that incorporate persuasive principles with *Maqasid al-Shariah*.

6) Evaluation of Persuasive Smartphone Application for Malaysian (Study 7)

The final study involved evaluating the effectiveness of the *Tahara* mobile application using a *Think-Aloud* approach. Participants were asked to interact with the app and verbalize their thoughts, reactions, and decisions during usage. The evaluation showed that *Tahara*, through its integration of persuasive design and *Maqasid al-Shari'ah*, was persuasive and capable of motivating users toward sustainable waste management behavior. It stood out in its ability to engage users both intellectually and spiritually, offering a culturally grounded and behaviourally impactful mobile solution.

In summary, this research offers a novel interdisciplinary approach by synthesizing behavioral science, persuasive technology, and Islamic ethics. The key contributions are:

1. **Contextual Insight:** Unveiling the religious and psychological factors influencing waste behaviour in urban Malaysian Muslims.
2. **Barrier Identification:** Mapping multi-level obstacles to green behavior through the socio-ecological model.
3. **User-Centered Persuasion:** Identifying culturally effective persuasive principles for Malaysian users.
4. **Islamic Framework Development:** Constructing and validating a *Maqasid al-Shari'ah* based framework for sustainable waste practices.
5. **Framework Integration:** Merging persuasive strategies with Islamic values for application design.
6. **Application Development and Testing:** Designing, developing, and evaluating the *Tahara* prototype for real-world usability and behavioural impact.

These contributions not only enrich academic discourse in Human-Computer Interaction, behavioral change, and Islamic studies but also offer a practical, culturally sensitive, faith-aligned, and behaviorally effective solution to urban waste management.

6.4 RESEARCH LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

Our approach on designing persuasive application to persuade Malaysian people to change their attitude and behavior towards waste disposal and increase their awareness from a Shariah perspective to practice their waste disposal more sustainably to protect the environment. Although the effort is significant, it has some limitations in process of conducting the analysis. Furthermore, it creates a lot of opportunities for future research to be more precise, significant, and convincing research in the future that will represent the entire population. Some of the research limitations that we encountered are listed below, along with several suggestions for future research:

- 1) All the respondents participated in the seven (7) studies presented in this thesis were comprised of Malaysian nationalities and living in Klang Valley. Maybe the respondents of this study have a different view compared to those from other states in Malaysia. Therefore, such a study may result in a different outcome. In Study 1 for future research, we recommend more respondents should be included to investigate their beliefs about the importance of proper waste disposal from the perspective of Shariah to protect religion, life, intellect, lineage, and property.
- 2) In Study 2 we have identified the barriers of various factors across multiple level of socio-ecological model. In our study, personal-level factors such as lack of awareness and knowledge as well as lack of personal responsibility, motivation and negative attitude were identified as main causes of poor WM behaviour among Malaysian residents. Past studies indicated that individual moral obligation and responsibility drive sustainable behaviour and influence to separate the solid waste at source (Sewak et al., 2021; Arshad et al., 2017). Therefore, our persuasive application focused more to influence factors identified at personal level.

Besides, to manage the barrier at policy level and organization level we have implemented a rewards and authority feature to facilitate residents to practice more to reduce, reuse and recycle. However, the barriers that influenced poor waste management behaviour by community level, are beyond the scope of our proposed persuasive application. For future research may investigate more how to design a persuasive application that could be used to influence behavioural factors identified at community level (lack of community participation in waste separation and recycling activities), organizational level (insufficient and inaccessibility of information regarding 3Rs, lack of facilities, and the infrequency of waste collection) and policy level (lack of enforcement and lack of financial initiatives).

- 3) In Study 3 we attempted to identify effective persuasive principles based on end user perceptions that would encourage them to sustainable waste

management practices in a Malaysian urban setting. The study involves interviewing seven (7) participants residing in different regions in Klang Valley. In this study, the small sample size was the major limitation. However, the focus on the participants of this study in the Klang Valley might not represent the whole population. Further, in this study, the *similarity*, *rehearsal*, and *recognition* principles were adversely viewed by the Malaysian community with a low level of adoption of waste management practices. Therefore, it is removed from the initial framework of WM practice. Thus, it is highly recommended for future researchers to replicate our detailed processes of designing persuasive application, in order to identify persuasive design principles that are most effective at encouraging behavioural change among the larger populations in Malaysia.

- 4) In Study 7, only a total of eleven participants participated in the case study evaluation. It was obvious that although the feedback from the usability tests was very positive however, this small sample size is also a limitation. For future research, respondents from different types of population and other areas such as Kuching, Penang, Malacca, Ipoh, Johor Bahru, and Kuala Terengganu should also be taken to represent the whole nation. Perhaps, the inclusion of participants from other areas might produce more meaningful results. Therefore, the further user test should be implemented with a large number of users to study their persuasion and shaping the behavior towards using *Tahara* app to protect the religion, life, intellect, dignity, and property. These tests are of great importance to promote pro-environmental behaviors and attitudes, and to keep studying the impact of this kind of interaction on different users.

6.5 CONCLUSION

For both economic and environmental reasons, countries around the globe increase household waste recycling rates. In Malaysia, where waste is isolated at the source, the success of Malaysia's waste management system largely depends on household participation. Several studies showed that the level of awareness on appropriate waste disposal of eco-friendly practices is still very weak in Malaysian society.

To address this gap, this research introduced a contemporary and promising solution—persuasive technology (PT)—to influence and improve waste disposal behaviors. The Persuasive System Design (PSD) framework has served as a foundational model for designing and evaluating persuasive systems, offering 28 persuasive strategies for behavior change. Nevertheless, the PSD model has been criticized for its generic nature and its lack of consideration for cultural and religious contexts that significantly shape user behavior.

Islam plays a central role in guiding ethical and moral practices, including environmental responsibility. Islam advocates for cleanliness, preservation of the environment, and conscious consumption—all of which align closely with the principles of sustainable waste management. Despite this, existing persuasive applications have not effectively integrated these spiritual values into their design.

In response, this thesis presented the development of *Tahara*, a persuasive mobile application grounded in the PSD framework and enriched by the integration of *Maqasid al-Shari'ah*, the higher objectives of Islamic law. By embedding religious principles into persuasive design, *Tahara* was developed as a culturally and spiritually resonant tool to encourage environmentally responsible behavior among Malaysian users.

The evaluation of *Tahara* application showed significant results with large effect proving that the application was indeed successful to increase awareness on the importance of proper disposal of municipal solid waste based on *Maqasid al-Shari'ah*. Moreover, it effectively motivated users to adopt greener practices in their daily lives (which is its intended design objective).

In conclusion, this study has shown that integrating persuasive technology with religious and cultural values can enhance the effectiveness of behavior change interventions. The successful design and evaluation of *Tahara* underscore the importance of culturally contextualized approaches in persuasive application development. This research contributes to both the theoretical and practical domains of Human-Computer Interaction (HCI), sustainability, and Islamic ethics, and offers a

valuable framework for future applications seeking to bridge technological innovation with faith-based guidance.



REFERENCES

- Abas, M. (2018). 'Understanding the concept of sustainable development for effective solid waste management: Malaysia perspective', *Open Access Journal of Waste Management & Xenobiotics*, Vol. 1, No. 2, pp.1–7.
- Abbasi, M., & El Hanandeh, A. (2016). Forecasting municipal solid waste generation using artificial intelligence modelling approaches. *Waste management*, 56, 13-22.
- Abd Rahman, N., & Jalil, M. H. (2021). Awareness of the Role of “Religious People” in Environmental Conservation from the Perspective of Islamic Studies Students. *Creative Education*, 12(8), 1755-1772.
- Abd Rahman, N., Zabidi, F. N. M., & Halim, L. (2020). Integration of Tauhidic Elements for Environmental Education from the Teachers’ Perspectives. *Religions*, 11(8), 394.
- Abdullah, A. H., & Halabi, K. A. (2017). The wisdom: A concept of character building based on islamic view. *International Journal of Academic Research in Business and Social Science*, 7(5), 412-425.
- Abdullahi, A. M., Orji, R., & Nwokeji, J. C. (2018, October). Personalizing Persuasive Educational Technologies to Learners’ Cognitive Ability. In *2018 IEEE Frontiers in Education Conference (FIE)* (pp. 1-9). IEEE.
- Abedi-Sarvestani, A., & Shahvali, M. (2008). Environmental ethics: Toward an Islamic perspective. *American-Eurasian Journal of Agricultural and Environmental Sciences*, 3(4), 609-617.
- Abu, N.H, Ajam, N.M.A, and Mansor, M.F.(2022). Household Knowledge and Practices in Solid Waste Segregation and Recycling in Malaysia. *Central Asia and the Caucasus* 22(5).
- Abubakar, I. R., Maniruzzaman, K. M., Dano, U. L., AlShihri, F. S., AlShammari, M. S., Ahmed, S. M. S., ... & Alrawaf, T. I. (2022). Environmental sustainability impacts of solid waste management practices in the global South. *International journal of environmental research and public health*, 19(19), 12717.
- Achmad, F. S. (2022). Waste management an Islamic perspective. *Journal of Advanced Research in Social Sciences and Humanities*, 7(4), 164-174.
- Adaji, I., & Adisa, M. (2022, July). A review of the use of persuasive technologies to influence sustainable behaviour. In *Adjunct proceedings of the 30th ACM conference on user modeling, adaptation and personalization* (pp. 317-325).
- Adler, M., & Ziglio, E. (1996). *Gazing into the oracle: The Delphi method and its application to social policy and public health*. Jessica Kingsley Publishers.

- Afroz, R., & Masud, M. M. (2011). Using a contingent valuation approach for improved solid waste management facility: Evidence from Kuala Lumpur, Malaysia. *Waste management*, 31(4), 800-808.
- Agamuthu, P. (2017). State of the 3Rs in Asia and the Pacific.
- Agamuthu, P., Fauziah, S. H., & Kahlil, K. (2009a). Evolution of solid waste management in Malaysia impacts and implications of the solid waste bill, 2007. *Journal of material cycles and waste management*, 11, 96-103.
- Agnisarman, S., Madathil, K. C., & Stanley, L. (2018). A survey of empirical studies on persuasive technologies to promote sustainable living. *Sustainable Computing: Informatics and Systems*, 19, 112-122.
- Ajzen, I. (1991). The theory of planned behavior. *Organizational behavior and human decision processes*, 50(2), 179-211.
- Akil, A.M. and Ho, C.S. (2014) 'Towards sustainable solid waste management: Investigating household participation in solid waste management', *IOP Conference Series: Earth and Environmental Science*, February, Vol. 18, No. 1, p.012163, IOP Publishing.
- Al Mamun, A., Mohiuddin, M., Ahmad, G.B., Thursamy, R. and Fazal, S.A. (2018) 'Recycling intention and behavior among low-income households', *Sustainability*, Vol. 10, No. 7, p.2407.
- Alam, M., & Siwar, C. (2015). Waste recycling in Malaysia: Transition from developing to developed country. *Jereme, IA, Alam, MM, and Siwar, C*, 1-14.
- Al-'Amilī, M.M.W. (2007). *Maqa sidush Shar'i Baynal Ifrati WatTafrīt*, Darul Hadī, Beirūt.
- Al-Ashqar, Umar Sulaiman. (1982). *Khasais al-Shariah al-Islamiyyah*. Kuwait: Maktabah Al-Falah.
- Albaina, I. M., Visser, T., van der Mast, C. a. P. G., & Vastenburg, M. H. 2009.
- Al-Bū tī, M.S.R. (1973). *Dawabitul Maslahati Fīsh Sharī'atil Islamiyyah*, Múassasatur Risalah, Beirūt
- Aldenaini, N., Oyeboode, O., Orji, R., & Sampalli, S. (2020). Mobile phone-based persuasive technology for physical activity and sedentary behavior: a systematic review. *Frontiers in Computer Science*, 2, 19.
- Al-Fasī (1993). *Maqasidush Sharī'atil Islamiyyati wa Makarimuha*, Darul Gharbil Islāmī, Beirūt.
- Al-Fawzan, S.I.M. (2014). "Taf'ieel al-Maqasid al-Shar'iyyah fi al-Maliyyat al-Islamiyyah: Al-Ta'sil wa al-Tatbiq", *5th International Conference on Islamic*

Jurisprudence in 21th Cenctury, International Islamic University Malaysia, pp. 40-82.

Al-Ghazalī, A. HM.I.M. (1413 AH). *Al-Mustasfa fī 'Ilmil Usūl*, Darul Kutubil 'Ilmiyyah, Beirūt

Almasi, A., Mohammadi, M., Azizi, A., Berizi, Z., Shamsi, K., Shahbazi, A., & Mosavi, S. A. (2019). Assessing the knowledge, attitude and practice of the kermanshahi women towards reducing, recycling and reusing of municipal solid waste. *Resources, Conservation and Recycling*, 141, 329-338.

Al-Mayman, N.I. (2005). "Al-Qawa'idu wad dawabitul fiqhiyyatu 'inda shaykhil islami ibni taymiyyata fī kitabayt *Taharati was salah*", PhD, Jami'atu Ummil Qura.

Al-Qaradawī, Y. (2008a). *Dirasatun fī Fiqhi Maqasidish Sharī'ati Baynal Maqasidil Kulliyati Wan Nusūsil Juz'īyyah*, Darush Shurūq, al-Qahirah.

Al-Qaradawi, Y. (2022). Conservation of the Environment in Islamic Law. Maybank Islamic Berhad.

Al-Raysuni, A. (2005). *Imam al-Shatibi's Theory of the Higher Objectives and Intents of Islamic Law*. London: International Institute of Islamic Thought.

Al-Raysūnī, A. (2012). "*I'tibarul maqasidi fil fatawal maliyyah*", Islamiyyatul Ma'rifah, Vol. 18 No. 70, pp. 13-42

Al-Raysūnī, A. (2013). *Muha daratun fī Maqasidish Sharī'ah*, Dar al-Kalimati lin Nashri wat Tawzī', al-Qahirah.

Anagnostopoulou, E., Bothos, E., Magoutas, B., Schrammel, J., & Mentzas, G. (2018). Persuasive technologies for sustainable mobility: State of the art and emerging trends. *Sustainability*, 10(7), 2128.

Arshad, N.A.M. and Zainudin, A.Z. and Adawiyah, S.R. and Ridzuan, M. and Norhidayah, (2017). A Review of Barriers That Hinder Households to Separate Solid Waste at Source. In: *Social Sciences Postgraduate International Seminar (SSPIS) 2017*. School of Social Sciences, USM, Pulau Pinang, Malaysia, pp. 646-651. ISBN 9789671544013

Atkinson, B. M. . 2006. Captology: A Critical Review. In. IJsselsteijn, Kort, Midden, Eggen & Hoven (Eds.). *Persuasive Technology*, LNCS 3962., 171–182. Springer Berlin Heidelberg. doi:10.1007/11755494_25

Auda, J. (2007). *Maqasid al-Shari'ah as Philosophy of Islamic Law: A Systems Approach*. International Institute of Islamic Thought, London. Washington, DC

Auda, J. (2011). "A maqasidī approach to contemporary application of the sharī 'ah", *Intellectual Discourse*, Vol. 19 No. 2.

- Azizah, A. N., Djalaluddin, A., & Siswanto, S. (2021). Waste Management Based on Maqashid Shari'ah And Circular Economy: Evidence in Blitar Regency. *Maliki Islamic Economics Journal*, 1(2), 86-100.
- Bakar, O. (2007). Environmental wisdom for planet earth: The Islamic heritage.
- Balazadeh, A. (2023). Design and Religion: examining Religious Values Role in Culture- Centered Design. *Conference: 1st international conference of Islamic humanities revolution*.
- Bandyopadhyay, J., & Dalvi, G. (2017). Can interactive installations bring about behaviour change? Using interactive installation to change food waste behaviours. In *Research into Design for Communities, Volume 2: Proceedings of ICoRD 2017* (pp. 235-245). Springer Singapore.
- Basel Convention (2018). Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (Basel Convention). In *Yearbook of International Cooperation on Environment and Development 1998–99* (pp. 87-89). Routledge.
- Battista, G., & de Lieto Vollaro, R. (2017). Correlation between air pollution and weather data in urban areas: Assessment of the city of Rome (Italy) as spatially and temporally independent regarding pollutants. *Atmospheric Environment*, 165, 240-247.
- Bawazir, M. A. (2019). Persuasive technology in the Islamic perspective: the principles and strategies. *International Journal on Perceptive and Cognitive Computing*, 5(2), 107-115.
- Bekhet, A. K. & Zauszniewski, J. 2012. Methodological triangulation : an approach to understanding data. *Nurse Researcher*, 20(2), 40–43.
- Benbasat, I., Goldstein, D. K., & Mead, M. 1987. The Case Research Strategy in Studies of Information Systems. *MIS Quarterly*, 11(3), 369–386. doi:10.2307/248684
- Berengueres, J., Alsuwairi, F., Zaki, N., & Ng, T. (2013, March). Gamification of a recycle bin with emoticons. In *2013 8th ACM/IEEE International Conference on Human-Robot Interaction (HRI)* (pp. 83-84). IEEE.
- Bin Don, A. G., Puteh, A., & Mokhtar, A. I. (2022). Da'wah Maqasid Al-Syariah in Nurturing Community Well-Being. *Jurnal Pengajian Islam*, 15(1), 249-258.
- Bockle, M., Novak, J., & Bick, M. (2020). Exploring gamified persuasive system design for energy saving. *Journal of Enterprise Information Management*.
- Bodjanova, S. (2006). Median alpha-levels of a fuzzy number. *Fuzzy sets and Systems*, 157(7), 879-891.

- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77-101. <https://doi.org/10.1191/1478088706qp063oa>
- Brehm, B. 2014. *Psychology of Health and Fitness*. 1st Edition. USA: F. A. Davis Company.
- Bremer, C. (2018). Not (B) interested? Using Persuasive Technology to Promote Sustainable Household Recycling Behaviour: An Identification and Implementation of Key Elements with Focus on Young Adults in Sweden.
- Bremer, C. (2020). Not (b) interested? Using persuasive technology to promote sustainable household recycling behavior.
- Brindal, E., Hendrie, G., Freyne, J., Coombe, M., Berkovsky, S., & Noakes, M. (2013). Design and pilot results of a mobile phone weight-loss application for women starting a meal replacement programme. *Journal of telemedicine and telecare*, 19(3), 166-174.
- Bronfenbrenner, U. (1979). *The ecology of human development: Experiments by nature and design*. Harvard university press.
- Cacioppo, J. T., Petty, R. E., Kao, C. F., & Rodriguez, R. (1986). Central and peripheral routes to persuasion: An individual difference perspective. *Journal of personality and social psychology*, 51(5), 1032.
- Center for Sustainable Systems, University of Michigan (2023). "Municipal Solid Waste Factsheet." Pub. No. CSS04-15.
- Cheng, C. H., & Lin, Y. (2002). Evaluating the best main battle tank using fuzzy decision theory with linguistic criteria evaluation. *European journal of operational research*, 142(1), 174-186.
- Cheng, K. M., Tan, J. Y., Wong, S. Y., Koo, A. C., & Amir Sharji, E. (2022). A review of future household waste management for sustainable environment in Malaysian cities. *Sustainability*, 14(11), 6517.
- Chin, P. M., Naim, A. N., Suja, F., & Ahmad Usul, M. F. (2020). Impact of Effluent from the Leachate Treatment Plant of Taman Beringin Solid Waste Transfer Station on the Quality of Jinjang River. *Processes*, 8(12), 1553.
- Choon, S. W., Tan, S. H., & Chong, L. L. (2017). The perception of households about solid waste management issues in Malaysia. *Environment, development and sustainability*, 19(5), 1685-1700.
- Chu, H. C., & Hwang, G. J. (2008). A Delphi-based approach to developing expert systems with the cooperation of multiple experts. *Expert systems with applications*, 34(4), 2826-2840.

- Chu, M. M. (2019, July 30). Generating more waste than ever. The Star. Retrieved November 11, 2021, from <https://www.thestar.com.my/news/nation/2019/07/30/generating-more-waste-than-ever#:~:text=He%20said%20in%202018%2C%20Malaysians,waste%20a%20day%20in%202005.>
- Chuvieco, E., Burgui, M., & Gallego-Álvarez, I. (2016). Impacts of religious beliefs on environmental indicators: Is christianity more aggressive than other religions?. *Worldviews: Global Religions, Culture, and Ecology*, 20(3), 251-271.
- Comber, R., & Thieme, A. (2013). Designing beyond habit: opening space for improved recycling and food waste behaviors through processes of persuasion, social influence and aversive affect. *Personal and ubiquitous computing*, 17(6), 1197-1210.
- Comber, R., Thieme, A., Rafiev, A., Taylor, N., Krämer, N., & Olivier, P. (2013). BinCam: Designing for engagement with Facebook for behavior change. In *Human-Computer Interaction-INTERACT 2013: 14th IFIP TC 13 International Conference, Cape Town, South Africa, Sept Nkwo ember 2-6, 2013, Proceedings, Part II 14* (pp. 99-115). Springer Berlin Heidelberg.
- Creswell J.W. (2008). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research*. Upper Saddle River, NJ: Pearson/Merrill Education.
- Creswell, J. W. & Plano Clark, V. L. (2011) *Designing and Conducting Mixed*
- Darus, F., Yusoff, H., Naim, A., Milianna, D., Mohamed Zain, M., Amran, A., Fauzi, H. and Purwanto, Y. (2013). "Islamic corporate social responsibility (i-CSR) framework from the perspective of maqasid al-Syariah and maslahah", *Issues in Social and Environmental Accounting*, Vol. 7 No. 2.
- Daud, N. A., Sahari, N., & Muda, Z. (2013). An initial model of persuasive design in web based learning environment. *Procedia Technology*, 11, 895-902.
- Davis, F. D. (1989) Perceived Usefulness, Perceived Ease Of Use , And User Accep. *MIS Quarterly*, 13(3), 319–340.
- Dennison, L., Morrison, L., Conway, G., & Yardley, L. (2013). Opportunities and challenges for smartphone applications in supporting health behavior change: qualitative study. *Journal of medical Internet research*, 15(4), e2583.
- Department of Statistics Malaysia (2010a). *Population and Housing Census of Malaysia 2010*. Kuala Lumpur: Malaysia Government.
- Desa, A., Ba' Yah Abd Kadir, N., & Yusoooff, F. (2011). 'A study on the knowledge, attitudes, awareness status and behaviour concerning solid waste management'. *Procedia-Social and Behavioral Sciences*, Vol 18 (2011), pp.643-648.

- Deuraseh, N. (2012). New Essential Values of Daruriyyah (Necessities) of The Objectives of Islamic Law (*Maqasid al-Shariah*)(Keperluan Nilai Baharu Dalam Maqasid Shariah (Objektif Undang-Undang Islam)). *Journal Hadhari: An International Journal*, 4(2), 107-116.
- Devadoss, P. M., Agamuthu, P., Mehran, S. B., Santha, C., & Fauziah, S. H. (2021). Implications of municipal solid waste management on greenhouse gas emissions in Malaysia and the way forward. *Waste Management*, 119, 135-144. *Economics (IJSDE)*, 2(1), 165–168.
- Directory, S. (2025, February 25). *Behavior change wheel* → term. Sustainability Directory. https://sustainability-directory.com/term/behavior-change-wheel/?utm_source=chatgpt.com
- Dix, A., Finlay, J., Abowd, G. and Beale, R. 1998. Human-Computer Interaction Prentice Hall, Upper Saddle River, NJ.
- Dusim, H. H., Korom, A., & Bagang, T. P. (2023). Sustainable Solid Waste Management Practices in Imbak Canyon Conservation Area (ICCA): An Assessment of Current Practices and Opportunities for Improvement. *Journal of Administrative Science*, 20(1), 297-310.
- Dusuki, A.W. and Abozaid, A. (2007). “A critical appraisal on the challenges of realizing maqasid AlShariah in Islamic banking and finance”, *IIUM Journal of Economics and Management*, Vol. 15 No. 2, pp. 143-165.
- Dusuki, A.W. and Bouheraoua, S. (2011). “The framework of maqasid al-Sharī‘ah and its implication for Islamic finance”, *Islam and Civilisational Renewal*, Vol. 2 No. 2, pp. 316-336.
- El-Mesawi, M. E. T. (2006). *Maqasid al-Shari‘ah* as an usuli doctrine or independent discipline: a study of Ibn ‘Ashur’s project. In *Proceeding of the International Conference on Islamic Jurisprudence and the Challenges of the 21st Century: Maqasid al-Shari‘ah and Its Realization in Contemporary Societies* (Vol. 3, pp. 51-66).
- Environment’, International Journal of Sustainable Development and Green Environmental protection agency - epa.ie. Environmental Protection Agency Epa Annual Report 2016. (n.d.). Retrieved October 9, 2021, from https://www.epa.ie/publications/corporate/governance/EPA_AnnualReport_2016_English_Final_Web.pdf.
- Farraji, H., Zaman, N. Q., & Mohajeri, P. (2020). Waste disposal: Sustainable waste treatments and facility siting concerns. In *Sustainable Infrastructure: Breakthroughs in Research and Practice* (pp. 659-690). IGI Global.
- Ferronato, N., & Torretta, V. (2019). Waste mismanagement in developing countries: A review of global issues. *International journal of environmental research and public health*, 16(6), 1060.

- Ferronato, N., Torretta, V., Ragazzi, M. and Rada, E.C. (2017). 'Waste mismanagement in developing countries: a case study of environmental contamination', *UPB Sci. Bull.*, Vol. 79, No. 2, pp.185–196.
- Festinger, L. (1957). *A theory of cognitive dissonance*: Stanford university press.[Google Scholar].
- Fogg, B. J. (2003). *Persuasive Technology: Using computers to change what we think and do*. San Fransisco: Morgan Kaufmann Publishers.
- Fogg, B. J. (2009). A behavior model for persuasive design. *Proceedings of the 4th International Conference on Persuasive Technology*, 1-7.
- Gada, M. Y. (2014). Environmental ethics in Islam: Principles and perspectives. *World Journal of Islamic History and Civilization*, 4(4), 130-138.
- Ghorai, K., Akter, S., Khatun, F., & Ray, P. (2014). mHealth for smoking cessation programs: a systematic review. *Journal of personalized medicine*, 4(3), 412-423.
- Goyal, A. (2021, May 14). Top reasons why mobile apps fail to make a mark in the market. *Business of Apps*. Retrieved September 10, 2021, from <https://www.businessofapps.com/insights/top-reasons-why-mobile-apps-fail-to-make-a-mark-in-the-market/>.
- Guangyu, Y. (2009). Disposal of Solid Wastes. Point Sources of Pollution: Local Effects and their Control-Volume II, 296.
- Hair, J., Black, W., Babin, B., Anderson, R. and Tatham, R. (2006) *Multivariate Data Analysis*. 6th Edition, Pearson Prentice Hall, Upper Saddle River.
- Hakami, B. A. (2016). Waste disposal and landfill: Information needs. *International Journal of Civil Engineering and Technology*.
- Halonen, E. (2024, December 5). The limits of COM-B and the Behaviour Change Wheel. *Square Peg Insight*. <https://www.squarepeginsight.com/post/addressing-common-objections-limits-of-com-b-and-behaviour-change-wheel>
- Hamid, H. A., Hussein, A., & Chu, S. L. (2011). Malaysian newspapers coverage of waste issues: problems in need of solutions? *The Sustainable World*, 142, 431.
- Hao, Y., & Xu, X. (2021). Research on Persuasive Design of Waste Sorting APP. *In E3S Web of Conferences (Vol. 236)*. EDP Sciences.
- Hartanto, S. (2019). Spirituality of Maslahah based waste management. *Al-Iktisab: Journal of Islamic Economic Law*, 3(1).
- Hasan, N.N.B.A., Noor, K. B M., Malik, A.A. and Ghani, Z.A. (2016). "The preliminary proposed model of the integraton of the principle of maqasid Al-

- Syari'ah in managerial decision-making process", *Journal of Global Business and Social Entrepreneurship (GBSE)*, Vol. 1 No. 5, pp. 1-8.
- Hassan, S. (2022). Recycling Knowledge Among Malaysians Towards Maintaning Clean Environment. *Management*, 7(29), 336-343.
- Hoehle, H., Zhang, X., & Venkatesh, V. (2015). An espoused cultural perspective to understand continued intention to use mobile applications: a four-country study of mobile social media application usability. *European journal of information systems*, 24(3), 337-359.
- Hoornweg, D., Bhada-Tata, P., and Kennedy, C. (2015). Peak waste: When is it likely to occur? *Journal of Industrial Ecology*. 19(1): 117-128.
- Hoppe, H. H. (1994). FA Hayek on government and social evolution: a critique. *The Review of Austrian Economics*, 7(1), 67-93.
- Hruschka, D. J., Schwartz, D., St. John, D. C., Picone-Decaro, E., Jenkins, R. A., & Carey, J. W. (2004). Reliability in coding open-ended data: Lessons learned from HIV behavioral research. *Field methods*, 16(3), 307-331.
- Hsu, Y. L., Lee, C. H., & Kreng, V. B. (2010). The application of Fuzzy Delphi Method and Fuzzy AHP in lubricant regenerative technology selection. *Expert systems with applications*, 37(1), 419-425.
- Huber, M. Z., & Hilty, L. M. (2015). Gamification and sustainable consumption: overcoming the limitations of persuasive technologies. In *ICT innovations for sustainability* (pp. 367-385). Springer, Cham.
- Ibn al-Athīr. (2002). *An Nihayatu fī Gharīb al-Hadīthi Wal Athar*, Darul Kutubil 'Ilmiyyah, Beirūt.
- Ibn 'Āshūr, M.A. T. (2001). *Maqasidush Sharī'atil Islamiyyah*, Darun Nafa'is, Jordan
- Ibn-Bayyah (2008). *Maqasid al-Sharī'ah fī al-Mu'amalat*, Al-Maqasid Research Centre in the Philosophy of Islamic Law, Al-Furqan Islamic Heritage Foundation, London.
- Ibrahim, A-M. (2010). *Green Deen: What Islam Teaches About Protecting the Planet*, Berrett-Koehler Publishers, Inc., San Francisco.
- IBRAHIM, J. (2023). Awareness crisis in climate change, March. The Star. Retrieved February 2, 2024, from <https://www.thestar.com.my/news/nation/2023/03/05/awareness-crisis-in-climate-change>
- Ilham, J., & Esa, N. (2017). Composting As a Sustainable Method To Minimize Waste At Source In Malaysia. *International Conference on Environmental Research and Technology (ICERT 2017)*

- Ishikawa, A., Amagasa, M., Shiga, T., Tomizawa, G., Tatsuta, R., & Mieno, H. (1993). The max-min Delphi method and fuzzy Delphi method via fuzzy integration. *Fuzzy sets and systems*, 55(3), 241-253.
- Ismail, M. H., Ghazi, T. I. M., Hamzah, M. H., Abd Manaf, L., Tahir, R. M., Nasir, A. M., & Omar, A. E. (2020). Impact of movement control order (Mco) due to coronavirus disease (covid-19) on food waste generation: A case study in Klang valley, Malaysia. *Sustainability*, 12(21), 8848.
- Ismail, Y., & Sarif, S. M. (2021, December). BUSINESS HIKMAH (WISDOM) IN MANAGING SOCIAL ENTERPRISES. In *International Conference on Change the World with Sejahtera Sustainability* (Vol. 29, p. 30).
- Jaccard, J. and Jacoby, J. (2019). Theory Construction and Model-Building Skills: A Practical Guide for Social Scientists, *Guilford Publications*.
- Jalloh, M. Y., Dahalan, W. S. A. W., & Khalid, R. M. (2022). The Islamic principles and guidelines to Household Solid Waste Management. *Al-Risalah: Journal of Islamic Revealed Knowledge and Human Sciences (ARJIHS)*, 6(2), 402-427.
- Johari, A., Alkali, H., Hashim, H., Ahmed, S. I., and Mat, R. (2014). Municipal solid waste management and potential revenue from recycling in Malaysia. *Modern Applied Science*. 8(4): 37-49.
- Jones, T.L., Baxter, M.A.J. and Khanduja, V. (2013) 'A quick guide to survey research', *The Annals of The Royal College of Surgeons of England*, Vol. 95, No. 1, pp.5-7.
- Kamali, M.H. (2017). "Actualisation (taf'īl) of the higher purposes (maqasid) of shariah", *Islam and Civilisational Renewal (Renewal)*, Vol. 8 No. 3, pp. 295-321.
- Kaptein, M., De Ruyter, B., Markopoulos, P., & Aarts, E. (2015). Personalizing persuasive technologies: Explicit and implicit personalization using persuasion profiles. *International Journal of Human-Computer Studies*, 77, 38-51.
- Kaptein, M., Duplinsky, S., & Markopoulos, P. 2011. Means Based Adaptive Persuasive Systems. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '11)*, pg.1-10. Vancouver, BC, Canada: ACM.
- Kaza, S., Yao, L., Bhada-Tata, P., & Van Woerden, F. (2018). What a waste 2.0: a global snapshot of solid waste management to 2050. The World Bank.
- Kelders, S. M., Kok, R. N., Ossebaard, H. C., & Van Gemert-Pijnen, J. E. W. C. 2012. Persuasive system design does matter: a systematic review of adherence to webbased interventions. *Journal of Medical Internet Research*, 14(6), e152. doi:10.2196/jmir.2104
- Kelman, H. C. (1961). Processes of opinion change. *Public opinion quarterly*, 25(1), 57-78.

- Khan, R. F., & Sutcliffe, A. (2014). Attractive agents are more persuasive. *International Journal of Human-Computer Interaction*, 30(2), 142-150.
- Kolodziej-Smith, R., Friesen, D. P., & Yaprak, A. (2013). Does culture affect how people receive and resist persuasive messages? Research proposals about resistance to persuasion in cultural groups. *Global Advances in Business Communication*, 2(1), 5.
- KPKT (Kementerian Kesejahteraan Bandar, Perumahan Dan Kerajaan Tempatan) and JPSPN (Jabatan Pengurusan Sisa Pepejal Negara) (2013). Survey on SW Composition, Characteristics & Existing Practice of SW Recycling in Malaysia - Final Report. Putrajaya. Available from: https://jpspn.kpkt.gov.my/resources/index/user_1/Sumber_Rujukan/kajian/Final_Report_REVz.pdf (accessed 21 Nov 2020).
- Laldin, M. A., & Furqani, H. (2013). Developing Islamic finance in the framework of Maqasid al-Shari'ah: Understanding the ends (maqasid) and the means (wasa'il). *International Journal of Islamic and Middle Eastern Finance and Management*, 6(4), 278-289.
- LeBlanc, V. R., & Posner, G. D. (2022). Emotions in simulation-based education: friends or foes of learning? *Advances in Simulation*, 7(1), 1-8.
- Lehto, T., & Oinas-Kukkonen, H. (2011). Persuasive features in web-based alcohol and smoking interventions: a systematic review of the literature. *Journal of medical Internet research*, 13(3), e1559.
- Lenkiewicz, Z. (2021, April 28). Waste collection: The Public Health Imperative. WasteAid. Retrieved November 10, 2021, from <https://wasteaid.org/waste-collection-the-public-health-imperative/>.
- Lerbinger, O. 1972. *Designs for Persuasive Communication*. USA: Prentice Hall.
- Liu, J., Li, Q., Gu, W., & Wang, C. (2019). The Impact of consumption patterns on the generation of municipal solid waste in China: evidence from provincial data. *International journal of environmental research and public health*, 16(10), 1717.
- Lu, X., Chen, Y., & A. Epstein, D. (2021, June). How cultural norms influence persuasive design: A study on Chinese food journaling apps. In *Proceedings of the 2021 ACM Designing Interactive Systems Conference* (pp. 619-637).
- Lund, A. M. (2001). Measuring usability with the use questionnaire12. *Usability interface*, 8(2), 3-6.
- Maham, R., & Bhatti, O. K. (2019). Impact of Taqwa (Islamic piety) on employee happiness: A study of Pakistan's banking sector. *Cogent Business & Management*, 6(1), 1678554.

- Malakahmad, A., Abualqumboz, M. S., Kutty, S. R. M., & Abunama, T. J. (2017). Assessment of carbon footprint emissions and environmental concerns of solid waste treatment and disposal techniques; case study of Malaysia. *Waste Management*, 70, 282-292.
- Mamat, M. N., & Mahamood, S. F. (2017). Islamic philosophy on behaviour-based environmental attitude. *Asian Journal of Environment-Behaviour Studies*, 2(2), 81-91.
- Manakandan, S. K., Rosnah, I., Mohd, R. J., & Priya, R. (2017). Pesticide applicators questionnaire content validation: A fuzzy delphi method. *Med J Malaysia*, 72(4), 228-235.
- Mangunjaya, F. (2015). Kerusakan Lingkungan: Epistemologi Sains Islam dan Tanggung Jawab Manusia. *Jurnal Theologia*, 26(1).
- Maree, J.G. (Ed.) (2012). *Complete Your Thesis or Dissertation Successfully: Practical Guidelines*, Juta, Cape Town.
- Marshal, M. N. "Sampling for Qualitative Research: Family Practice." no. 6 (1996): 522-525. <https://doi.org/10.1093/fampra/13.6.522>
- Matthews, J., Win, K. T., Oinas-Kukkonen, H., & Freeman, M. (2016). Persuasive technology in mobile applications promoting physical activity: a systematic review. *Journal of medical systems*, 40(3), 1-13.
- Mattson, G. (2020). Applying the Behaviour Change Wheel to design and evaluate a food waste reducing prototype for workplace kitchens.
- McGuire, W. J. 1973. Persuasion. In. G. A. Miller (Ed.). *Communication, Language, and Meaning Psychological Perspectives*, pg.242–255. New York, NY, USA: Basic Books.
- McKay, J.E., Mangunjaya, F.M., Dinata, Y., Harrop, S.R. and Khalid, F. (2014). 'Practice what you preach: a faith-based approach to conservation in Indonesia', *Oryx*, Vol. 48, No. 1, pp.23–29.
- Mendiola, J. (2018). Pro-environmental behaviors, belief in individual responsibility to protect the environment, and social class: a qualitative exploration (Doctoral dissertation, Washington State University).
- MHLG. Ministry of Housing and Local Government Malaysia, 2015; Final Lab Report: Solid Waste Management Lab; MHLG: Malaysia, 2015. Available online: http://www.kpkt.gov.my/resources/index/user_1/Attachments/hebahan_slider/s_laid_dapatan_makmal.pdf (accessed on 25 Feb 2021)
- Miller, G. R. (2013). On being persuaded: Some basic distinctions.

- Miller, L. G. R. 2002. Chapter 1 : On Being Persuaded : Some Basic Distinctions. In. Dillard & Pfau (Eds.). *The Persuasion Handbook: Developments in Theory and Practice*, SAGE Publications.
doi:<http://dx.doi.org/10.4135/9781412976046.n1>
- Mmereki, D., Baldwin, A., & Li, B. (2016). A comparative analysis of solid waste management in developed, developing and lesser developed countries. *Environmental technology reviews*, 5(1), 120-141.
- Moh, Y., and Abdul Manaf, L. (2017). Solid waste management transformation and future challenges of source separation and recycling practice in Malaysia. *Resources, Conservation and Recycling*. 116: 1-14.
- Mohadis, H. M., Mohamad Ali, N., & Smeaton, A. F. (2016). Designing a persuasive physical activity application for older workers: understanding end-user perceptions. *Behaviour & information technology*, 35(12), 1102-1114.
- Mohamad, A. D., Osman, K. H. A. Z. R. I., & Mokhtar, A. I. (2020). Spirituality in maqasid for the empowerment of human well-being. *International Journal of Business and Social Science*, 11(10).
- Mohammed, M.M., Tok, M.E. and Ali, S.N. (2020). “The potential of Islamic finance in reinforcing and regaining economic stability in Qatar”, *Journal of Economic Cooperation and Development*, Vol. 41 No. 4, pp. 191-217
- Mohd Jamil, M. R., & Mat Noh, N. (2020). *Kepelbagaian Metodologi dalam Penyelidikan Reka Bentuk dan Pembangunan. Bangi: Qaisar Prestige Resources.*
- Mohd Mahudin, N. D., Mohd Noor, N., Dzulkifli, M. A., & Janon, N. S. (2016). Religiosity among Muslims: A scale development and validation study. *Makara Hubs-Asia*, 20(2), 109-121.
- Mohd Noor, N. H., Mustafa, M. A. S., Saharom, M., & Shamsol Kamal, N. S. S. (2022). Understanding Malaysian household waste separation: An extended theory of planned behavior. *Malaysian Journal of Sustainable Environment (MySE)*, 9(1), 19-35.
- Mouhoun-Chouaki, S., Derridj, A., Tazdaït, D., & Salah-Tazdaït, R. (2019). A study of the impact of municipal solid waste on some soil physicochemical properties: the case of the landfill of Ain-El-Hammam Municipality, Algeria. *Applied and Environmental Soil Science*, 2019.
- Muhammad Abdullahi, A., Orji, R., & Oyibo, K. (2018, July). Personalizing persuasive technologies: Do gender and age affect susceptibility to persuasive strategies?. In *Adjunct publication of the 26th conference on user modeling, adaptation and personalization* (pp. 329-334).
- Muslimin, J. M., Chakim, L., & Fauzani. (2018). *Maqasid al-Shari'ah* in Environmental Conservation of Yusuf al-Qardawi's Perspective. *Proceedings of*

the 1st International Conference on Recent Innovations. Published.
<https://doi.org/10.5220/0009919008690877>

- Namara, M., Wilkinson, D., Lowens, B. M., Knijnenburg, B. P., Orji, R., & Sekou, R. L. (2018, December). Cross-cultural perspectives on eHealth privacy in Africa. In *Proceedings of the Second African Conference for Human Computer Interaction: Thriving Communities* (pp. 1-11).
- Nasir, N. M., Nair, M. S., & Ahmed, P. K. (2022). Environmental Sustainability and Contemporary Islamic Society: A Shariah Perspective. *Asian Academy of Management Journal*, 27(2), 211-231.
- Nasir, Z. M., & Yaacob, M. (2022). Social and Religious Influences on Environmentally Ethical Behavior of Muslim Community in Malaysia. *Creative Education*, 13(12), 3996-4016.
- National Recycling Coalition, Inc. (1999) Purchasing Strategies – To Prevent Waste and Save Money [online] <https://p2infohouse.org/ref/18/17300.pdf> (accessed 28 September 2021).
- Nazarovam, M. & Keski-Mattinen, T. (2021). *The use of Behavior Change Wheel framework in the design of the mobile recycling application | LAB Open*. LAB Open. <https://www.labopen.fi/en/lab-pro/the-use-of-behavior-change-wheel-framework-in-the-design-of-the-mobile-recycling-application/>
- Nkwo, B. S. T. O. M., & Orji, R. (2020). Bota: A Personalized Persuasive Mobile App for Sustainable Waste Management.
- Nkwo, M. (2019, May). Mobile persuasive technology: Promoting positive waste management behaviors in developing African nations. In *Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems* (pp. 1-5).
- Nkwo, M., & Orji, R. (2018, December). Persuasive technology in African context: deconstructing persuasive techniques in an African online marketplace. In *Proceedings of the Second African Conference for Human Computer Interaction: Thriving Communities* (pp. 1-10).
- Nkwo, M., Orji, R., & Ugah, J. (2018, December). Persuasion for promoting clean and sustainable environment. In *Proceedings of the Second African Conference for Human Computer Interaction: Thriving Communities* (pp. 1-5).
- Nkwo, M., Suruliraj, B., & Orji, R. (2021). Persuasive Apps for Sustainable Waste Management: A Comparative Systematic Evaluation of Behavior Change Strategies and State-of-the-Art. *Frontiers in artificial intelligence*, 4.
- Nkwo, M., Suruliraj, B., Orji, R., & Ugah, J. (2020). Socially oriented Persuasive Strategies and Sustainable Behavior Change: Implications for Designing for Environmental Sustainability. In *Persuasive (Adjunct)*.

- Noor Azlina. 2018. Anggaran Penjanaan Sisa Pepejal Di Malaysia Mengikut Tahunan. JPSPN. http://www.data.gov.my/data/ms_MY/dataset/anggaran-penjanaan-sisa-pepejal-di-malaysia-pada-tahun-2012-2017.
- Noorbehbahani, F., & Zarein, Z. (2018, October). The impact of demographic factors on persuasion strategies in personalized recommender system. In *2018 8th International Conference on Computer and Knowledge Engineering (ICCCKE)* (pp. 104-109). IEEE.
- Nor Faiza, M. T., Noor Artika, H., & Yusof, M. Z. (2019). Health Care Waste Management and Sustainable Development Goals in Malaysia. *Journal of Wastes and Biomass Management*, 1(1), 18-20.
- Nunn, P. D., Mulgrew, K., Scott-Parker, B., Hine, D. W., Marks, A. D., Mahar, D., & Maebuta, J. (2016). Spirituality and attitudes towards Nature in the Pacific Islands: insights for enabling climate-change adaptation. *Climatic Change*, 136(3), 477-493.
- Nurhaida, D., Kusuma Wijaya, A., & Fazriah, S. (2022, January). The Impact of Muslim Religiosity on Environmentally Friendly Behavior: The mediating role of Eco-Literacy and Environmental Concern. In *Proceedings of the First Lekantara Annual Conference on Public Administration, Literature, Social Sciences, Humanities, and Education, LePALISSHE 2021, August 3, 2021, Malang, Indonesia*.
- Ocampo, L., Ebisa, J. A., Ombe, J., & Escoto, M. G. (2018). Sustainable ecotourism indicators with fuzzy Delphi method—A Philippine perspective. *Ecological indicators*, 93, 874-888.
- Oduor, M., Alahäivälä, T., & Oinas-Kukkonen, H. (2014). Persuasive software design patterns for social influence. *Personal and ubiquitous computing*, 18(7), 1689-1704.
- Oinas-kukkonen, H. 2010a. Behavior Change Support Systems : The Next Frontier for Web Science. *Web Science Conference 2010*, pg.1–8. Raleigh, North Carolina, USA.
- Oinas-kukkonen, H. 2013. A foundation for the study of behavior change support systems. *Personal and Ubiquitous Computing*, (17), 1223–1235. doi:10.1007/s00779-012-0591-5
- Oinas-Kukkonen, H., & Harjumaa, M. (2008, June). A systematic framework for designing and evaluating persuasive systems. In *International conference on persuasive technology* (pp. 164-176). Springer, Berlin, Heidelberg.
- Oinas-Kukkonen, H., & Harjumaa, M. (2009). Persuasive systems design: Key issues, process model, and system features. *Communications of the Association for Information Systems*, 24(1), 28.

- Omar, S. M., Chowdhury, A. J. K., & Hashi, A. A. (2018). Islamic ethics of waste management towards sustainable environmental health. *IIUM Medical Journal Malaysia*, 17(1).
- Orji, F., Deters, R., Greer, J., & Vassileva, J. (2018, November). ClassApp: a motivational course-level app. In 2018 IEEE 9th Annual Information Technology, Electronics and Mobile Communication Conference (IEMCON) (pp. 49-53). IEEE.
- Orji, R. (2017, April). Why are persuasive strategies effective? Exploring the strengths and weaknesses of socially-oriented persuasive strategies. In *international conference on persuasive technology* (pp. 253-266). Springer, Cham.
- Orji, R., & Moffatt, K. (2018). Persuasive technology for health and wellness: State-of-the-art and emerging trends. *Health informatics journal*, 24(1), 66-91.
- Orji, R., Mandryk, R. L., & Vassileva, J. (2015). Gender, age, and responsiveness to Cialdini's persuasion strategies. In *Persuasive Technology: 10th International Conference, PERSUASIVE 2015, Chicago, IL, USA, June 3-5, 2015, Proceedings 10* (pp. 147-159). Springer International Publishing.
- Orji, R., Reilly, D., & Mandryk, R. L. (2017). Persuasion strategies for games for health: Effects of player traits. *Journal of the American Medical Informatics Association*, 24(1), 20-29.
- Orji, R., Tondello, G. F., & Nacke, L. E. (2018, April). Personalizing persuasive strategies in gameful systems to gamification user types. In *Proceedings of the 2018 CHI conference on human factors in computing systems* (pp. 1-14).
- Orji, R., Vassileva, J., & Mandryk, R. L. (2014). Modeling the efficacy of persuasive strategies for different gamer types in serious games for health. *User Modeling and User-Adapted Interaction*, 24, 453-498.
- Othman, N. (2017). A comparative study between Western and Islamic perspectives on human development and life-friendly environment. *Online Journal of Research in Islamic Studies*, 1(1), 5-29.
- Oyebode, O., Ganesh, A., & Orji, R. (2021, August). TreeCare: development and evaluation of a persuasive mobile game for promoting physical activity. In *2021 IEEE Conference on Games (CoG)* (pp. 1-8). IEEE.
- Oyebode, O., Ndulue, C., Mulchandani, D., A. Zamil Adib, A., Alhasani, M., & Orji, R. (2021, May). Tailoring persuasive and behaviour change systems based on stages of change and motivation. In *Proceedings of the 2021 CHI conference on human factors in computing systems* (pp. 1-19).
- Paghasian, M. C. (2017, September). 'Awareness and practices on solid waste management among college students in Mindanao State University Maigo School of Arts and Trades'. *Proceedings of the 3rd International Conference on Education and Training (ICET 2017)* Vol.128, pp.5-12. Atlantis Press.

- Pane, C., Spaccini, R., Piccolo, A., Celano, G., & Zaccardelli, M. (2019). Disease suppressiveness of agricultural greenwaste composts as related to chemical and bio-based properties shaped by different on-farm composting methods. *Biological Control*, 137, 104026.
- Pariatamby, A. (2017). Country chapter state of the 3Rs in Asia and the Pacific-Malaysia. *United Nations Centre for Regional Development*, Nagoya.
- Petrou, A. D. 2003. Book Review: Persuasive Technology. *Journal of the American Society for Information Science and Technology*, (October), 1168–1170. Johnson. 2004. Book Reviews: Persuasive Technology. *Journal of Business and Technical Communication*, (April), 251–254.
- Petty, R. E. & Cacioppo, J. T. 1986. The Elaboration Likelihood Model of Persuasion. In. Berkowitz (Ed.). *Advances in Experimental Social Psychology*, pg. Vol. 19, 123–205. New York: Academic Press.
- Pill, J. (1971). The Delphi method: substance, context, a critique and an annotated bibliography. *Socio-economic planning sciences*, 5(1), 57-71.
- Rahman et al., (2020). Review on Current Municipal Solid Waste Management in Malaysia. *International Journal of Disaster Recovery and Business Continuity* Vol.11, No. 1, pp. 2230-2242
- Ramli, R. M. (2020). The Principle of Natural Resources Management Based on Maqasid Al-Shari'ah: A Conceptual Framework. *International Journal of Islamic Economics and Finance Research*, 3(1 July), 57-74.
- Rangga, J. U., Ismail, S. N. S., Rasdi, I., & Karuppiah, K. (2022). Waste Management Costs Reduction and the Recycling Profit Estimation from the Segregation Programme in Malaysia. *Pertanika Journal of Science & Technology*, 30(2).
- Ravitch, S.M. and Riggan, M. (2016). Reason and Rigor: How Conceptual Frameworks Guide Research, *Sage Publications*.
- Ray, M., & Rahaman, M. (2016). An overview of legal framework for waste management system in India with special allusion to SWM rules, 2016. *Int J Interdis Multidis Stud*, 4(1), 13-19.
- Razi, H. H. M., Roslly, K. A., Jurimi, S., & Sharkawi, S. (2022). Why does waste Separation at Source Initiative (SSI) did not fully commission in Malaysia? An exploratory preliminary study. *Journal of Entrepreneurship, Business and Economics*, 10(2), 86-109.
- Revelle, G., Reardon, E., Mays Green, M., Betancourt, J., & Kotler, J. (2007). The use of mobile phones to support children's literacy learning. In *Persuasive Technology: Second International Conference on Persuasive Technology, PERSUASIVE 2007, Palo Alto, CA, USA, April 26-27, 2007, Revised Selected Papers 2* (pp. 253-258). Springer Berlin Heidelberg.

- Rutledge, P. B., & Hogg, J. L. C. (2020). In-depth interviews. *The International Encyclopedia of Media Psychology*, 1-7.
- Saad, M. Z. M., Kamarudin, S., Meddin, N. A., Maikol, N., Ramaiya, S. D., Teng, L. W., & Ramlan, N. H. (2023). Malaysians' perspectives on solid waste management and e-Waze as an online waste reporting system. *Malaysia Journal of Invention and Innovation*, 2(2), 20-24.
- Saged, A. A. G., Alhaj, T. A. A., & Bi, M. Y. Z. (2017). The role of the Maqās. id al-Sharī'ah in preserving the environment. *Humanomics*, 33(2), 125-132.
- Salim, M. H. M., Ali, N. M., & Noah, S. A. M. (2017). Mobile application on healthy diet for elderly based on persuasive design. *International Journal on Advanced Science, Engineering and Information Technology*, 7(1), 222-227.
- Samori, Z., Khairudin, Z., Saedon, R., Anas, N. and Harun, H.M.F. (2017) 'Sustainable waste management via incineration system: an Islamic outlook for conservation of the environment', *Journal of Fundamental and Applied Science*, Vol. 9, No. 6, pp.538–557.
- Saputra, A. S., Susiani, I. R., & Syam, N. (2021, May). Hifdh al-Bī 'ah as part of Maqāsid Al-Sharī'ah: Yūsuf Al-Qardāwy's perspective on the environment in Ri'āyat al-Bī 'ah fī Sharī'ah al-Islām book. In *AIP Conference Proceedings* (Vol. 2353, No. 1, p. 030106). AIP Publishing LLC.
- Sarif, S. M., Ismail, Y., & Zainudin, D. (2022). Business Continuity With Budi, Knowledge And Hikmah. *Journal of Islamic Management Studies*, 4(1), 38-48.
- Sarkawi, A. A., Abdullah, A., Dali, N. M., & Khazani, N. A. M. (2017). The philosophy of *Maqasid al-Shari'ah* and its application in the built environment. *Journal of Built Environment, Technology and Engineering*, 2(3), 215-222.
- Schiefelbein, U. H., Pereira, W. B., de Souza, R. L., Lima, J. C. D., & da Rocha, C. C. (2019). The Use of Persuasive Strategies in Systems to Achieve Sustainability in the Fields of Energy and Water: A Systematic Review. In *ICEIS* (1) (pp. 258-265).
- Sekaran, U. (2003). *Research Methods for Business: A Skill-Building Approach*. 4th Edition, John Wiley & Sons, New York.
- Sekaran, U., & Bougie, R. (2016). *Research methods for business: A skill building approach*. john wiley & sons.
- Sewak, A., Deshpande, S., Rundle-Thiele, S., Zhao, F., & Anibaldi, R. (2021). Community perspectives and engagement in sustainable solid waste management (SWM) in Fiji: A socioecological thematic analysis. *Journal of Environmental Management*, 298, 113455.

- Shompa, Z. A., & Mohadis, H. M. (2022). A Conceptual Integrated Persuasive Behavioral Change Framework Based on Maqasid al-Shari'ah to Encourage Green Practices of Municipal Solid Waste (MSW) Disposal.
- Singh, S. (2020). 'Solid Waste Management in Urban India: Imperatives For Improvement'. *Observer Research Foundation*.
- Steiner, R. (2021, May 13). Why 99.5% of consumer apps fail (and how to keep yours alive). Fyresite. <https://www.fyresite.com/how-many-apps-fail/>
- Stiff, J. B., & Mongeau, P. A. (2016). Persuasive communication. *Guilford Publications*.
- Strydom, W.F. (2018a) 'Applying the theory of planned behavior to recycling behavior in South Africa', *Recycling*, Vol. 3, No. 3, p.43.
- Strydom, W.F. (2018b) 'Barriers to household waste recycling: empirical evidence from South Africa', *Recycling*, Vol. 3, No. 3, p.41.
- Suhaidi.N (2023, September 11). Empowering communities through education: Fostering recycling habits among youth with AFES. *The Malaysian Reserve*. <https://themalaysianreserve.com/2023/09/11/empowering-communities-through-education-fostering-recycling-habits-among-youth-with-afes/>
- Suruliraj, B., Nkwo, M., & Orji, R. (2020, April). Persuasive Mobile Apps for Sustainable Waste Management: A Systematic Review. In *International Conference on Persuasive Technology* (pp. 182-194). Springer, Cham.
- SWCorp – Perbadanan Pengurusan Sisa Pepejal dan Pembersihan Awam, 2017. Kompedium Pengurusan Sisa Pepejal Malaysia (Edition 1). Solid Waste Management and Public Cleaning Corporation (SWCorp) of Ministry of Urban Wellbeing, Housing and Local Government of Malaysia
- SWCorp, (2012). Composition on household solid waste in Malaysia. Final Report survey on Solid Waste Composition, Characteristic, and Existing Practice of Solid Waste Recycling in Malaysia.
- Tabachnick, B. G., Fidell, L. S., & Ullman, J. B. (2013). *Using multivariate statistics* (Vol. 6, pp. 497-516). Boston, MA: pearson.
- Tang, Chia-Wei, and Cheng-Ta Wu. "Obtaining a picture of undergraduate education quality: a voice from inside the university." *Higher Education* 60 (2010): 269-286.
- Tang, W. C., Nirmal, U., Lau, S. T., & Murugan, S. (2019). A Review on Managing Solid Waste Produced from Homes in Malaysia. *Current Journal of Applied Science and Technology*, 1-23.

- Teo, C. B. C. (2016). Recycling behaviour of malaysian urban households and upcycling prospects. *Journal of International Business, Economics and Entrepreneurship (JIBE)*, 1(1), 9-15.
- The Malaysian Reserve (2017, April 3). The promise of Klang Valley's southern expansion. Retrieved from: <https://themalaysianreserve.com/2017/04/03/the-promise-of-klang-valleys-southern-expansion/> [Accessed 18 May 2021].
- Thomas, D.R. (2006). "A general inductive approach for analyzing qualitative evaluation data", *American Journal of Evaluation*, Vol. 27 No. 2, pp. 237-246.
- Tim, Y., Pan, S. L., Bahri, S., & Fauzi, A. (2018). Digitally enabled affordances for community-driven environmental movement in rural Malaysia. *Information Systems Journal*, 28(1), 48-75.
- Torning, K., & Oinas-Kukkonen, H. (2009, April). Persuasive system design: state of the art and future directions. In *Proceedings of the 4th international conference on persuasive technology* (pp. 1-8).
- Usmani, M.T. (2014). "Maqasid ash-Shari'ah theory: between use and misuse", *Journal of Islamic Sciences*, Vol. 2 No. 1, pp. 1-2
- Vallero, D. A., & Blight, G. (2019, January). The Municipal Landfill. In *Waste* (pp. 235-258). *Academic Press*.
- Van Velsen, L., Broekhuis, M., Jansen-Kosterink, S., & Op den Akker, H. (2019). Tailoring persuasive electronic health strategies for older adults on the basis of personal motivation: web-based survey study. *Journal of medical Internet research*, 21(9), e11759.
- Vaverkova, M. D. (2019). Landfill impacts on the environment. *Geosciences*, 9(10), 431.
- Vom Brocke, J., Watson, R. T., Dwyer, C., Elliot, S., & Melville, N. (2013). Green information systems: Directives for the IS discipline. *Communications of the association for information systems*, 33(1), 30.
- Waldt, G.V.D. (2020). "Constructing conceptual frameworks in social science research", TD: *The Journal for Transdisciplinary Research in Southern Africa*, Vol. 16 No. 1, pp. 1-9.
- Weiss, E. B. (2017). Our Rights and Obligations to Future Generations for the Environment. In *Environmental Rights* (pp. 385-394). Routledge.
- Wiafe, I., Nakata, K., & Gulliver, S. R. (2011). Designing persuasive third party applications for social networking services based on the 3D-RAB model. In *Future Information Technology: 6th International Conference, FutureTech 2011*, Loutraki, Greece, June 28-30, 2011, Proceedings, Part II (pp. 54-61). Springer Berlin Heidelberg.

- Wiafe, I., Nakata, K., Moran, S., & Gulliver, S. (2011). Considering user attitude and behaviour in persuasive systems design: The 3D-RAB model.
- Wicker, A. W. (1969). Attitudes versus actions: The relationship of verbal and overt behavioral responses to attitude objects. *Journal of Social issues*, 25(4), 41-78.
- Wilson, Holly Skodol, and Sally A. Hutchinson. "Triangulation of qualitative methods: Heideggerian hermeneutics and grounded theory." *Qualitative health research* 1, no. 2 (1991): 263-276. <https://doi.org/10.1177/104973239100100206>
- World Bank (1999a). What a Waste: Solid Waste Management in Asia. Washington: The World Bank.
- World Bank (2012a). What a Waste: A Global Review of Solid Waste Management.
- Xu, L., Ling, M., Lu, Y. and Shen, M. (2017) 'Understanding household waste separation behaviour: testing the roles of moral, past experience, and perceived policy effectiveness within the theory of planned behaviour', *Sustainability*, Vol. 9, No. 4, p.625.
- Yan, Z. W., Wang, J., Xia, J. J., & Feng, J. M. (2016). Review of recent studies of the climatic effects of urbanization in China. *Advances in Climate Change Research*, 7(3), 154-168.
- Yiougo, L. S., Oyedotun, T. D., Some, C. Y., & Da, E. C. (2013). Urban cities and waste generation in developing countries: A gis evaluation of two cities in burkina faso. *Journal of Urban and Environmental Engineering*, 7(2), 280-285.
- Yoke, C. C., Mun, Y. W., Munusamy, K., Peng, L. M., Nair, M., & Yean, U. L. (2019). Government Initiatives and Public Awareness on Sustainable Environment. *Journal of Tourism*, 4(14), 40-50.
- Yong, Z. J., Bashir, M. J., Ng, C. A., Sethupathi, S., Lim, J. W., & Show, P. L. (2020). Sustainable Waste-to-Energy Development in Malaysia: Appraisal of Environmental, Financial, and Public Issues Related with Energy Recovery from Municipal Solid Waste. *Green Technologies: Bridging Conventional Practices and Industry* 4.0.
- Yukalang, N., Clarke, B., & Ross, K.E. (2017). Barriers to Effective Municipal Solid Waste Management in a Rapidly Urbanizing Area in Thailand. *International Journal of Environmental Research and Public Health*, 14.
- Yusof, N., Hashim, N. L., & Hussain, A. (2022, August). A review of fuzzy Delphi method application in human-computer interaction studies. In *AIP Conference Proceedings* (Vol. 2472, No. 1). AIP Publishing.
- Zabidi, F. N. M., Abd Rahman, N., & Halim, L. (2021). Integration of Islamic Values for Environmental Conservation: An Analysis of School Textbooks. *Religions*, 12(7), 509.

- Zailani, M. N., Mohd Satar, N., & Zakaria, R. H. (2022). A review of indicators for the preservation of wealth (Hifz al-mal) based on *Maqasid al-Shariah*. *Journal of Islamic Philanthropy & Social Finance (JIPSF)*, 4(1), 23-29.
- Zainu, Z.A. and Songip, A.R. (2017). 'Policies, challenges and strategies for municipal waste management in Malaysia', *Journal of Science, Technology and Innovation Policy*, Vol. 3, No. 1.
- Zeng, C., Niu, D., Li, H., Zhou, T., & Zhao, Y. (2016). Public perceptions and economic values of source-separated collection of rural solid waste: A pilot study in China. *Resources, Conservation and Recycling*, 107, 166-173.
- Zhang, D., Huang, G., Yin, X. and Gong, Q. (2015) 'Residents' waste separation behaviors at the source: using SEM with the theory of planned behavior in Guangzhou, China', *International Journal of Environmental Research and Public Health*, Vol. 12, No. 8, pp.9475–9491.



APPENDIX I: QUESTIONNAIRE USED IN STUDY 1

Dear Respondents,

My name is Zohora Azmin Shompa. I am a postgraduate student undertaking PhD at Kulliyah of Information and Communication Technology, International Islamic university Malaysia (IIUM).

The purpose of this survey is to investigate solid waste disposal behavior and practices among community in Malaysia.

Solid waste is defined as any substance or object that is considered worthless to be used and usually discarded as garbage by society (for example: food waste, paper and plastic etc). So, we would like to know your current practices of disposing these waste at home.

All information given will be treated as confidential and will be used for academic purpose only.

The survey will take approximately about 10 minutes.

Shall you have any enquiry regarding this survey, feel free to contact me at shomparz_iium@yahoo.com.

Thank you for your willingness to participate in this survey. Your cooperation to answer this survey is very much appreciated.

~~~~~

## PART A: BACKGROUND INFORMATION

Instruction: Please tick (✓) the correct answer about yourself.

1. Gender:

☐ Male ☐ Female

2. Age:

☐ below 20 years  
☐ 21-30 years  
☐ 31-40 years  
☐ 41-50 years  
☐ 51-60 years  
☐ 61 and above years

3. Ethnicity:

☐ Malay  
☐ Chinese  
☐ Indian  
☐ Non-Malaysian  
☐ Other (please specify): \_\_\_\_\_

4. Religion:

☐ Islam  
☐ Hindu  
☐ Buddhist  
☐ Christian  
☐ Atheist  
☐ Other

5. Level of education:

☐ Primary school  
☐ SPM  
☐ STPM / A-Level  
☐ Diploma  
☐ Bachelor degree  
☐ Master degree  
☐ PhD  
☐ No formal education  
☐ Other (please specify): \_\_\_\_\_

6. Occupation:

☐ Government sector  
☐ Private sector  
☐ Self-employed  
☐ Online Drop ship  
☐ Full time housewife



- ☐ Student
- ☐ Unemployed
- ☐ Others\_\_\_\_\_

7. Types of houses:

- ☐ Bungalow
- ☐ Single-storey Terrace
- ☐ Double-storey Terrace
- ☐ Apartment
- ☐ Condominium
- ☐ Other (please specify):\_\_\_\_\_

8. Monthly earning (RM):

- ☐ less than 2,500
- ☐ 2,500-3,169
- ☐ 3,170-3,969
- ☐ 3,970- 4,849
- ☐ 4,850- 5,879
- ☐ 5,880- 7,099
- ☐ 7,110- 8,699
- ☐ 8,700-10,959
- ☐ 10,960-15,093
- ☐ 15,093 or more
- ☐ Prefer not to tell

9. People living in your household:

- ☐ Small family (1-4 persons)
- ☐ Medium family (5-7 persons)
- ☐ Large family (more than 8 persons)

**PART B: SOLID WASTE DISPOSAL PRACTICES**

Please tick (✓) the answer that best reflect about your solid waste disposal practices.

1. Types of waste generated in your household:

- ☐ Food
- ☐ Plastics
- ☐ Glass
- ☐ Metal
- ☐ Paper/ Cardboard
- ☐ Clothing materials
- ☐ Electronic waste (e.g., batteries, old phone)
- ☐ Others (please specify):\_\_\_\_\_

2. How many garbage generated by the household per week?
  - ☐ 1 bag
  - ☐ 2 bags
  - ☐ 3 bags
  - ☐ 4 bags or more
  
3. How many bins do you use to dispose waste at home?
  - ☐ 1
  - ☐ 2
  - ☐ 3
  - ☐ More than 3
  - ☐ Do not use
  
4. Do you use different bins for different type of waste?
  - ☐ Yes, I separate different type of waste.
  - ☐ No, I did not separate waste.
  
5. How did you dispose your household waste? (Can choose more than 1)
  - ☐ Garbage trucks pick up waste at home
  - ☐ Using community bins
  - ☐ Recycling
  - ☐ Composting
  - ☐ Burning
  - ☐ Thrown at open places
  - ☐ Other (please specify): \_\_\_\_\_
  
6. Which of the following difficulties that you have experienced in order to reduce, reuse and recycle your household waste? "(can choose more than one)
  - ☐ I don't know how to reduce my household waste
  - ☐ I don't know how I can reuse my waste for other purpose.
  - ☐ I don't know how to recycle my household waste.
  - ☐ I am not interested to reduce, reuse and recycle waste.
  - ☐ I did not have time to sort my waste and sent it to recycling center.
  - ☐ I don't have enough space at home to keep reusable and recyclable waste.
  - ☐ Recycling requires too much effort.
  - ☐ Recycling center is too far. There is not much recycling facilities or recycle bin around my housing area.
  - ☐ Others (please state): \_\_\_\_\_

### **PART C: AWARENESS ON SOLID WASTE DISPOSAL BASED ON PROTECTION OF FAITH/BELIEF (AL-DIN)**

Based on the following agreement scale, please choose an answer that based reflect your personal opinion on each statement.

| 1                 | 2        | 3       | 4     | 5              |
|-------------------|----------|---------|-------|----------------|
| Strongly disagree | Disagree | Neutral | Agree | Strongly Agree |

|    |                                                                             |   |   |   |   |   |
|----|-----------------------------------------------------------------------------|---|---|---|---|---|
| 1. | Because of my faith, I <b>separate</b> my waste to protect the environment. | 1 | 2 | 3 | 4 | 5 |
| 2. | Because of my faith, I <b>reduce</b> my waste to protect the environment.   | 1 | 2 | 3 | 4 | 5 |
| 3. | Because of my faith, I <b>reuse</b> my waste to protect the environment.    | 1 | 2 | 3 | 4 | 5 |
| 4. | Because of my faith, I <b>recycle</b> my waste to protect the environment.  | 1 | 2 | 3 | 4 | 5 |

#### **PART D: AWARENESS ON SOLID WASTE DISPOSAL BASED ON PROTECTION OF LIFE/BODY (AL-NAFS)**

Based on the following agreement scale, please choose an answer that based reflect your personal opinion on each statement.

| 1                 | 2        | 3       | 4     | 5              |
|-------------------|----------|---------|-------|----------------|
| Strongly disagree | Disagree | Neutral | Agree | Strongly Agree |

|    |                                                                                                                                                                 |   |   |   |   |   |
|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|---|
| 1. | I keep the bins clean and tidy at all times to preserve my personal hygiene and cleanliness.                                                                    | 1 | 2 | 3 | 4 | 5 |
| 2. | I reduce amount of waste produced, knowing that large amount of waste would cause harmful effect on our health.                                                 | 1 | 2 | 3 | 4 | 5 |
| 3. | I dispose my waste properly to preserve my house cleanliness as well as to maintain the cleanliness of the environment.                                         | 1 | 2 | 3 | 4 | 5 |
| 4. | I did not throw my household waste in public area (such as river and drain) as it would lead to environmental pollution and cause harmful effect to our health. | 1 | 2 | 3 | 4 | 5 |

**PART E: DISPOSAL BASED ON PROTECTION OF INTELLECT/REASONING (AL-AQL)**

Based on the following agreement scale, please choose an answer that based reflect your personal opinion on each statement.

| 1                 | 2        | 3       | 4     | 5              |
|-------------------|----------|---------|-------|----------------|
| Strongly disagree | Disagree | Neutral | Agree | Strongly Agree |

|    |                                                                                                                                                                      |   |   |   |   |   |
|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|---|
| 1. | I know it is important to learn and understand about green practices (reuse, reduce, recycle waste).                                                                 | 1 | 2 | 3 | 4 | 5 |
| 2. | I should know about how to separate my household waste (e.g. food waste, plastics, aluminum, glasses, papers waste).                                                 | 1 | 2 | 3 | 4 | 5 |
| 3. | I should learn more about how to integrate good reuse and recycling practices into my daily life.                                                                    | 1 | 2 | 3 | 4 | 5 |
| 4. | I should learn more about how I can reuse different waste items to serve other purpose (e.g. reuse patches of old clothes to make a blanket, reuse box for storage). | 1 | 2 | 3 | 4 | 5 |

**PART F: AWARENESS ON SOLID WASTE DISPOSAL BASED ON PROTECTION OF LINEAGE/PROSPERITY (AL-NASAB)**

Based on the following agreement scale, please choose an answer that based reflect your personal opinion on each statement.

| 1                 | 2        | 3       | 4     | 5              |
|-------------------|----------|---------|-------|----------------|
| Strongly disagree | Disagree | Neutral | Agree | Strongly Agree |

|    |                                                                                                                                                                       |   |   |   |   |   |
|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|---|
| 1. | I purchase environmentally friendly product for my daily needs because I think about the future generation.                                                           | 1 | 2 | 3 | 4 | 5 |
| 2. | I avoid buying disposable items (e.g., plastic bags, plastic cutlery and certain kind of plastic wrapping materials) to secure the environment for future generation. | 1 | 2 | 3 | 4 | 5 |

|    |                                                                                                                                                                                                                                              |   |   |   |   |   |
|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|---|
| 3. | I rather reuse the materials that I already have than buying a new one (e.g., reusing plastic bags, glass, bottles, rubber, plastic bands, carton box etc.) because I want to reduce waste and secure the environment for future generation. | 1 | 2 | 3 | 4 | 5 |
| 4. | I redesign old materials into a new product (e.g., redesigning patches of cloth into blanket) to reduce waste and secure environment for future generation.                                                                                  | 1 | 2 | 3 | 4 | 5 |

#### **PART G: AWARENESS ON SOLID WASTE DISPOSAL BASED ON PROTECTION OF WEALTH (AL-MAAL)**

Based on the following agreement scale, please choose an answer that based reflect your personal opinion on each statement.

| 1                 | 2        | 3       | 4     | 5              |
|-------------------|----------|---------|-------|----------------|
| Strongly disagree | Disagree | Neutral | Agree | Strongly Agree |

|    |                                                                                                                               |   |   |   |   |   |
|----|-------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|---|
| 1. | I purchase only what is necessary so that I can save money and not generating a lot of waste at home.                         | 1 | 2 | 3 | 4 | 5 |
| 2. | I always reuse materials, so that I can save money and avoid unnecessary purchases.                                           | 1 | 2 | 3 | 4 | 5 |
| 3. | I only cook adequate amount of food daily to save money and avoid generating a lot of food waste.                             | 1 | 2 | 3 | 4 | 5 |
| 4. | I enjoy collecting recyclable materials (such as paper, glass, plastics), send it to recycle center and get some cash reward. | 1 | 2 | 3 | 4 | 5 |

## PART H (LAST PART): ATTITUDE AND BEHAVIOURAL INTENTION TOWARDS WASTE DISPOSAL

Based on the following agreement scale, please choose an answer that based reflect your personal opinion on each statement.

| 1                 | 2        | 3       | 4     | 5              |
|-------------------|----------|---------|-------|----------------|
| Strongly disagree | Disagree | Neutral | Agree | Strongly Agree |

| No. | Statement                                                                                                              | Agreement |   |   |   |   |
|-----|------------------------------------------------------------------------------------------------------------------------|-----------|---|---|---|---|
| 1.  | I have an idea of waste disposal.                                                                                      | 1         | 2 | 3 | 4 | 5 |
| 2.  | I think that proper waste disposal is important.                                                                       | 1         | 2 | 3 | 4 | 5 |
| 3.  | I feel that our streets should be clean and free of waste.                                                             | 1         | 2 | 3 | 4 | 5 |
| 4.  | Most people who are important to me influence me to reduce, reuse and recycle my waste.                                | 1         | 2 | 3 | 4 | 5 |
| 5.  | I think many people who are important to me expect that I should reduce, reuse and recycle my waste.                   | 1         | 2 | 3 | 4 | 5 |
| 6.  | Whether to adopt green practices (reduce, reuse, recycle) is entirely up to me.                                        | 1         | 2 | 3 | 4 | 5 |
| 7.  | I have the relevant resources, time, and opportunity to adopt green practices ( <b>reduce, reuse, recycle waste</b> ). | 1         | 2 | 3 | 4 | 5 |
| 8.  | I can adopt green practices as long as I want.                                                                         | 1         | 2 | 3 | 4 | 5 |
| 9.  | I will make an effort to adopt reduce, reuse and recycle shortly.                                                      | 1         | 2 | 3 | 4 | 5 |
| 10. | I intend to isolate food waste separately when discarding.                                                             | 1         | 2 | 3 | 4 | 5 |
| 11. | I intend to dispose waste into appropriate bins and separate waste for recycling.                                      | 1         | 2 | 3 | 4 | 5 |
| 12. | I intend to isolate dangerous waste separately when discarding.                                                        | 1         | 2 | 3 | 4 | 5 |

Would you like to participate in a follow up study (an interview session) regarding waste disposal practices? You would be paid RM 30 for the interview session. If so, please kindly leave your email. The interview will be online only via Google meet.

Email: \_\_\_\_\_

- END OF SURVEY -

## APPENDIX II: INTERVIEW USED IN STUDY 2

Dear participants,

Thank you for taking part in this interview on household green practices in Klang Valley.

I am Zohora Azmin Shompa, a PhD student at Kulliyah of Information and Communication Technology, International Islamic university Malaysia (IIUM). The title of my research is “An Integrated Persuasive System Design Framework based on *Maqasid al-Shari'ah* for Municipal Solid Waste Disposal”.

Solid waste is defined as any substance or object that is considered worthless to be used and usually discarded as garbage by society (for example: food waste, paper and plastic etc). In Malaysia the level of awareness on appropriate waste disposal of eco-friendly practices is still very weak as millions of tons of solid waste was generated every year. Although the government has tried to raise awareness on the importance of household participation in environmentally friendly disposal of Municipal Solid Waste (MSW) through numerous measures, it is still inadequate.

Therefore, our research aim to design a mobile application that will able to persuade Malaysian citizens to adopt green practices (reduce, reuse and recycle) of solid waste disposal.

There are five (5) essential objectives of Maqasid al-Shari'ah mainly preservation of faith, life, mind, lineage and wealth. These dimensions of Maqasid Shariah not only deals, prescribes, upholds and directs the modes of worship for the individual and gives guidance for personal morality and action, but also prescribes directives for a collective life containing various subjects, like global warming, environmental crisis, health, family relationships, socio-economic affairs, duties of citizens, decision-making structures, laws of war and peace, international relations, as well as, how to preserve and protect a healthy environment (Deuraseh, 2012).

Accordingly, the purpose of this interview is to identify users' perspectives on Maqasid Shariah dimension and the persuasive behaviour change strategies that could encourage behavioural change towards green practices (reduce, reuse, recycle) of municipal solid waste disposal.

All data gathered in this interview will be kept confidential and use for academic purposes only.

## SECTION A: DEMOGRAPHIC INFORMATION

Kindly take a few minutes to provide the following information. This section is seeking information about your background. Please choose the answer that applies to you.

1. Your age group:
  - ☐ Under 18
  - ☐ 18-25
  - ☐ 26-35
  - ☐ 36-45
  - ☐ Over 46
2. Your gender:
  - ☐ Male
  - ☐ Female
3. Nationality:
  - ☐ Malaysian
  - ☐ Non-Malaysian
4. Race:
  - ☐ Malay
  - ☐ Chinese
  - ☐ Indian
  - ☐ Non-Malaysian
  - ☐ Other. Please state: \_\_\_\_\_
5. Religion:
  - ☐ Islam
  - ☐ Hindu
  - ☐ Buddhist
  - ☐ Christian
  - ☐ Atheist
  - ☐ Other. Please state: \_\_\_\_\_
6. How many years have you live in Klang Valley?
  - ☐ Less than 1 year
  - ☐ 1-4 years
  - ☐ 5-10 years
  - ☐ More than 10 years
7. Which part of Klang Valley do you currently live in?
  - ☐ Kuala Lumpur
  - ☐ Petaling
  - ☐ Klang
  - ☐ Gombak
  - ☐ Hulu Langat
  - ☐ Sepang
  - ☐ Kuala Langat



8. Years of experience of using smartphones?
- Less than 1 year
  - 1-3 years
  - 4-6 years
  - More than 6 years

## **SECTION B: PROBLEMS AND CHALLENGES OF APPLYING GREEN PRACTICES OF MSW DISPOSAL IN KLANG VALLEY**

Based on the following questions, please indicate your opinion about the problems and challenges of applying Green Practices of MSW Disposal in Klang Valley

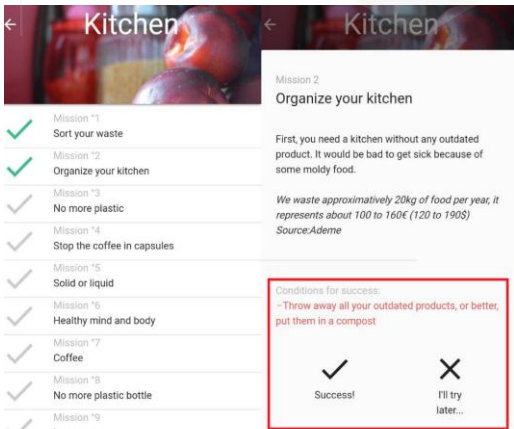
| <b>Socio-ecological Level</b> | <b>Question</b>                                                                                                                                                                                                                                                                                                                                                                        |
|-------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Personal                      | 1. Do you adopt green practices of waste disposal at home?<br>2. What are the challenges do you face to adopt green practices at home?<br>3. In your opinion, what are the factors that could hinder waste disposal behavior?                                                                                                                                                          |
| Community                     | 4. What are the barriers currently being found in the community with regard to adopting green practices?                                                                                                                                                                                                                                                                               |
| Organizational                | 5. Can you describe how waste is being disposed in your areas?<br>(Do they provide two types of recycle bin and non-recycle bin)<br>6. What kinds of facilities are provided to dispose waste?<br>7. Are appropriate recycling facilities provided?<br>8. Are there any problems associated with services or facilities provided by local authorities for waste disposal in your area? |
| Policy                        | 9. Are you aware of any policies regarding waste disposal? What is the policy that you are aware of waste disposal? (e.g., if you throw hazard waste into the river you will get punished, summons)<br><br>10. In your opinion, what are the barriers towards the effective implementation of laws or policies on solid waste management?                                              |

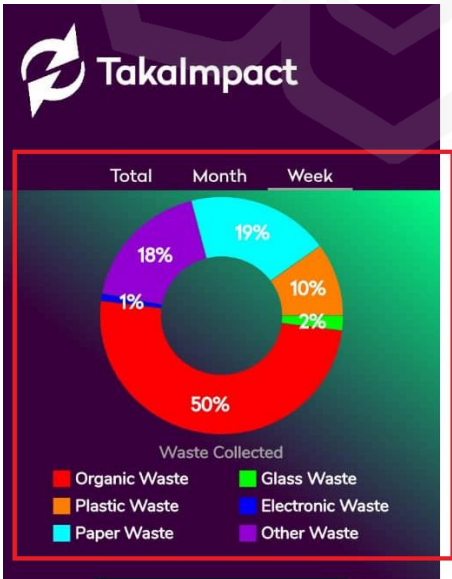
### APPENDIX III: INTERVIEW IN STUDY 3

In this section you will be shown with the concept of a smartphone application which is designed to encourage green practices (reduce, reuse, and recycle) of MSW.

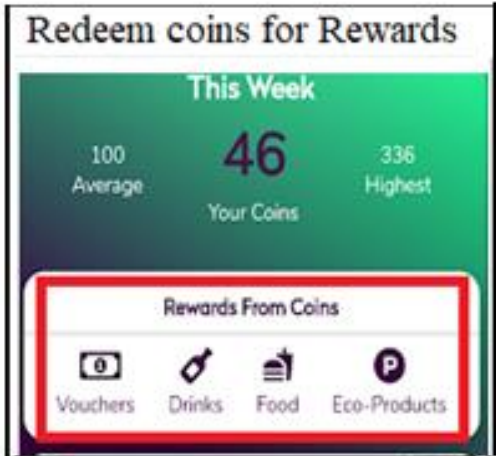
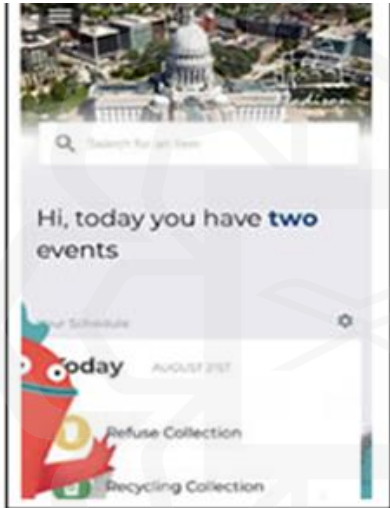
You are expected to tell us about your opinion on the *persuasive strategies* implemented in the application that potentially would encourage and motivated people towards green practices of MSW disposal.

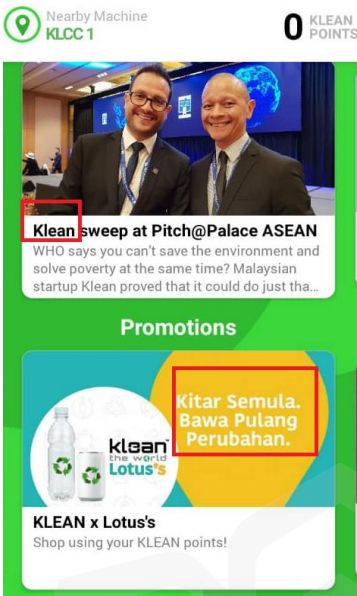
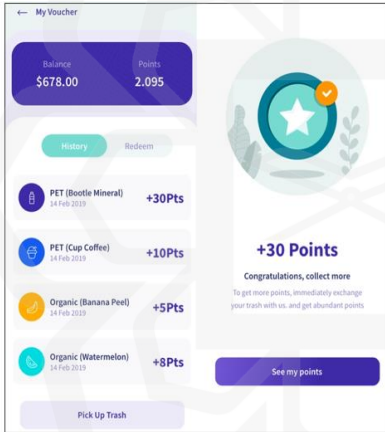
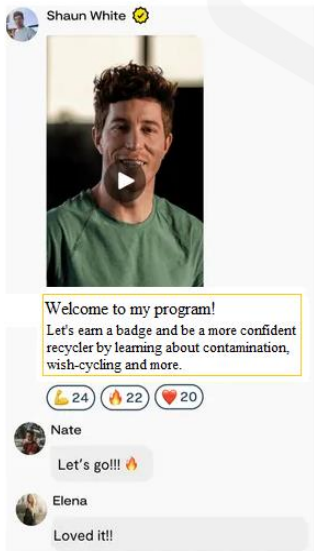
(Based on the given trigger) please rank the level of persuasion from 1 to 5 based on how much you think the features of the application would be able to persuade people towards green practices of waste disposal.

| No | Persuasive Strategies                                                                                | Example of features implemented                                                                                                                                             | Level of persuasion |
|----|------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| 1. | <b>Reduction</b>   | The application displays a color-coding calendar for a garbage collection schedule.                                                                                         | 1-2-3-4-5           |
| 2. | <b>Tunneling</b>  | The application that provides roadmap to complete quizzes and articles, step-by-step guide, instruction, and a Do It Yourself (DIY) project of recycling and reusing waste. | 1-2-3-4-5           |
| 3. | <b>Tailoring</b>                                                                                     | The application provides the address-based garbage                                                                                                                          | 1-2-3-4-5           |

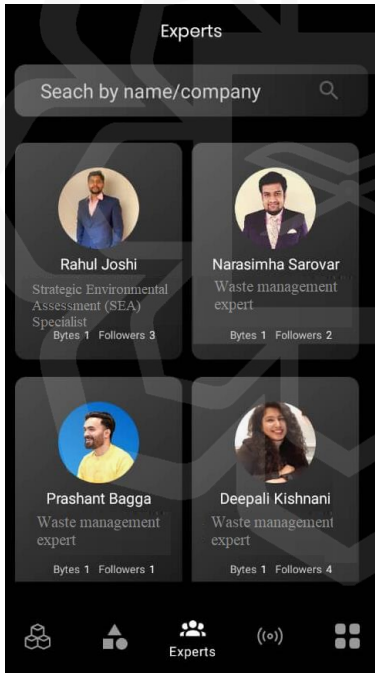
|    |                                                                                                                   |                                                                                                                                                                                               |           |
|----|-------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
|    |                                  | collection schedules in different residential areas in Klang Valley.                                                                                                                          |           |
| 4. | <p><b>Personalization</b></p>   | The application offers personalized preferred languages, notification times, email reminders, save location, user profiles, and personalized setting of user preferences and payment options. | 1-2-3-4-5 |
| 5. | <p><b>Self-monitoring</b></p>  | The application displays my personal history of waste disposal, relevant statistics, and my personal contribution towards environmental impact and amount of CO2 released.                    | 1-2-3-4-5 |

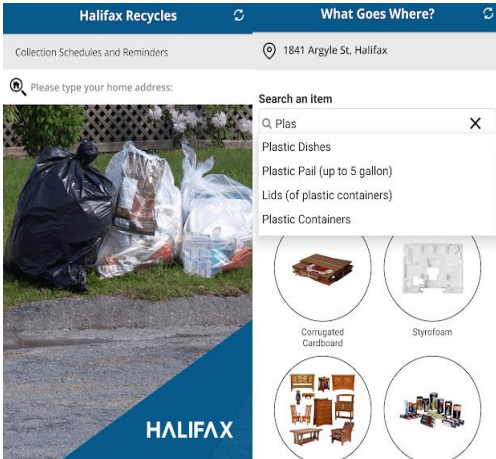
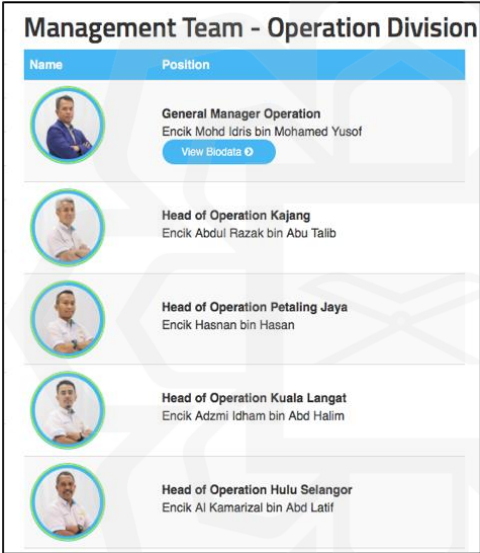
|    |                          |                                                                                                                                                                                                                                 |           |
|----|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| 6. | <p><b>Simulation</b></p> | <p>The application shows the impacts of waste being recycled on the environment. In this example, the application informs that the user has created 57 new plastic products by recycling 4% of the plastic waste generated.</p> | 1-2-3-4-5 |
| 7. | <p><b>Rehearsal</b></p>  | <p>An application that encourages me to rehearse waste sorting and recycling behavior within the app.</p>                                                                                                                       | 1-2-3-4-5 |
| 8. | <p><b>Praise</b></p>     | <p>An application that praises and congratulates me for completing a level of recycling and disposing of waste.</p>                                                                                                             | 1-2-3-4-5 |

|     |                                                                                                              |                                                                                                                                                                                                                 |           |
|-----|--------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| 9.  | <p><b>Rewards</b></p>       | <p>An application that integrates gamification by offering rewards point after completing a certain level of recycling.</p>                                                                                     | 1-2-3-4-5 |
| 10. | <p><b>Reminders</b></p>    | <p>The application that reminds me to follow green practices of waste disposal by sending push notification about disposing of garbage, interesting events, and new events, waste or recycling pickup date.</p> | 1-2-3-4-5 |
| 11. | <p><b>Suggestion</b></p>  | <p>An app that provides suggestions on alternative ways of reducing waste.</p>                                                                                                                                  | 1-2-3-4-5 |

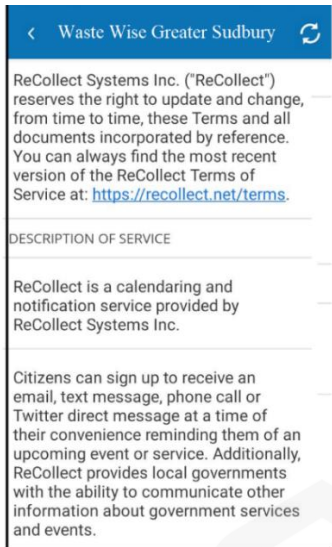
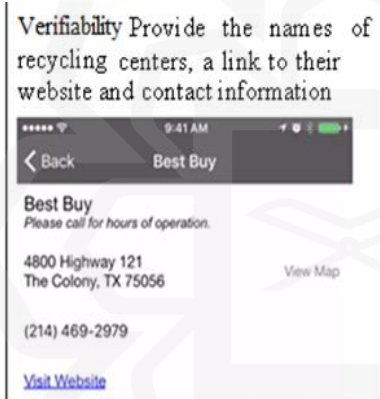
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| 12. | <p><b>Similarity</b></p>     | <p>The application speaks the user's language, showing images, quotes that remind them about their religion, culture. Any aspects that make users feel familiar with the application</p> | 1-2-3-4-5 |
| 13. | <p><b>Liking</b></p>        | <p>The app contains a visually attractive appearance that matches users' preferences.</p>                                                                                                | 1-2-3-4-5 |
| 14. | <p><b>Social role</b></p>  | <p>Having a respected and prominent person as ambassador or role model that practices sustainable lifestyle, and adopt green practices of waste disposal.</p>                            | 1-2-3-4-5 |

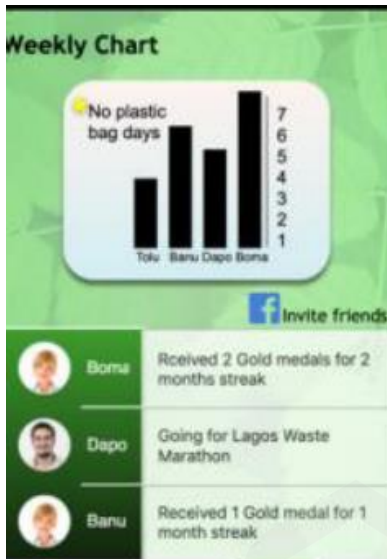
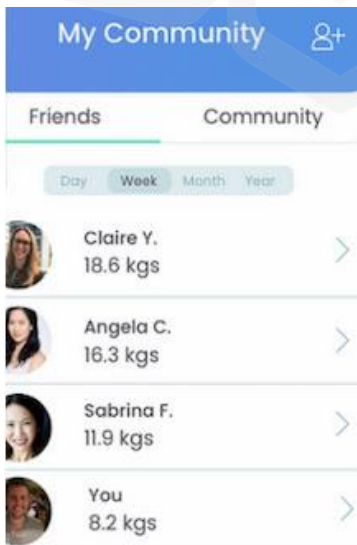


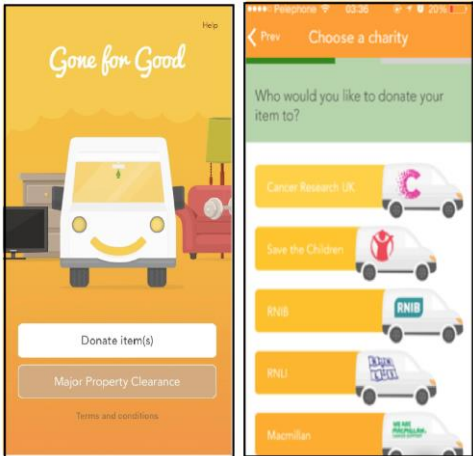
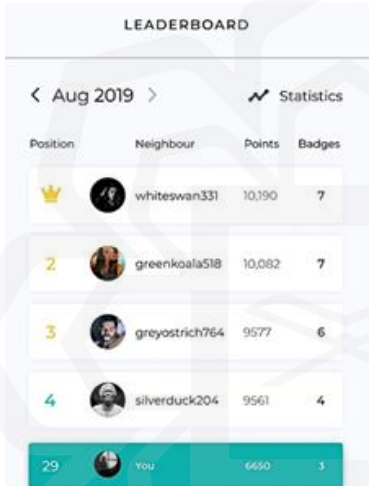
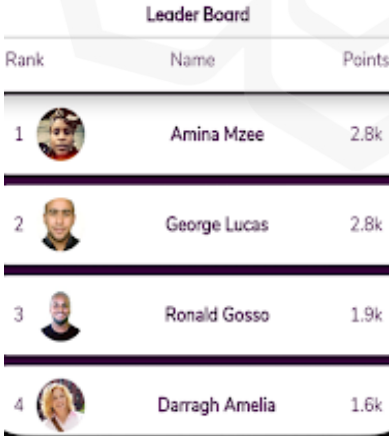
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|-----|-----------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|-----------|
| 15. | <p><b>Trustworthiness</b></p>  | <p>An app that provides truthful, reasonable, and unbiased information.</p>                              | 1-2-3-4-5 |
| 16. | <p><b>Expertise</b></p>       | <p>The app provides the platform for seeking experts to get advice about waste management practices.</p> | 1-2-3-4-5 |

|     |                                                                                                                     |                                                                                                                                                                                                                                       |           |
|-----|---------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| 17. | <p><b>Surface credibility</b></p>  | <p>The user interfaces of the application have a competent look and feel. (e.g., respond the feedback and email, do not oblige to fill a registration form, don't overdo mobile advertising, send appropriate push notifications)</p> | 1-2-3-4-5 |
| 18. | <p><b>Real-world feel</b></p>     | <p>The application identifies the people behind the <i>i-Clean Selangor</i> app.</p>                                                                                                                                                  | 1-2-3-4-5 |
| 19. | <p><b>Authority</b></p>          | <p>The application provides services to submit waste collection complaint to authority.</p>                                                                                                                                           | 1-2-3-4-5 |



|     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                 |           |
|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| 20. | <p><b>Third-party Endorsement</b></p>  <p>ReCollect Systems Inc. ("ReCollect") reserves the right to update and change, from time to time, these Terms and all documents incorporated by reference. You can always find the most recent version of the ReCollect Terms of Service at: <a href="https://recollect.net/terms">https://recollect.net/terms</a>.</p> <p>DESCRIPTION OF SERVICE</p> <p>ReCollect is a calendaring and notification service provided by ReCollect Systems Inc.</p> <p>Citizens can sign up to receive an email, text message, phone call or Twitter direct message at a time of their convenience reminding them of an upcoming event or service. Additionally, ReCollect provides local governments with the ability to communicate other information about government services and events.</p> | <p>The used of the application was encourage and endorsed by the ministry/government (any well-known respected sources).</p>                    | 1-2-3-4-5 |
| 21  | <p><b>Verifiability</b></p> <p>Verifiability Provide the names of recycling centers, a link to their website and contact information</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <p>The application provides the name of recycling and reuse center, a link to their website and contact information to verify the accuracy.</p> | 1-2-3-4-5 |
| 22  | <p><b>Social learning</b></p> <p>My Recycling Diary</p>  <p>Karrissa Marie</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <p>The application provides opportunity for me to learn about recycling behavior from other people.</p>                                         | 1-2-3-4-5 |

|    |                                                                                                                       |                                                                                                                                                                                                                                                       |           |
|----|-----------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| 23 | <p><b>Social comparison</b></p>      | <p>The application provide opportunity for me to compare my recycling performances with other</p>                                                                                                                                                     | 1-2-3-4-5 |
| 24 | <p><b>Normative influence</b></p>   | <p><i>Recycle Mate</i>, an Australia's first community-driven recycling app provides a live national platform that allows governments, recyclers, and the whole community to all work together to gather, share and update recycling information.</p> | 1-2-3-4-5 |
| 25 | <p><b>Social facilitation</b></p>  | <p>The application allows me to recycle better when I feel others are recycling with me.</p>                                                                                                                                                          | 1-2-3-4-5 |

|     |                                                                                                               |                                                                                                                                                                                                                                                       |           |
|-----|---------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| 26. | <p><b>Cooperation</b></p>    | <p><i>Gone-for-Good</i> app provide opportunity for users to donate unused item for charity or good causes (e.g. donate used for people who were affected by flood disaster)</p>                                                                      | 1-2-3-4-5 |
| 27. | <p><b>Competition</b></p>   | <p>The application provides the leaderboard to see how your recycling habits compare with other members of the community.</p>                                                                                                                         | 1-2-3-4-5 |
| 28. | <p><b>Recognition</b></p>  | <p>The application that shows publicly available ratings for garbage service providers, a wall of fame to display exceptional performers in reducing waste, public leaderboard and display names to all users when the user starts using the app.</p> | 1-2-3-4-5 |

1. Why do you rate a 'Reduction' as '\_\_\_ [insert rank]'. Do you think the features would be effective/ not effective to persuade people to adopt green practices of waste disposal?

Your answer: \_\_\_\_\_

2. Why do you rate a 'Tunneling' as '\_\_\_'. Do you think the features would be effective/ not effective to persuade people to adopt green practices of waste disposal?

Your answer: \_\_\_\_\_

3. Why do you rate a 'Tailoring' as '\_\_\_'. Do you think the features would be effective/ not effective to persuade people to adopt green practices of waste disposal?

Your answer: \_\_\_\_\_

4. Why do you rate a 'Personalization' as '\_\_\_'. Do you think the features would be effective/ not effective to persuade people to adopt green practices of waste disposal?

Your answer: \_\_\_\_\_

5. Why do you rate a 'Self-monitoring' as '\_\_\_'. Do you think the features would be effective/ not effective to persuade people to adopt green practices of waste disposal?

Your answer: \_\_\_\_\_

6. Why do you rate a 'Simulation' as '\_\_\_'. Do you think the features would be effective/ not effective to persuade people to adopt green practices of waste disposal?

Your answer: \_\_\_\_\_

7. Why do you rate a 'Rehearsal' as '\_\_\_'. Do you think the features would be effective/ not effective to persuade people to adopt green practices of waste disposal?

Your answer: \_\_\_\_\_

8. Why do you rate a 'Praise' as '\_\_\_'. Do you think the features would be effective/ not effective to persuade people to adopt green practices of waste disposal?

Your answer: \_\_\_\_\_

9. Why do you rate a 'Rewards' as '\_\_\_'. Do you think the features would be effective/ not effective to persuade people to adopt green practices of waste disposal?

Your answer: \_\_\_\_\_

10. Why do you rate a 'Reminders' as '\_\_\_'. Do you think the features would be effective/ not effective to persuade people to adopt green practices of waste disposal?

Your answer: \_\_\_\_\_

11. Why do you rate a 'Suggestion' as '\_\_\_'. Do you think the features would be effective/ not effective to persuade people to adopt green practices of waste disposal?

Your answer: \_\_\_\_\_

12. Why do you rate a 'Similarity' as '\_\_\_'. Do you think the features would be effective/ not effective to persuade people to adopt green practices of waste disposal?

Your answer: \_\_\_\_\_

13. Why do you rate a 'Liking' as '\_\_\_'. Do you think the features would be effective/ not effective to persuade people to adopt green practices of waste disposal?

Your answer: \_\_\_\_\_

14. Why do you rate a 'Social role' as '\_\_\_'. Do you think the features would be effective/ not effective to persuade people to adopt green practices of waste disposal?

Your answer: \_\_\_\_\_

15. Why do you rate 'Trustworthiness as '\_\_\_'. Do you think the features would be effective/ not effective to persuade people to adopt green practices of waste disposal?

Your answer: \_\_\_\_\_

16. Why do you rate a 'Expertise' as '\_\_\_'? Do you think the features would be effective/ not effective to persuade people to adopt green practices of waste disposal?

Your answer: \_\_\_\_\_

17. Why do you rate a 'Surface credibility as '\_\_\_'. Do you think the features would be effective/ not effective to persuade people to adopt green practices of waste disposal?

Your answer: \_\_\_\_\_

18. Why do you rate a 'Real-world feel' as ' \_\_\_\_ '. Do you think the features would be effective/ not effective to persuade people to adopt green practices of waste disposal?

Your answer: \_\_\_\_\_

19. Why do you rate a 'Authority' as ' \_\_\_\_ '. Do you think the features would be effective/ not effective to persuade people to adopt green practices of waste disposal?

Your answer: \_\_\_\_\_

20. Why do you rate a 'Third-party Endorsement' feel as ' \_\_\_\_ '. Do you think the features would be effective/ not effective to persuade people to adopt green practices of waste disposal?

Your answer: \_\_\_\_\_

21. Why do you rate a 'Verifiability' as ' \_\_\_\_ '. Do you think the features would be effective/ not effective to persuade people to adopt green practices of waste disposal?

Your answer: \_\_\_\_\_

22. Why do you rate a 'Social learning' as ' \_\_\_\_ '. Do you think the features would be effective/ not effective to persuade people to adopt green practices of waste disposal?

Your answer: \_\_\_\_\_

23. Why do you rate a 'Social Comparison' as ' \_\_\_\_ '. Do you think the features would be effective/ not effective to persuade people to adopt green practices of waste disposal?

Your answer: \_\_\_\_\_

24. Why do you rate a 'Normative influence' as ' \_\_\_\_ '. Do you think the features would be effective/ not effective to persuade people to adopt green practices of waste disposal?

Your answer: \_\_\_\_\_

25. Why do you rate a 'Social facilitation' as '\_\_\_'. Do you think the features would be effective/ not effective to persuade people to adopt green practices of waste disposal?

Your answer: \_\_\_\_\_

26. Why do you rate a 'Cooperation' as '\_\_\_'. Do you think the features would be effective/ not effective to persuade people to adopt green practices of waste disposal?

Your answer: \_\_\_\_\_

27. Why do you rate a 'Competition' as '\_\_\_'. Do you think the features would be effective/ not effective to persuade people to adopt green practices of waste disposal?

Your answer: \_\_\_\_\_

28. Why do you rate a 'Recognition' as '\_\_\_'. Do you think the features would be effective/ not effective to persuade people to adopt green practices of waste disposal?

Your answer: \_\_\_\_\_

29. Are there any other features that you think would encourage people to reduce, reuse and recycle better?

Your answer: \_\_\_\_\_

30. Is there anything else you like to mention?

Your answer: \_\_\_\_\_

>>>>>>>**The End**<<<<<<<<<<

## APPENDIX IV: INTERVIEW IN STUDY 4

Based on the following questions, please indicate your opinion how *Maqasid al-Shari'ah* can be integrated into application to encourage us to dispose solid waste at home based on the five dimensions of *Maqasid al-Shariah* namely protection of faith, life, intellect, lineage, and wealth.

| Maqasid al-Shariah Dimension                   | Questions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| General                                        | <ol style="list-style-type: none"> <li>1. Did you aware about the waste management and disposal based on <i>Maqasid al shariah</i>? What do you know about this?</li> <li>2. What is your opinion of managing the waste and preserving natural resources according to five fundamental values of <i>Maqasid al-Shari'ah</i> namely preservation of faith, life, intellect, lineage, and wealth?</li> </ol>                                                                                                                                                                                                                                                                           |
| Protection of faith ( <i>Hifz al-din</i> )     | <ol style="list-style-type: none"> <li>3. By preserving the natural resources, human beings are fulfilling the role of Khalifah (man's vicegerency) religiously towards people and the environment. People should be made aware that protecting the environment is indeed an '<i>amanah</i>' (trust) from Allah, and thus should strive to protect it and avoid any behavior that is damaging to the environment. <ol style="list-style-type: none"> <li>1. In your opinion, what do you think the effect of improper waste disposal towards our faith?</li> <li>2. How can we use app to persuade people to dispose waste properly to overcome this problem?</li> </ol> </li> </ol> |
| Protection of life ( <i>Hifz al-nafs</i> )     | <ol style="list-style-type: none"> <li>4. Our safety and health hazard are associated with waste management. People should be made aware that reducing amount of waste is indeed crucial to protect life and body. <ol style="list-style-type: none"> <li>a) In your opinion, what do you think the effect of improper waste disposal towards our Life / Body?</li> <li>b) How can we use app to persuade people to dispose waste properly to overcome this problem?</li> </ol> </li> </ol>                                                                                                                                                                                          |
| Protection of intellect ( <i>Hifz al-aql</i> ) | <ol style="list-style-type: none"> <li>5. In this context, people should feel obliged to learn green practices (reduce, reuse, recycle) that would assist them to make a good judgement (reasoning) in handling municipal solid waste disposal at home. <ol style="list-style-type: none"> <li>a) In your opinion, what do you think the effect of improper waste disposal towards our intellect / reasoning?</li> </ol> </li> </ol>                                                                                                                                                                                                                                                 |



|                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|---------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                         | <p>b) How can we use app to persuade people to dispose waste properly to overcome this problem?</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <p>Protection of lineage<br/>(<i>Hifz al-nasab</i>)</p> | <p>6. Islam pays great attention on societal life through the preservation of lineage. In this context, people should be made aware that by adopting green practices (reduce, reuse, recycle) of waste disposal, we would be able to reduce air and water pollutions and our children (offspring) would be able to grow up in a healthy natural environment</p> <p>a) In your opinion, what do you think the effect of improper waste disposal towards our Lineage /future generation?</p> <p>b) How can we use app to persuade people to dispose waste properly to overcome this problem?</p> |
| <p>Protection of wealth<br/>(<i>Hifz al-Mal</i>)</p>    | <p>7. Islam emphasized on the wise use of natural resources and environment. Thus, any excessive consumption such as food waste is indeed non-Islamic as it leads to detrimental effect to the environment (e.g., opening new area due to insufficient of landfills -which eventually lead to increase of carbon and methane emissions).</p> <p>a) What do you think the effect of improper waste disposal towards our wealth (e.g., moderates our consumption and avoids excesses)?</p> <p>b) How can we use app to persuade people to dispose waste properly to overcome this problem?</p>   |

## APPENDIX V: EXPERT REVIEW (ROUND I) USED IN STUDY 5

|                                      |                                                                                                                                                                                                                                                                                                                       |
|--------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Document No.</b><br><br><b>01</b> | <b>EXPERT REVIEW:</b><br><b>Expert Review on Persuasive Design Framework for Sustainable Waste Management Practices based on Maqasid al-Shariah</b><br><br><i>Expert Demographic &amp; Research Explanation</i><br>Kulliyyah of Information Communication and Technology<br>International Islamic University Malaysia |
|--------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### A) DEMOGRAPHIC

Areas of Expertise

Years of Experience:

### B) RESEARCH WORK EXPLANATION

My name is Zohora Azmin Shompa, a PhD candidate from Kulliyyah of Information and Communication Technology, International Islamic University Malaysia (IIUM). As part of my doctoral study entitled ***Persuasive System Design Framework based on Maqasid al-Shari'ah for Sustainable Waste Management Practices***, you are kindly invited to validate the proposed components of the persuasive design framework.

Looking at your rich background and expertise, I would like to humbly solicit your opinions, suggestions and recommendations to review our persuasive design framework.

#### **Objectives**

The purpose of this study is to conduct an expert review to validate the design framework that we have developed – *A Persuasive Design Framework based on Maqasid al-Shari'ah for Sustainable Waste Management Application (see Document 03: Proposed Persuasive Design Framework: Key Concepts and Definitions)*. This framework had been developed based on relevant persuasive design principles identified in previous user studies that could potentially be effective at persuading people to change their behaviour towards sustainable waste management practices.

In this expert review study, you are required to:

1. To **rate the importance of the persuasive principles** by rating from 1-5.
2. To **give a comment** for each persuasive principle in terms of how important and relevant is the persuasive principle at persuading people towards sustainable waste management practices?

**This booklet contains 45 pages, with 4 sections.** The sections in this booklet are as below:

Document No. 01: Expert Demographic & Research Explanation

Document No. 02: Expert Reviewer Consent Form

Document No. 03 : The Proposed Persuasive Design Framework: Key Concepts and Definitions

Document No. 04 : Expert Review Form

### **Confidentiality**

Your participation will be completely confidential, and you will remain completely anonymous throughout this process. The data gathered within this survey will not be subject to any public disclosure and would be only use as part of a PhD research project.

### **Honorarium**

An honorarium of **RM 100** will be given as an appreciation of your participation as an expert in this study. Upon completion of the survey, kindly provide us your bank account number for payment purposes.

The answers obtained from this expert evaluation will be part of the discussions in the findings. All information shall be used solely for the purpose of this study. The success of this survey greatly depends on your participation. Your cooperation is highly appreciated, as it is beneficial to both academia and society.

Thank you.

**Zohora Azmin Shompa,**

G2020648

Kulliyyah of Information Communication Technology

International Islamic University Malaysia (UIAM)

***Supervisor: Asst. Prof. Dr. Hazwani binti Mohd Mohadis***

***Co-Supervisor: Asst. Prof. Dr. Aznan Zuhid Saidin***

|                                      |                                                                                                                                             |
|--------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Document No.</b><br><br><b>02</b> | <b>EXPERT REVIEWER CONSENT FORM</b><br>Kulliyah of Information Communication Technology<br>International Islamic University Malaysia (UIAM) |
|--------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|

1. With the expertise and the existing knowledge that I have, I volunteer to be an expert reviewer for a study on persuasive design framework for sustainable waste management practices based on *Maqasid al-Shari'ah* conducted by Zohora Azmin Shompa under supervision of Dr. Hazwani Mohd Mohadis, UIAM.
2. I understand that this expert review study is designed to gather information and to get expert opinion, feedback and comments to validate the proposed framework.
3. I understand that no part of the proposed framework may be reproduced, stored in retrieved system, or transmitted in any form or by any means, electronic, mechanical photocopying, recording, or otherwise, without prior permission from the researcher and her supervisors.
4. I understand that the researcher will not identify me by name in any report using information obtained from the questionnaire, and that my confidentiality as a participant in this study will remain secure. Subsequent uses of records and data will be subject to standard data use policies, which protect the anonymity of individuals and institutions.
5. I have read and understood the explanation provided to me. I have had all my questions answered to my satisfactions, and I voluntarily agree to participate in this study.

\_\_\_\_\_  
**Signature Date:**  
**Name and Official Stamp**

|                                      |                                                                                                                                                                                                                                               |
|--------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Document No.</p> <p><b>03</b></p> | <p><b>EXPERT REVIEW</b></p> <p><b>Expert Review on Persuasive Design Framework for Sustainable Waste Management Practices based on Maqasid al-Shariah</b></p> <p><i>Proposed Persuasive Design Framework: Key Concepts and Definition</i></p> |
|--------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### 3.0 DEFINITION OF KEY CONCEPTS

Some of the terms that are used throughout this study are presented, in order to clarify for the readers, the concepts and reduce risk of misunderstandings.

| No | Term                                   | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|----|----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. | Persuasive Technology                  | Persuasive technology is defined as “computerized software or information systems designed to reinforce, change or shape attitudes or behaviors or both without using coercion or deception”. (Oinas-Kukkonen and Harjumaa, 2009)                                                                                                                                                                                                                        |
| 2. | Persuasive Design                      | Persuasive design is an area of design practice that focuses on influencing human behavior through a products or service’s characteristics.                                                                                                                                                                                                                                                                                                              |
| 3. | Sustainable Waste Management Practices | Sustainable Waste Management Practices can be defined as practices that reduce the volume of different types of waste being dumped into landfill sites by reducing, reusing, and recycling (3Rs) and thus have less harmful effects on the environment, human health, or future generations.                                                                                                                                                             |
| 4. | Waste Management Applications          | The waste management applications are designed to encourage users to adapt their waste management behaviors using persuasive technology with the goal to reduce the environmental impact. It can become a valuable tool for government agencies, businesses, citizens, and other stakeholders by integrating this application into the fight for environmental protection, waste prevention, recycling, monitoring and tracking waste pickups, and more. |
| 5. | <i>Maqasid al-Shariah</i>              | According to Imam Al-Ghazālī an eminent Muslim scholar, the definition of <i>Maqasid al-Shari’ah</i> is                                                                                                                                                                                                                                                                                                                                                  |

|  |  |                                                                                                                                                                                                                                                                                                                          |
|--|--|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  |  | <p><i>“The objective of the Shariah is to promote the well-being of all mankind, which lies in safeguarding their faith, their human self, their intellect, their posterity and their wealth. Whatever ensures the safeguard of these five serves public interest and is desirable” (Yaakub and Abdullah, 2020).</i></p> |
|--|--|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### 3.1 RESEARCH BACKGROUND

Achieving sustainable waste management practices in Malaysia is very challenging as our citizens are generally not actively recycling, reusing, or reducing their household waste. Tremendous campaigns and efforts have been done to get communities to participate in sustainable waste management practices. However, none of those efforts has been successful due to the wrong attitude, and lack of awareness on the purpose of recycle, reduce, and reuse of waste towards sustainable waste management and environmental protection (Zainu and Songip, 2017; Yoke et al., 2019).

Meanwhile, there are many waste management applications developed to address inappropriate waste disposal behavior. However, a major limitation of these existing applications is the lack of spiritual and religious values that could guide human behavior.

As Muslims’ attitudes and behaviors are largely influenced by religious values, this study explores new ways to persuade the Muslim community in Malaysia to improve their waste management behaviors by integrating *Maqasid al-Shari’ah* components into the design of a smartphone application aiming for sustainable waste management practices.

### 3.2 PROPOSED PERSUASIVE DESIGN FRAMEWORK FOR WASTE MANAGEMENT PRACTICES BASED ON MAQASID AL-SHARIAH

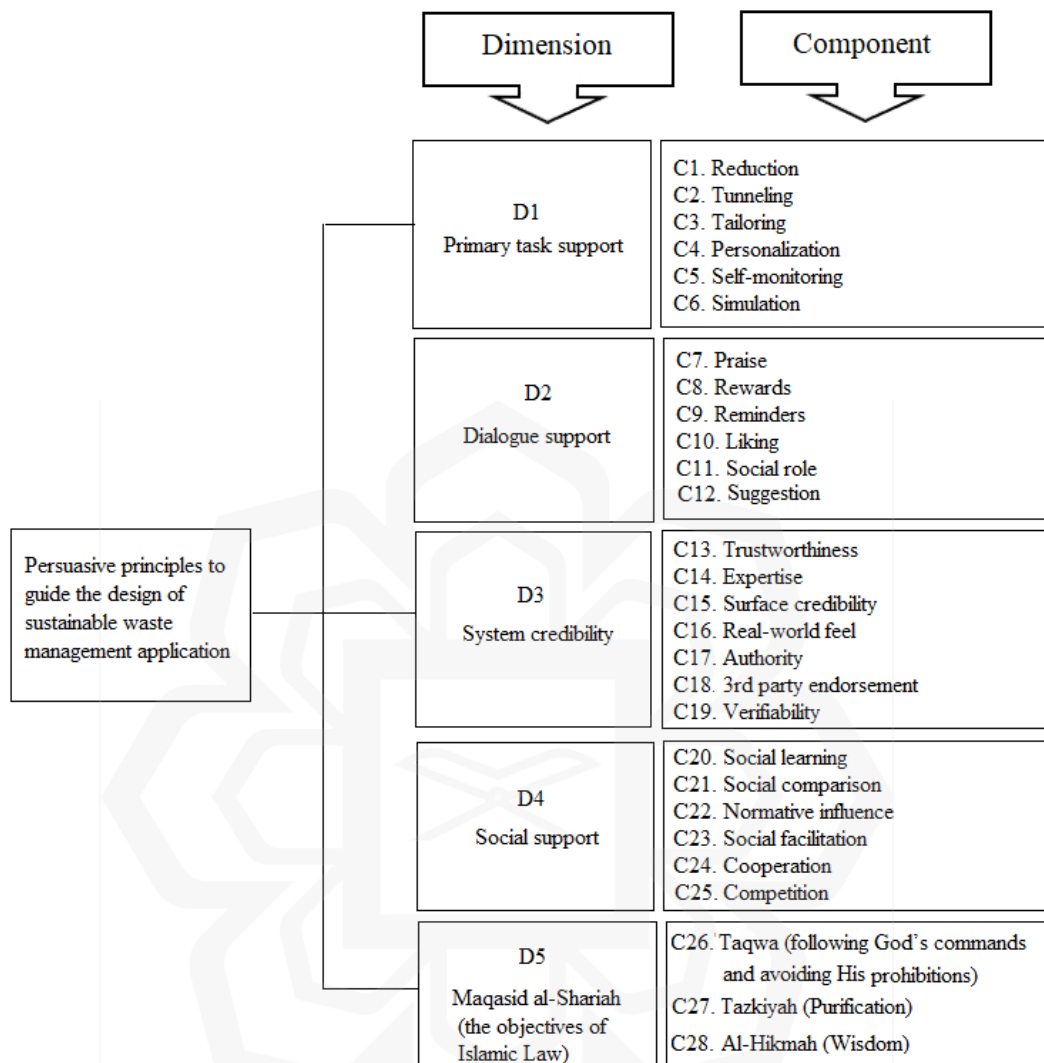


Figure 1: Proposed Persuasive Design Framework for Waste Management Practices based on *Maqasid al-Shariah*

Based on Figure 1, there are a total of 28 persuasive design principles, categorized into five (5) dimensions. The description of each dimension is summarized in the following Table 1.

Table 1: Description of each dimension

| Dimension                      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Adapted from                      |
|--------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|
| D1: Primary Task Support       | Primary task support strategies (PTS) include design principles for assisting individuals and groups in carrying out their main activities. The design principles in this category are reduction, tunneling, tailoring, personalization, self-monitoring, simulation, and rehearsal.                                                                                                                                                                                                                                                                           | Oinas-Kukkonen and Harjumaa, 2009 |
| D2: Dialogue Support           | The dialogue support category focuses on assisting the user by offering some level of feedback that could boost the user's motivation to carry out their intended behavior. They include praise, rewards, reminders, suggestion, similarity, liking, and social role.                                                                                                                                                                                                                                                                                          | Oinas-Kukkonen and Harjumaa, 2009 |
| D3: System Credibility Support | The system credibility support category includes principles that increase the system's credibility and persuasiveness. The category of system credibility consists of trustworthiness, expertise, surface credibility, real-world feel, authority, third-party endorsements, and verifiability.                                                                                                                                                                                                                                                                | Oinas-Kukkonen and Harjumaa, 2009 |
| D4: Social Support             | The social support design principles have a significant impact on the user's interpersonal relationships with others (family, friends, and coworkers), which boosts the user's motivation and confidence to engage in social activities. The design principles that belong into this category are social facilitation, social comparison, normative influence, social learning, cooperation, competition, and recognition.                                                                                                                                     | Oinas-Kukkonen and Harjumaa, 2009 |
| D5: Maqasid Al-Shariah         | <p>The roles of the <i>Maqasid al-Shari'ah</i> in waste disposal are as follows:</p> <p><b>1. Protection of faith/belief (al-Din):</b></p> <p>The preservation of faith lead people to embrace the greatness of Allah thus directing him to perform the role as 'khalifah' (man's viceregency) responsibly, not only to other human being but also to the environment. People should be made aware that protecting the environment is indeed an 'amanah' (trust) from Allah, and thus should strive to protect it and avoid any behaviour that is damaging</p> |                                   |



|  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |
|--|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
|  | <p>to the environment (Samori et al., 2017). Protecting the environment is the same as observing religion (hifddiin), as this is stated in the Qur'an:</p> <p><i>“And do not cause corruption in the earth, when it has been set in order.” (Surah Al-A'raf:56)</i></p> <p><b>2. Protection of life/body (al-Nafs):</b><br/>The accumulation of large amount of waste at landfills increase the carbon and methane emissions that are hazardous human health. Thus, people should be made aware that reducing amount of waste is indeed crucial to protect life and body.</p> <p><b>3. Protection of intellect/reasoning (al-Aql):</b> Preservation of intellect paves the way for people to acquire intellectual skills and knowledge and to be able to appraise right and wrong (Sarkawi et. al., 2015). In the context of waste management, people should feel obliged to learn green practices (reduce, reuse, recycle) that would assist them to make a good judgement (reasoning) in handling municipal solid waste disposal at hpamee pamesome.am pays great attention on societal life through the preservation of lineage. In this context, people should be made aware that by adopting green practices (reduce, reuse, recycle) of waste disposal, we would be able to reduce air and water pollution and our children (offspring) would be able to grow up in a healthy natural environment.</p> <p><b>5. Protection of wealth (al-Maal):</b><br/>Islam strongly emphasized the wise use of natural resources and forbids extravagant behavior and excessive consumption (e.g., wasting food). The Quran has ordered in Surah Al-Araf verse 31:</p> |  |
|--|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|

|  |                                                                                                        |  |
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|  | <i>“Eat and drink: But waste not by excess, for Allah loveth not the wasters.” (Surah al-Araf: 31)</i> |  |
|--|--------------------------------------------------------------------------------------------------------|--|

There are six (6) persuasive principles in primary task support category, six (6) persuasive principles in dialogue support category, seven (7) persuasive principles in system credibility support category, six (6) persuasive principles in social support category and three (3) persuasive concepts were derived from *Maqasid al-Shariah*. The following Table 2 summarized the definition of each persuasive principles.

Table 2: Definition of persuasive principles

| <b>Persuasive Principles</b>    | <b>Definition</b>                                                                                                                                                                      | <b>Adapted From</b>               |
|---------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|
| <i>D1: Primary Task Support</i> |                                                                                                                                                                                        |                                   |
| Reduction                       | A system that reduces complex behavior into simple tasks helps users perform the target behavior, and it may increase the benefit/cost ratio of a behavior.                            | Oinas-Kukkonen and Harjumaa, 2009 |
| Tunneling                       | Using the system to guide users through a process or experience provides opportunities to persuade along the way.                                                                      | Oinas-Kukkonen and Harjumaa, 2009 |
| Tailoring                       | Information provided by the system will be more persuasive if it is tailored to the potential needs, interests, personality, usage context, or other factors relevant to a user group. | Oinas-Kukkonen and Harjumaa, 2009 |
| Personalization                 | A system that offers personalized content or services have a greater capability for persuasion.                                                                                        | Oinas-Kukkonen and Harjumaa, 2009 |
| Self-monitoring                 | A system that keeps track of one's own performance or status supports the user in achieving goals.                                                                                     | Oinas-Kukkonen and Harjumaa, 2009 |
| Simulation                      | Systems that provide simulations can persuade by enabling users to observe immediately the link between cause and effect.                                                              | Oinas-Kukkonen and Harjumaa, 2009 |
| <i>D2: Dialogue Support</i>     |                                                                                                                                                                                        |                                   |
| Praise                          | By offering praise, a system can make users more open to                                                                                                                               | Oinas-Kukkonen and                |

|                                       |                                                                                                                      |                                   |
|---------------------------------------|----------------------------------------------------------------------------------------------------------------------|-----------------------------------|
|                                       | persuasion.                                                                                                          | Harjumaa, 2009                    |
| Rewards                               | Systems that reward target behaviors may have great persuasive powers.                                               | Oinas-Kukkonen and Harjumaa, 2009 |
| Reminder                              | If a system reminds users of their target behavior, the users will more likely to achieve their goals.               | Oinas-Kukkonen and Harjumaa, 2009 |
| Suggestion                            | Systems offering fitting suggestions will have greater persuasive powers.                                            | Oinas-Kukkonen and Harjumaa, 2009 |
| Liking                                | A system that is visually attractive for its users is likely to be more persuasive.                                  | Oinas-Kukkonen and Harjumaa, 2009 |
| Social role                           | If a system adopts a social role, users will more likely use it for persuasive purposes.                             | Oinas-Kukkonen and Harjumaa, 2009 |
| <i>D3: System Credibility Support</i> |                                                                                                                      |                                   |
| Trustworthiness                       | A system that is viewed as trustworthy will have increased powers of persuasion.                                     | Oinas-Kukkonen and Harjumaa, 2009 |
| Expertise                             | A system that is viewed as incorporating expertise will have increased powers of persuasion.                         | Oinas-Kukkonen and Harjumaa, 2009 |
| Surface credibility                   | People make initial assessments of the system credibility based on a firsthand inspection.                           | Oinas-Kukkonen and Harjumaa, 2009 |
| Real-world feel                       | A system that highlights people or organization behind its content or services will have more credibility.           | Oinas-Kukkonen and Harjumaa, 2009 |
| Authority                             | A system that leverages roles of authority will have enhanced powers of persuasion.                                  | Oinas-Kukkonen and Harjumaa, 2009 |
| Third-party endorsements              | Third-party endorsements, especially from well-known and respected sources, boost perceptions on system credibility. | Oinas-Kukkonen and Harjumaa, 2009 |
| Verifiability                         | Credibility perceptions will be enhanced if a system makes                                                           | Oinas-Kukkonen and                |

|                                                                |                                                                                                                                                                                                                                                                                                                                                                                                              |                                    |
|----------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|
|                                                                | it easy to verify the accuracy of site content via outside sources.                                                                                                                                                                                                                                                                                                                                          | Harjumaa, 2009                     |
| <i>D4: Social Support</i>                                      |                                                                                                                                                                                                                                                                                                                                                                                                              |                                    |
| Social learning                                                | A person will be more motivated to perform a target behavior if (s)he can use a system to observe others performing the behavior.                                                                                                                                                                                                                                                                            | Oinas-Kukkonen and Harjumaa, 2009  |
| Social comparison                                              | System users will have a greater motivation to perform the target behavior if they can compare their performance with the performance of others.                                                                                                                                                                                                                                                             | Oinas-Kukkonen and Harjumaa, 2009  |
| Normative influence                                            | A system can leverage normative influence or peer pressure to increase the likelihood that a person will adopt a target behavior.                                                                                                                                                                                                                                                                            | Oinas-Kukkonen and Harjumaa, 2009  |
| Social facilitation                                            | System users are more likely to perform target behavior if they discern via the system that others are performing the behavior along with them.                                                                                                                                                                                                                                                              | Oinas-Kukkonen and Harjumaa, 2009  |
| Cooperation                                                    | The app motivates users to adopt a target attitude or behavior by leveraging human beings' natural drive to co-operate.                                                                                                                                                                                                                                                                                      | Oinas-Kukkonen and Harjumaa, 2009  |
| Competition                                                    | A system can motivate users to adopt a target attitude or behavior by leveraging human beings' natural drive to compete.                                                                                                                                                                                                                                                                                     | Oinas-Kukkonen and Harjumaa, 2009  |
| <i>D5: Maqasid al-Shariah</i>                                  |                                                                                                                                                                                                                                                                                                                                                                                                              |                                    |
| Taqwa (following God's commands and avoiding His prohibitions) | <p><i>Taqwa</i> is an Islamic term for being conscious and cognizant of God, of truth, piety, fear of God. <i>Taqwa</i> is defined as traits of righteousness or good deeds, which traits Allah SWT commands a believer to have Sidek et al., (2017). Allah said in Quran</p> <p><i>"Those who believe and do good deeds will go to Heaven, where they will remain eternally."</i> [surah al-Baqarah:82]</p> | Sidek et al., (2017)               |
| Tazkiyah (Purification)                                        | The word Tazkiyah (Arabic: تزكية) is an Arabic-Islamic term referring to "tazkiyat al-nafs" meaning "sanctification" or "purification of the self" as the purification of the heart and soul. According to Mohamad, Osman, and Mokhtar (2020) tazkiyah means growth, increase, germination, development,                                                                                                     | Mohamad, Osman, and Mokhtar (2020) |

|                    |                                                                                                                                                                                                                                                                                                                              |                          |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
|                    | formation, upgrade, repair, cleaning, and purification.                                                                                                                                                                                                                                                                      |                          |
| Al-Hikmah (Wisdom) | Wisdom is a result of the highest virtue in acquiring knowledge. In the Quran, hikmah is referred to as الحكيم (all-wise) (Quran 45, al-Jazziyah, ayat 37). It is the All-Wise or Al-Hakim (Allah) who enables mankind to gain wisdom from various events and encounters (al-hikmah) in different facets and phases of life. | (Ismail and Sarif, 2021) |

Examples of how these persuasive design principles were applied into the design of persuasive application aiming to persuade people towards sustainable waste management practices are provided in Document 04: Expert Review Form.

#### REFERENCES:

1. Sidek, H. M., Ismail, S., Said, N. S. M., Behak, F. P., Baharun, H., Ramli, S., ... & Ali, S. M. (2017). An analysis of taqwa in the Holy Quran: Surah al-Baqarah. *International E-Journal of Advances in Social Sciences*, 3(8), 401-406.
2. Mohamad, A. D., Osman, K. H. A. Z. R. I., & Mokhtar, A. I. (2020). Spirituality in maqasid for the empowerment of human well-being. *International Journal of Business and Social Science*, 11(10)
3. Ismail, Y., & Sarif, S. M. (2021, December). BUSINESS HIKMAH (WISDOM) IN MANAGING SOCIAL ENTERPRISES. In *International Conference on Change the World with Sejahtera Sustainability* (Vol. 29, p. 30)
4. Yaakub, S., & Abdullah, N. A. H. N. (2020). Towards Maqasid Shariah In Sustaining The Environment Through Impactful Strategies. *International Journal of Islamic Business*, 5(1), 36-45.
5. Samori, Z., Khairudin, Z., Saedon, R., Anas, N., & Harun, H. M. F. (2017). Sustainable waste management via incineration system: an Islamic outlook for conservation of the environment. *Journal of Fundamental and Applied Sciences*, 9(6S), 538-557
6. Oinas-Kukkonen, H., & Harjumaa, M. (2009). Persuasive systems design: Key issues, process model, and system features. *Communications of the Association for Information Systems*, 24(1), 28.

|                                      |                                                                                                                                                                                                                                                               |
|--------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Document No.</b><br><br><b>04</b> | <b>EXPERT REVIEW</b><br><b>Expert Review on Persuasive Design Framework for Sustainable Waste Management Application</b><br><br><b>Expert Review Form</b><br>Kuliyah of Information Communication and Technology<br>International Islamic University Malaysia |
|--------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

**PART A: REVIEW ON PERSUASIVE DESIGN PRINCIPLES FOR SUSTAINABLE WASTE MANAGEMENT APPLICATION**

**Instruction for Expert**

Based on the following scale, please provide your judgments that reflect your expert opinion about how important is the persuasive principle to be integrated into the design of application aiming to persuade people towards sustainable waste management practices.

|                  |             |                      |           |                |
|------------------|-------------|----------------------|-----------|----------------|
| <b>1</b>         | <b>2</b>    | <b>3</b>             | <b>4</b>  | <b>5</b>       |
| Very Unimportant | Unimportant | Moderately Important | Important | Very Important |

| No | Persuasive Principle | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Scale                                                                                                                                                                         |   |   |   |   |
|----|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|
|    |                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 1                                                                                                                                                                             | 2 | 3 | 4 | 5 |
| 1. | <b>Reduction</b>     | <b>Reduction principle:</b> A system that reduces complex behavior into simple tasks helps users perform the target behavior, and it may increase the benefit/cost ratio of a behavior.<br><br><b>Example:</b> The application displays a color-coding calendar for a garbage collection schedule making it easier for people to know specific day/date for specific type of waste collection (e.g., Thursday, for recyclable waste, Tuesday for burnable garbage). | <b>Comments</b>                                                                                                                                                               |   |   |   |   |
|    |                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | In your opinion, how <b>important and relevant</b> is this persuasive principle to persuade people towards sustainable waste management practices?<br>_____<br>_____<br>_____ |   |   |   |   |
| 2. | <b>Tunneling</b>     | <b>Tunneling Principle:</b> Using the system to guide users through a process or experience provides                                                                                                                                                                                                                                                                                                                                                                | 1                                                                                                                                                                             | 2 | 3 | 4 | 5 |
|    |                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Comments</b>                                                                                                                                                               |   |   |   |   |

|                                                                                                                                                                                                  |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                    |   |   |   |   |   |                 |  |  |  |  |                                                                                                                                                                                                  |  |  |  |  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|---|-----------------|--|--|--|--|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--|--|--|
|                                                                                                                                                                                                  |                        | <p>opportunities to persuade along the way.</p> <p><b>Example:</b> The application provides step-by-step instructions on how to reuse and recycle waste.</p>                                                                                                                                                                                                                                                                             | <p>In your opinion, how <b>important and relevant</b> is this persuasive principle to persuade people towards sustainable waste management practices?</p> <p>_____</p> <p>_____</p> <p>_____</p>                                                                                                                                                   |   |   |   |   |   |                 |  |  |  |  |                                                                                                                                                                                                  |  |  |  |  |
| 3.                                                                                                                                                                                               | <b>Tailoring</b>       | <p><b>Tailoring principle:</b><br/>Information provided by the system will be more persuasive if it is tailored to the potential needs, interests, personality, usage context, or other factors relevant to a user group.</p> <p><b>Example:</b><br/>The application provides information about garbage and recycling items collection schedules based on user home address.</p>                                                         | <table><tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td colspan="5"><b>Comments</b></td></tr><tr><td colspan="5"><p>In your opinion, how <b>important and relevant</b> is this persuasive principle to persuade people towards sustainable waste management practices?</p><p>_____</p><p>_____</p><p>_____</p></td></tr></table> | 1 | 2 | 3 | 4 | 5 | <b>Comments</b> |  |  |  |  | <p>In your opinion, how <b>important and relevant</b> is this persuasive principle to persuade people towards sustainable waste management practices?</p> <p>_____</p> <p>_____</p> <p>_____</p> |  |  |  |  |
| 1                                                                                                                                                                                                | 2                      | 3                                                                                                                                                                                                                                                                                                                                                                                                                                        | 4                                                                                                                                                                                                                                                                                                                                                  | 5 |   |   |   |   |                 |  |  |  |  |                                                                                                                                                                                                  |  |  |  |  |
| <b>Comments</b>                                                                                                                                                                                  |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                    |   |   |   |   |   |                 |  |  |  |  |                                                                                                                                                                                                  |  |  |  |  |
| <p>In your opinion, how <b>important and relevant</b> is this persuasive principle to persuade people towards sustainable waste management practices?</p> <p>_____</p> <p>_____</p> <p>_____</p> |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                    |   |   |   |   |   |                 |  |  |  |  |                                                                                                                                                                                                  |  |  |  |  |
| 4.                                                                                                                                                                                               | <b>Personalization</b> | <p><b>Personalization principle:</b><br/>A system that offers personalized content or services have a greater capability for persuasion.</p> <p><b>Example:</b><br/>The application offers personalized users’ preferred languages, personalized reminders, and time and date for waste disposal. The user profile could be personalized with personal photos, addresses, and waste payment collection options for recyclable waste.</p> | <table><tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td colspan="5"><b>Comments</b></td></tr><tr><td colspan="5"><p>In your opinion, how important and relevant is this persuasive principle to persuade people towards sustainable waste management practices?</p><p>_____</p><p>_____</p><p>_____</p></td></tr></table>        | 1 | 2 | 3 | 4 | 5 | <b>Comments</b> |  |  |  |  | <p>In your opinion, how important and relevant is this persuasive principle to persuade people towards sustainable waste management practices?</p> <p>_____</p> <p>_____</p> <p>_____</p>        |  |  |  |  |
| 1                                                                                                                                                                                                | 2                      | 3                                                                                                                                                                                                                                                                                                                                                                                                                                        | 4                                                                                                                                                                                                                                                                                                                                                  | 5 |   |   |   |   |                 |  |  |  |  |                                                                                                                                                                                                  |  |  |  |  |
| <b>Comments</b>                                                                                                                                                                                  |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                    |   |   |   |   |   |                 |  |  |  |  |                                                                                                                                                                                                  |  |  |  |  |
| <p>In your opinion, how important and relevant is this persuasive principle to persuade people towards sustainable waste management practices?</p> <p>_____</p> <p>_____</p> <p>_____</p>        |                        |                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                    |   |   |   |   |   |                 |  |  |  |  |                                                                                                                                                                                                  |  |  |  |  |

|    |                        |                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                    |   |   |   |   |
|----|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|
| 5. | <b>Self-monitoring</b> | <b>Self-monitoring principle:</b><br>A system that keeps track of one's own performance or status supports the user in achieving goals.<br><br><b>Example:</b><br>The application shows different types of waste produced for each day, weekly and monthly.                                                                                                                                                  | 1                                                                                                                                                  | 2 | 3 | 4 | 5 |
|    |                        |                                                                                                                                                                                                                                                                                                                                                                                                              | <b>Comments</b>                                                                                                                                    |   |   |   |   |
|    |                        |                                                                                                                                                                                                                                                                                                                                                                                                              | In your opinion, how <b>important and relevant</b> is this persuasive principle to persuade people towards sustainable waste management practices? |   |   |   |   |
|    |                        |                                                                                                                                                                                                                                                                                                                                                                                                              | <hr/> <hr/> <hr/>                                                                                                                                  |   |   |   |   |
| 6. | <b>Simulation</b>      | <b>Simulation principle:</b><br>Systems that provide simulations can persuade by enabling users to observe immediately the link between cause and effect.<br><br><b>Example:</b><br>The application shows the impacts of waste being recycled on the environment. In this example, the application informs that the user has created 57 new plastic products by recycling 4% of the plastic waste generated. | 1                                                                                                                                                  | 2 | 3 | 4 | 5 |
|    |                        |                                                                                                                                                                                                                                                                                                                                                                                                              | <b>Comments</b>                                                                                                                                    |   |   |   |   |
|    |                        |                                                                                                                                                                                                                                                                                                                                                                                                              | In your opinion, how <b>important and relevant</b> is this persuasive principle to persuade people towards sustainable waste management practices? |   |   |   |   |
|    |                        |                                                                                                                                                                                                                                                                                                                                                                                                              | <hr/> <hr/> <hr/>                                                                                                                                  |   |   |   |   |
| 7. | <b>Praise</b>          | <b>Praise principle:</b><br>By offering praise, a system can make users more open to persuasion.<br><br><b>Example:</b><br>The application praises and congratulates me for completing a level of recycling and disposing of waste.                                                                                                                                                                          | 1                                                                                                                                                  | 2 | 3 | 4 | 5 |
|    |                        |                                                                                                                                                                                                                                                                                                                                                                                                              | <b>Comments</b>                                                                                                                                    |   |   |   |   |
|    |                        |                                                                                                                                                                                                                                                                                                                                                                                                              | In your opinion, how <b>important and relevant</b> is this persuasive principle to persuade people towards sustainable waste management practices? |   |   |   |   |
|    |                        |                                                                                                                                                                                                                                                                                                                                                                                                              | <hr/> <hr/> <hr/>                                                                                                                                  |   |   |   |   |



|     |                   |                                                                                                                                                                                                                                                                                                                               |                                                                                                                                             |   |   |   |   |
|-----|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|
| 8.  | <b>Rewards</b>    | <b>Rewards principle:</b><br>Systems that reward target behaviors may have great persuasive powers.<br><br><b>Example:</b><br>The application offering rewards point or coin after completing a certain level of recycling.                                                                                                   | 1                                                                                                                                           | 2 | 3 | 4 | 5 |
|     |                   |                                                                                                                                                                                                                                                                                                                               | <b>Comments</b>                                                                                                                             |   |   |   |   |
|     |                   |                                                                                                                                                                                                                                                                                                                               | In your opinion, how important and relevant is this persuasive principle to persuade people towards sustainable waste management practices? |   |   |   |   |
|     |                   |                                                                                                                                                                                                                                                                                                                               |                                                                                                                                             |   |   |   |   |
|     |                   |                                                                                                                                                                                                                                                                                                                               |                                                                                                                                             |   |   |   |   |
| 9.  | <b>Reminder</b>   | <b>Reminder principle:</b><br>If a system reminds users of their target behavior, the users will more likely achieve their goals.<br><br><b>Example:</b> The app notifies and reminds users about their task to dispose of garbage, and waste collection schedule. For example, the day /date for recycling item collection.  | 1                                                                                                                                           | 2 | 3 | 4 | 5 |
|     |                   |                                                                                                                                                                                                                                                                                                                               | <b>Comments</b>                                                                                                                             |   |   |   |   |
|     |                   |                                                                                                                                                                                                                                                                                                                               | In your opinion, how important and relevant is this persuasive principle to persuade people towards sustainable waste management practices? |   |   |   |   |
|     |                   |                                                                                                                                                                                                                                                                                                                               |                                                                                                                                             |   |   |   |   |
|     |                   |                                                                                                                                                                                                                                                                                                                               |                                                                                                                                             |   |   |   |   |
| 10. | <b>Suggestion</b> | <b>Suggestion principle:</b><br>Systems offering fitting suggestions will have greater persuasive powers.<br><br><b>Example:</b><br>An app that provides suggestions on alternative ways of reducing waste. (e.g., reusing plastic bags when shopping, reusing boxes for storage etc., making an art/craft from old clothes.) | 1                                                                                                                                           | 2 | 3 | 4 | 5 |
|     |                   |                                                                                                                                                                                                                                                                                                                               | <b>Comments</b>                                                                                                                             |   |   |   |   |
|     |                   |                                                                                                                                                                                                                                                                                                                               | In your opinion, how important and relevant is this persuasive principle to persuade people towards sustainable waste management practices? |   |   |   |   |
|     |                   |                                                                                                                                                                                                                                                                                                                               |                                                                                                                                             |   |   |   |   |
|     |                   |                                                                                                                                                                                                                                                                                                                               |                                                                                                                                             |   |   |   |   |

|     |                        |                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                             |   |   |   |   |
|-----|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|
| 11. | <b>Liking</b>          | <b>Liking principle:</b><br>A system that is visually attractive for its users is likely to be more persuasive.<br><br><b>Example:</b><br>The app presents information for recycling activities that are visually appealing to the user.                                                                                                                  | 1                                                                                                                                           | 2 | 3 | 4 | 5 |
|     |                        |                                                                                                                                                                                                                                                                                                                                                           | <b>Comments</b>                                                                                                                             |   |   |   |   |
|     |                        |                                                                                                                                                                                                                                                                                                                                                           | In your opinion, how important and relevant is this persuasive principle to persuade people towards sustainable waste management practices? |   |   |   |   |
|     |                        |                                                                                                                                                                                                                                                                                                                                                           | <hr/> <hr/> <hr/>                                                                                                                           |   |   |   |   |
| 12. | <b>Social role</b>     | <b>Social role Principle:</b><br>If a system adopts a social role, users will more likely use it for persuasive purposes.<br><br><b>Example:</b> Having a respected and prominent person as ambassador or role model (e.g., social influencers, politician, celebrity) that practices sustainable lifestyle, and adopt green practices of waste disposal. | 1                                                                                                                                           | 2 | 3 | 4 | 5 |
|     |                        |                                                                                                                                                                                                                                                                                                                                                           | <b>Comments</b>                                                                                                                             |   |   |   |   |
|     |                        |                                                                                                                                                                                                                                                                                                                                                           | In your opinion, how important and relevant is this persuasive principle to persuade people towards sustainable waste management practices? |   |   |   |   |
|     |                        |                                                                                                                                                                                                                                                                                                                                                           | <hr/> <hr/> <hr/>                                                                                                                           |   |   |   |   |
| 13. | <b>Trustworthiness</b> | <b>Trustworthiness Principle:</b><br>A system that is viewed as trustworthy will have increased powers of persuasion.<br><br><b>Example:</b><br>An app that provides truthful, reasonable, and unbiased information about waste management practices (e.g., composting).                                                                                  | 1                                                                                                                                           | 2 | 3 | 4 | 5 |
|     |                        |                                                                                                                                                                                                                                                                                                                                                           | <b>Comments</b>                                                                                                                             |   |   |   |   |
|     |                        |                                                                                                                                                                                                                                                                                                                                                           | In your opinion, how important and relevant is this persuasive principle to persuade people towards sustainable waste management practices? |   |   |   |   |
|     |                        |                                                                                                                                                                                                                                                                                                                                                           | <hr/> <hr/> <hr/>                                                                                                                           |   |   |   |   |

|     |                            |                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                             |   |   |   |   |
|-----|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|
| 14. | <b>Expertise</b>           | <b>Expertise Principle:</b><br>A system that is viewed as incorporating expertise will have increased powers of persuasion.<br><br><b>Example:</b><br>The app provides the platform for seeking experts to get advice about waste management practices.                                                                                                                  | 1                                                                                                                                           | 2 | 3 | 4 | 5 |
|     |                            |                                                                                                                                                                                                                                                                                                                                                                          | <b>Comments</b>                                                                                                                             |   |   |   |   |
|     |                            |                                                                                                                                                                                                                                                                                                                                                                          | In your opinion, how important and relevant is this persuasive principle to persuade people towards sustainable waste management practices? |   |   |   |   |
|     |                            |                                                                                                                                                                                                                                                                                                                                                                          | <hr/> <hr/>                                                                                                                                 |   |   |   |   |
| 15. | <b>Surface credibility</b> | <b>Surface credibility Principle:</b><br>People make initial assessments of the system credibility based on a firsthand inspection.<br><br><b>Example:</b> The user interfaces (UIs) of the application have a competent look and feel (e.g., the app responds to the feedback and email, does not overdo mobile advertising, and sends appropriate push notifications.) | 1                                                                                                                                           | 2 | 3 | 4 | 5 |
|     |                            |                                                                                                                                                                                                                                                                                                                                                                          | <b>Comments</b>                                                                                                                             |   |   |   |   |
|     |                            |                                                                                                                                                                                                                                                                                                                                                                          | In your opinion, how important and relevant is this persuasive principle to persuade people towards sustainable waste management practices? |   |   |   |   |
|     |                            |                                                                                                                                                                                                                                                                                                                                                                          | <hr/> <hr/>                                                                                                                                 |   |   |   |   |
| 16. | <b>Real-world feel</b>     | <b>Real-world feel principle:</b><br>A system that highlights people or organizations behind its content or services will have more credibility.<br><br><b>Example:</b><br>The application identifies the people behind the <i>i-Clean Selangor</i> app.                                                                                                                 | 1                                                                                                                                           | 2 | 3 | 4 | 5 |
|     |                            |                                                                                                                                                                                                                                                                                                                                                                          | <b>Comments</b>                                                                                                                             |   |   |   |   |
|     |                            |                                                                                                                                                                                                                                                                                                                                                                          | In your opinion, how important and relevant is this persuasive principle to persuade people towards sustainable waste management practices? |   |   |   |   |
|     |                            |                                                                                                                                                                                                                                                                                                                                                                          | <hr/> <hr/>                                                                                                                                 |   |   |   |   |

|     |                                |                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                             |   |   |   |   |
|-----|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|
| 17. | <b>Authority</b>               | <b>Authority principle:</b><br><br>A system that leverages roles of authority will have enhanced powers of persuasion.<br><br><b>Example:</b> Facilitate residents to submit waste collection and public cleansing complaints to Waste Management authority.                                                                                                                    | 1                                                                                                                                           | 2 | 3 | 4 | 5 |
|     |                                |                                                                                                                                                                                                                                                                                                                                                                                 | <b>Comments</b>                                                                                                                             |   |   |   |   |
|     |                                |                                                                                                                                                                                                                                                                                                                                                                                 | In your opinion, how important and relevant is this persuasive principle to persuade people towards sustainable waste management practices? |   |   |   |   |
|     |                                |                                                                                                                                                                                                                                                                                                                                                                                 | <hr/> <hr/> <hr/>                                                                                                                           |   |   |   |   |
| 18. | <b>Third-party Endorsement</b> | <b>Third-party endorsements Principle:</b><br><br>Third-party endorsements, especially from well-known and respected sources, boost perceptions on system credibility.<br><br><b>Example:</b> The use of the application was encouraged and endorsed by the ministry/government (any well-known respected sources).                                                             | 1                                                                                                                                           | 2 | 3 | 4 | 5 |
|     |                                |                                                                                                                                                                                                                                                                                                                                                                                 | <b>Comments</b>                                                                                                                             |   |   |   |   |
|     |                                |                                                                                                                                                                                                                                                                                                                                                                                 | In your opinion, how important and relevant is this persuasive principle to persuade people towards sustainable waste management practices? |   |   |   |   |
|     |                                |                                                                                                                                                                                                                                                                                                                                                                                 | <hr/> <hr/> <hr/>                                                                                                                           |   |   |   |   |
| 19. | <b>Verifiability</b>           | <b>Verifiability Principle:</b><br><br>Credibility perceptions will be enhanced if a system makes it easy to verify the accuracy of site content via outside sources.<br><br><b>Example:</b> The application provides the name of waste management organization (e.g. KDEB Waste Management Sdn. Bhd.), a link to their website and contact information to verify the accuracy. | 1                                                                                                                                           | 2 | 3 | 4 | 5 |
|     |                                |                                                                                                                                                                                                                                                                                                                                                                                 | <b>Comments</b>                                                                                                                             |   |   |   |   |
|     |                                |                                                                                                                                                                                                                                                                                                                                                                                 | In your opinion, how important and relevant is this persuasive principle to persuade people towards sustainable waste management practices? |   |   |   |   |
|     |                                |                                                                                                                                                                                                                                                                                                                                                                                 | <hr/> <hr/> <hr/>                                                                                                                           |   |   |   |   |

|     |                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                             |   |   |   |   |
|-----|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|
| 20. | <b>Social learning</b>     | <b>Social learning Principle:</b><br>A person will be more motivated to perform a target behavior if (s)he can use a system to observe others performing the behavior.<br><br><b>Example:</b> The application provides an opportunity for me to learn about recycling behavior from other people.                                                                                                                                                 | 1                                                                                                                                           | 2 | 3 | 4 | 5 |
|     |                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>Comments</b>                                                                                                                             |   |   |   |   |
|     |                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                   | In your opinion, how important and relevant is this persuasive principle to persuade people towards sustainable waste management practices? |   |   |   |   |
|     |                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                   | _____                                                                                                                                       |   |   |   |   |
|     |                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                   | _____                                                                                                                                       |   |   |   |   |
| 21. | <b>Social comparison</b>   | <b>Social comparison Principle:</b><br>System users will have a greater motivation to perform the target behavior if they can compare their performance with the performance of others.<br><br><b>Example:</b> The application provides an opportunity for me to compare my recycling performance with other. (See how other people reusing, reducing and recycling waste.)                                                                       | 1                                                                                                                                           | 2 | 3 | 4 | 5 |
|     |                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>Comments</b>                                                                                                                             |   |   |   |   |
|     |                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                   | In your opinion, how important and relevant is this persuasive principle to persuade people towards sustainable waste management practices? |   |   |   |   |
|     |                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                   | _____                                                                                                                                       |   |   |   |   |
|     |                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                   | _____                                                                                                                                       |   |   |   |   |
| 22. | <b>Normative influence</b> | <b>Normative influence Principle:</b><br>A system can leverage normative influence or peer pressure to increase the likelihood that a person will adopt a target behavior.<br><br><b>Example:</b> <i>Recycle Mate</i> , an Australia's first community-driven recycling app provides a live national platform that allows governments, recyclers, and the whole community to all work together to gather, share and update recycling information. | 1                                                                                                                                           | 2 | 3 | 4 | 5 |
|     |                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>Comments</b>                                                                                                                             |   |   |   |   |
|     |                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                   | In your opinion, how important and relevant is this persuasive principle to persuade people towards sustainable waste management practices? |   |   |   |   |
|     |                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                   | _____                                                                                                                                       |   |   |   |   |
|     |                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                   | _____                                                                                                                                       |   |   |   |   |

|     |                            |                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                             |   |   |   |   |
|-----|----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|
| 23. | <b>Social facilitation</b> | <b>Social facilitation Principle:</b><br>System users are more likely to perform target behavior if they discern via the system that others are performing the behavior along with them.<br><br><b>Example:</b> The application allows me to recycle better when I feel others are recycling with me.                                                    | 1                                                                                                                                           | 2 | 3 | 4 | 5 |
|     |                            |                                                                                                                                                                                                                                                                                                                                                          | <b>Comments</b>                                                                                                                             |   |   |   |   |
|     |                            |                                                                                                                                                                                                                                                                                                                                                          | In your opinion, how important and relevant is this persuasive principle to persuade people towards sustainable waste management practices? |   |   |   |   |
|     |                            |                                                                                                                                                                                                                                                                                                                                                          | <hr/> <hr/> <hr/>                                                                                                                           |   |   |   |   |
| 24. | <b>Cooperation</b>         | <b>Cooperation Principle:</b><br>The app motivates users to adopt a target attitude or behavior by leveraging human beings' natural drive to co-operate.<br><br><b>Example:</b> <i>Gone-for-Good</i> app provide opportunity for users to donate unused item for charity or good causes (e.g donate used for people who were affected by flood disaster) | 1                                                                                                                                           | 2 | 3 | 4 | 5 |
|     |                            |                                                                                                                                                                                                                                                                                                                                                          | <b>Comments</b>                                                                                                                             |   |   |   |   |
|     |                            |                                                                                                                                                                                                                                                                                                                                                          | In your opinion, how important and relevant is this persuasive principle to persuade people towards sustainable waste management practices? |   |   |   |   |
|     |                            |                                                                                                                                                                                                                                                                                                                                                          | <hr/> <hr/> <hr/>                                                                                                                           |   |   |   |   |
| 25. | <b>Competition</b>         | <b>Competition Principle:</b><br>A system can motivate users to adopt a target attitude or behavior by leveraging human beings' natural drive to compete.<br><br><b>Example:</b><br><br>The application provides the leaderboard to see your recycling behavior performance in comparison with other members of the community.                           | 1                                                                                                                                           | 2 | 3 | 4 | 5 |
|     |                            |                                                                                                                                                                                                                                                                                                                                                          | <b>Comments</b>                                                                                                                             |   |   |   |   |
|     |                            |                                                                                                                                                                                                                                                                                                                                                          | In your opinion, how important and relevant is this persuasive principle to persuade people towards sustainable waste management practices? |   |   |   |   |
|     |                            |                                                                                                                                                                                                                                                                                                                                                          | <hr/> <hr/> <hr/>                                                                                                                           |   |   |   |   |

## PART B: PERSUASIVE CONCEPTS FOR SUSTAINABLE WASTE MANAGEMENT APPLICATION BASED ON MAQASID AL-SHARIAH

Based on the following scale, please provide your judgments that reflect your personal opinion about how **important** is the following persuasive concepts (*Taqwa*, *Tazkiyah* and *Hikmah*) derived from *Maqasid al-Shari'ah* to be implemented into the design of sustainable waste management applications to persuade people to adopt sustainable waste management behaviour.

| 1                | 2           | 3                    | 4         | 5              |
|------------------|-------------|----------------------|-----------|----------------|
| Very Unimportant | Unimportant | Moderately Important | Important | Very Important |

| No  | Persuasive Principle                                                     | User Interface Design Example                                                                                                                   | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Scale |                                                                                                                                                    |   |   |   |
|-----|--------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|----------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|
| 26. | <b>Taqwa</b><br>(following God's commands and avoiding His prohibitions) | Below (Figure 1) is the example of how the concept of <i>Taqwa</i> is implement in the user interface design of a waste management application. | <p>Taqwa is an Islamic term for being conscious and cognizant of God, of truth, piety, fear of God. 'Taqwa' is defined as traits of righteousness or good deeds, which traits Allah SWT commands a believer to have.</p> <p>In this study, <i>taqwa</i> refers to following God's commands, avoiding His prohibitions, and protecting the environment by managing waste appropriately. This is one of the main persuasive concepts to encourage sustainable waste management practices.</p> <p>In Islam, good deeds are one of the pillars of faith. Every Muslim needs to preserve his/her own faith, and that is by obeying Allah (s.w.t) and fulfilling His amanah, and one way of obeying and fulfilling the amanah is by protecting the environment and avoiding injustice against Allah's earth because that has been commanded in the Quran in Surah al-A'raf verse 85 in following words:</p> | 1     | 2                                                                                                                                                  | 3 | 4 | 5 |
|     |                                                                          |                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |       | <b>Comments</b>                                                                                                                                    |   |   |   |
|     |                                                                          |                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |       | In your opinion, how <b>important and relevant</b> is this persuasive principle to persuade people towards sustainable waste management practices? |   |   |   |
|     |                                                                          |                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |       | <hr/> <hr/> <hr/> <hr/> <hr/>                                                                                                                      |   |   |   |

|  |  |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |  |
|--|--|--|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
|  |  |  | <p>“...and make no mischief on earth after it has been set in good order. That will be best for you, if ye have faith.” (Surah al-A’raf: 85)</p> <p>Therefore, <i>Taqwa</i> emphasized that managing waste appropriately is a means of performing good deeds for every Muslim and they will receive a set of reward and remuneration from Allah.</p> <p>Allah said in Quran:</p> <p>“And those who believe and do righteous good deeds, they are dwellers or paradise, they will dwell therein forever.”</p> <p>(Surah Al-Baqarah 2: Ayah 82)</p> |  |
|--|--|--|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|

### Taqwa

*Do what Allah loves, and see His blessings flow down on you by nurturing sustainable waste.*

  
 Reduce Waste

  
 Reuse Waste

  
 Recycle Waste

  
 Moderate Food Consumption

  
 No Littering

  
 Clean Trashes From Roads

  
 Avoid Urinating in Standing Water

  
 Avoid Urinating on Roads, Public Places, or Trees

Home
 Tazkiyah
 Taqwa
 Wisdom
 Progress

### Moderate Food Consumption

**Quran**

There are plenty of Ayahs from the Quran which speak against being excessive food consumption.

اَيُّهَا بَنِي آدَمُ خُذُوا زِينَتَكُمْ عِنْدَ كُلِّ مَسْجِدٍ وَكُلُوا وَاشْرَبُوا وَلَا تُسْرِفُوا إِنَّهُ لَا يُحِبُّ الْمُسْرِفِينَ

**“O Children of Adam, take your adornment at every place of prayer, eat and drink, but be not excessive. Indeed Allah likes not those who commit excess”**

[Surah al Araf:31]

The above verse is sufficient to show the dislike of Almighty Allah (s.w.t.) towards the extravagant people.

**Hadith**

“The first calamity for this nation after the Prophet’s (PBUH) death is fullness of their stomachs; when their stomachs became full, they became obese and their hearts weakened and their desires became wild”

[Bukhari]

**SPECIAL NOTES**

Clearly, the Quran warns us of the tests that come with attaining material possessions or being excessive in our consumption. The more you possess, the more distracted you are from focusing on Allah subhānahu wa ta’āla (glorified and exalted be He). The more we consume, the greedier we become. Thus, any overconsumption, such as wasting food, is indeed non-Islamic as it leads to harmful effects on the environment, such as opening new areas due to inadequate landfills, which eventually lead to an increase in carbon and methane emissions.

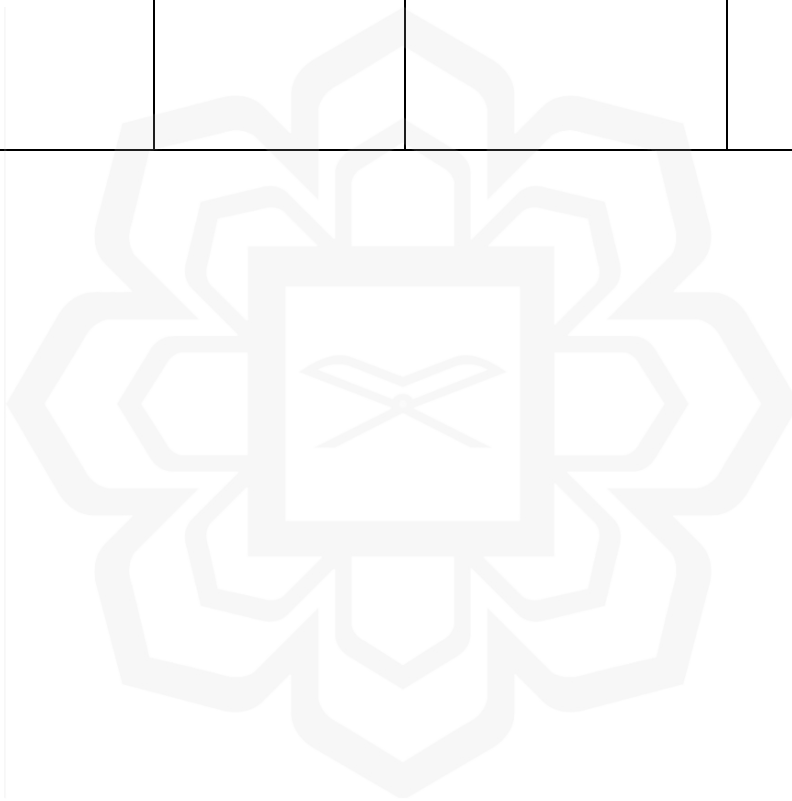
Home
 Tazkiyah
 Taqwa
 Wisdom
 Progress

Figure 1: Example of interface designs of Taqwa in waste management app



| No  | Persuasive Principle                  | User Interface Design Example                                                                                                               | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Scale                                                                                                                                                                                                    |   |   |   |   |
|-----|---------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|
|     |                                       |                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 1                                                                                                                                                                                                        | 2 | 3 | 4 | 5 |
| 27. | <b>Tazkiyah</b><br><br>(Purification) | Below (Figure 2) is the example of how the concept of Tazkiyah is implement in the user interface design of a waste management application. | <p>Tazkiyah (Arabic: تزكية) is an Arabic-Islamic term alluding to "tazkiyat al-nafs" meaning "sanctification" or "purification of the self" as the purification of the heart and soul. In this study, the word tazkiyah means the purification and cleansing of the individual from any substance or object that is normally discarded by society as garbage so that he/she can reach the point of perfection in a favorable environment.</p> <p>In this study, tazkiyah for waste disposal is essential for sustaining life. The cleanliness reflects our faith, Iman, and religion as well as our soul.</p> <p>Waste disposal is a part of cleanliness, and Islam requires us to clean our entire way of life. To achieve this purpose, the app can help people to manage their waste disposal by maintaining the cleanliness of their homes and places by separating their waste, clean the dustbin regularly and so on.</p> <p>To show the importance of a hygienic lifestyle, the Prophet (s. a. w.) said: "There are some seventy branches of faith. The highest is to bear witness that 'There is no god but Allah and Muhammad is the Messenger of Allah'; the lowest is the removal of harm or waste materials from the road."</p> <p>Therefore, we believed that implementing Tazkiya in apps will reduce household waste as well as reduce methane emissions from landfills and promote a</p> |                                                                                                                                                                                                          |   |   |   |   |
|     |                                       |                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <p><b>Comments</b></p> <p>In your opinion, how <b>important and relevant</b> is this persuasive principle to persuade people towards sustainable waste management practices?</p> <hr/> <hr/> <hr/> <hr/> |   |   |   |   |

|  |  |  |                                                                                                                                                                                                                                                                            |  |
|--|--|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
|  |  |  | <p>cleaner environment, which is completely in line with the Prophet's saying, "God is good and loves kindness, clean and loves cleanliness, kind and lives kindness, generous and loves generosity; so clean your houses and do not follow the footsteps of the Jews"</p> |  |
|--|--|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|



Each category has its own reminder from Quran and Hadith, and calendar. And indicate if you can achieve your goal or not.

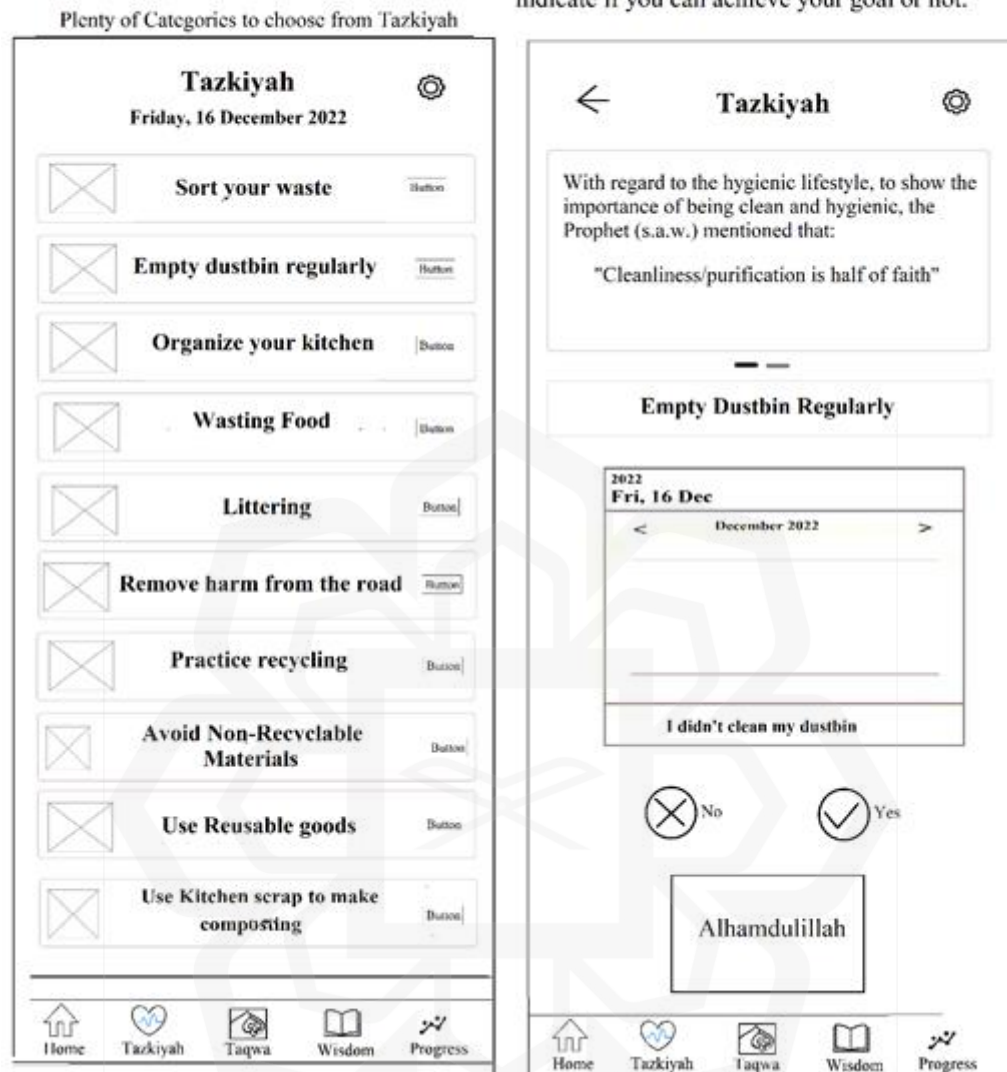


Figure 2: Example of interface designs of Tazkiyah in waste management app

| No  | Persuasive Principle      | User Interface Design Example                                                                                                                | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Scale                                                                                                                                                                                                                  |   |   |   |   |
|-----|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|
|     |                           |                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 1                                                                                                                                                                                                                      | 2 | 3 | 4 | 5 |
| 28. | <b>Al-Hikmah (Wisdom)</b> | Below (Figure 3) is the example of how the concept of Al Hikmah is implement in the user interface design of a waste management application. | <p>Hikmah or wisdom facilitate understanding on the importance of sustainable waste management behaviour based on Islamic perspectives, as well as knowledge on the detrimental effect of improper waste disposal towards progeny (protection of lineage).</p> <p>The Hikmah-related content are important to implement in waste management application to make people gain more knowledge about the importance of sustainable waste management practices from Islamic perspectives and subsequently change their own behavior accordingly.</p> <p>The following figure below (Figure 3) are example the user interface of al-Hikmah in the waste management app.</p> <p>In your opinion, how important is this persuasive concept derived from <i>Maqasid al-Shari'ah</i> to be integrated into the design of application aiming to encourage sustainable waste management practices</p> | <b>Comments</b>                                                                                                                                                                                                        |   |   |   |   |
|     |                           |                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <p>In your opinion, how <b>important and relevant</b> is this persuasive principle to persuade people towards sustainable waste management practices?</p> <p>_____</p> <p>—</p> <p>_____</p> <p>_____</p> <p>_____</p> |   |   |   |   |

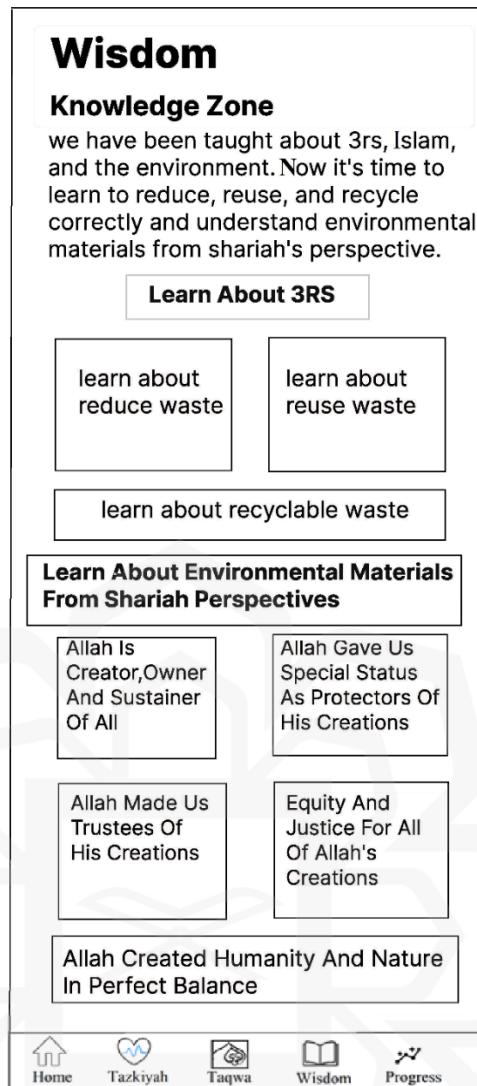


Figure 3: Interface design of Hikmah in waste management app

- END OF SURVEY -

## APPENDIX VI: EXPERT REVIEW (ROUND II) USED IN STUDY 6

|                                      |                                                                                                                                                                                                                        |
|--------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Document No.</b><br><br><b>03</b> | <b>Expert Review on Persuasive Design Framework for<br/>Sustainable Waste Management Practices based on Maqasid al-<br/>Shariah</b><br><br><b>Revised Persuasive Design Framework:<br/>Key Concepts and Definition</b> |
|--------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### DEFINITION OF KEY CONCEPTS

Some of the terms that are used throughout this study are presented, in order to clarify for the readers, the concepts and reduce risk of misunderstandings.

| No | Term                                   | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|----|----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. | Persuasive Technology                  | Persuasive technology is defined as “computerized software or information systems designed to reinforce, change or shape attitudes or behaviors or both without using coercion or deception”. (Oinas-Kukkonen and Harjumaa, 2009)                                                                                                                                                                                                                        |
| 2. | Persuasive Design                      | Persuasive design is an area of design practice that focuses on influencing human behavior through a product’s or service’s characteristics.                                                                                                                                                                                                                                                                                                             |
| 3. | Sustainable Waste Management Practices | Sustainable Waste Management Practices can be defined as practices that reduce the volume of different types of waste being dumped into landfill sites by reducing, reusing, and recycling (3Rs) and thus have less harmful effects on the environment, human health, or future generations.                                                                                                                                                             |
| 4. | Waste Management Applications          | The waste management applications are designed to encourage users to adapt their waste management behaviors using persuasive technology with the goal to reduce the environmental impact. It can become a valuable tool for government agencies, businesses, citizens, and other stakeholders by integrating this application into the fight for environmental protection, waste prevention, recycling, monitoring and tracking waste pickups, and more. |

|    |                           |                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|----|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5. | <i>Maqasid al-Shariah</i> | <p>According to Imam Al-Ghazālī an eminent Muslim scholar, the definition of <i>Maqasid al-Shari'ah</i> is</p> <p><i>“The objective of the Shariah is to promote the well-being of all mankind, which lies in safeguarding their faith, their human self, their intellect, their posterity and their wealth. Whatever ensures the safeguard of these five serves public interest and is desirable” (Yaakub and Abdullah, 2020).</i></p> |
|----|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

## RESEARCH BACKGROUND

Achieving sustainable waste management practices in Malaysia is very challenging as our citizens are generally not actively recycling, reusing, or reducing their household waste. Tremendous campaigns and efforts have been done to get communities to participate in sustainable waste management practices. However, none of those efforts has been successful due to the wrong attitude, and lack of awareness on the purpose of recycle, reduce, and reuse of waste towards sustainable waste management and environmental protection (Zainu and Songip, 2017; Yoke et al., 2019).

Meanwhile, there are many waste management applications developed to address inappropriate waste disposal behavior. However, a major limitation of these existing applications is the lack of spiritual and religious values that could guide human behavior.

As Muslims' attitudes and behaviors are largely influenced by religious values, this study explores new ways to persuade the Muslim community in Malaysia to improve their waste management behaviors by integrating *Maqasid al-Shari'ah* components into the design of a smartphone application aiming for sustainable waste management practices.

## REVISED PERSUASIVE DESIGN FRAMEWORK FOR WASTE MANAGEMENT PRACTICES BASED ON MAQASID AL-SHARIAH

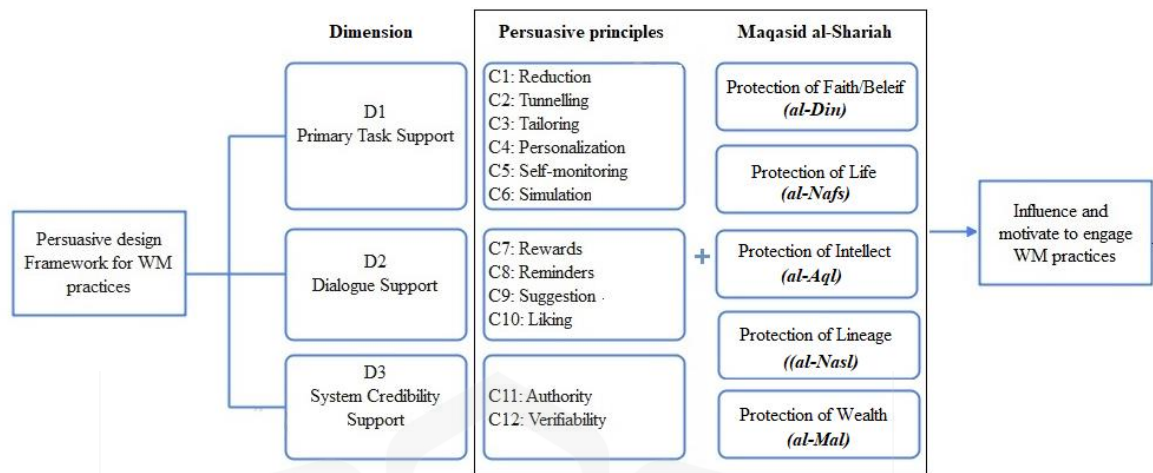


Figure 1: Revised Persuasive Design Framework for Waste Management Practices Based on *Maqasid al-Shariah*

The Figure 1 shows the revised persuasive design framework for waste management practices based on *Maqasid al-Shariah*. In the framework, twelve (12) persuasive components were selected for waste management application from 1<sup>st</sup> round of fuzzy Delphi analysis that are marked as C1 TO C12. The five dimensions of Maqasid al -Shariah was applied with each persuasive components to achieve the goal of influencing, motivating, and increasing awareness towards WM practices among the Malaysian Community. Table 1 shows the definition of each persuasive component implemented with *Maqasid al-Shari'ah* and Figure 2 shows the framework of waste management practices based on *Maqasid al-Shari'ah* that are integrated with each persuasive component.

Examples of how these persuasive principles based on *Maqasid al-Shari'ah* were applied into the prototype design of our mobile app aiming to persuade people towards sustainable waste management practices are provided in Document 04: Expert Review Form.



Table 1: Definition of persuasive component implemented with Maqasid al-Shariah.

| <b>Persuasive Principles</b> | <b>Definition of Persuasive Principles Supporting with Quranic Ayah and Hadith</b>                                                                                                                                                                                                                                                                                           | <b>Implemented Maqasid al Shariah (Daruriyyah)</b> |
|------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|
| Reduction                    | <p><b>Definition</b><br/>A system that reduces complex behavior into simple tasks helps users perform the target behavior, and it may increase the benefit/cost ratio of a behavior.</p> <p><b>Supporting Quranic Ayah and Hadith</b><br/>Verily! Allah will not change the condition of a people unless there is a change of what is in themselves. (Surah al-Anfal:53)</p> | (Hifz al-Din, Nafs, Nasl, Aql, and Mal).           |
| Tunneling                    | <p><b>Definition</b><br/>Using the system to guide users through a process or experience provides opportunities to persuade along the way.</p> <p><b>Supporting Quranic Ayah and Hadith</b><br/>Verily! Allah will not change the condition of a people unless there is a change of what is in themselves. (al-Anfal:53)</p>                                                 | Hifz al-Din, Nafs, Nasl, Aql And Mal.              |
| Tailoring                    | <p><b>Definition</b><br/>Information provided by the system will be more persuasive if it is tailored to the potential needs, interests, personality, usage context, or other factors relevant to a user group.</p>                                                                                                                                                          |                                                    |
| Personalization              | <p><b>Definition</b><br/>A system that offers personalized content or services have a greater capability for persuasion.</p> <p><b>Supporting Quranic Ayah and Hadith</b><br/>The Prophet (pbuh) has said that Allah is beautiful, and He loves beauty.<br/>- Therefore, user profile should make it beautiful way with content and services</p>                             |                                                    |
| Self-monitoring              | <p><b>Definition</b><br/>A system that keeps track of one's own performance or status supports the user in achieving goals.</p>                                                                                                                                                                                                                                              | Hifz al-Din                                        |

|            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |              |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
|            | <p><b>Supporting Quranic Ayah and Hadith</b><br/>         So, whoever does an atom's weight of good will see it. And whoever does an atom's weight of evil will see it. (Surah Zalzalah: 7 and 8). So, we have to monitor ourselves.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |              |
| Simulation | <p><b>Definition</b><br/>         Systems that provide simulations can persuade by enabling users to observe immediately the link between cause and effect.</p> <p><b>Supporting Quranic Ayah and Hadith</b></p> <ul style="list-style-type: none"> <li>a) <b>Contributed to the preservation of life</b></li> <li>b) <b>Renewable reward of planting trees-</b> "If a Muslim plant a tree or sows seeds, and then a bird, or a person or an animal eats from it, it is regarded as a charitable gift (sadaqah) for him." – Imam Bukhari.</li> <li>c) <b>Plant a tree even if it's your last deed-</b> Anas (May Allah be pleased with him) reported that the Prophet (peace and blessings be upon him) said "If the Hour (the day of Resurrection) is about to be established and one of you was holding a palm shoot, let him take advantage of even one second before the Hour is established to plant it."</li> </ul> | Hifz al-nafs |
| Rewards    | <p><b>Definition</b><br/>         Systems that reward target behaviors may have great persuasive powers.</p> <p><b>Supporting Quranic Ayah and Hadith</b></p> <p>a) <b>Earning rewards for good deeds in the hereafter</b><br/>         وَاللَّهُ يُحِبُّ الْمُطَهِّرِينَ Allah loves those who purify themselves. (Surah At-Tawba: 108)</p> <p>And (remember) that Allah is aware of whatever good you do (and you shall be rewarded for it) (Al-Baqarah: 215).</p> <p>b) <b>Reward of Removing Something Harmful from the Street</b></p>                                                                                                                                                                                                                                                                                                                                                                                | Hifz al-Din  |

|          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |             |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
|          | The Prophet sallahu alayhi wa salam said:<br>Removing harmful things from the way is charity                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |             |
| Reminder | <p><b>Definition</b><br/>If a system reminds users of their target behavior, the users will more likely to achieve their goals.</p> <p><b>Supporting Quranic Ayah and Hadith</b></p> <p><b>a) Reminder benefits the believers</b></p> <p>Hadith: إِذَا هَمَّ رَجُلٌ بِحَسَنَةٍ فَعَمَلَهَا كُتِبَتْ لَهُ عَشْرُ حَسَنَاتٍ<br/>         “When a person intends to do a good deed, and then does it, ten good deeds will be recorded for him.</p> <p>“And cause not corruption upon the earth after its reformation. And invoke Him in fear and aspiration. Indeed, the mercy of Allah is near to the doers of good”. (Surah al-Araf: 56)</p> <p>Surely this is a reminder, then let him, who will take the way to his Lord. (Surah Muzzammil:19)</p> <p>And remind, for indeed, the reminder benefits the believers. (Surah-dhariyat: 55)</p> <p>“And to Thamud [We sent] their brother Salih. He said, “O my people, worship Allah; you have no deity other than Him. He has produced you from the earth and settled you in it, so ask forgiveness of Him and then repent to Him. Indeed, my Lord is near and responsive.” (Surah Hud:61)</p> <p><b>b) The danger of Throwing Harm in the Street (Littering):</b> Sa’d ibn Abi Waqqas said: “Beware of action that will incur cursing: that a person throw his garbage in the street. So no one passes the street except he says: may Allah curse the one who did this” [al-Musaawi ul-Akhlaaq of Kharaaiti no. 800 with the a Saheeh chain]</p> | Hifz al-Din |

|               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                              |
|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|
| Suggestion    | <p><b>Definition</b><br/>Systems offering fitting suggestions will have greater persuasive powers.</p> <p><b>Supporting Quranic Ayah and Hadith</b><br/>As for those who struggle in Our cause, we will surely guide them along Our Way. And Allah is certainly with the good-doers. (Surat Al-‘Ankabut Ayat 69)</p> <p>Everybody needs to find the method or alternative ways to reduce, reuse and recycle waste. We can encourage them to do efforts to practice 3Rs.</p> | Hifz al-Din,<br>Hifz Al-Maal |
| Liking        | <p><b>Definition</b><br/>A system that is visually attractive for its users is likely to be more persuasive.</p>                                                                                                                                                                                                                                                                                                                                                            |                              |
| Authority     | <p><b>Definition</b><br/>A system that leverages roles of authority will have enhanced powers of persuasion.</p>                                                                                                                                                                                                                                                                                                                                                            |                              |
| Verifiability | <p><b>Definition</b><br/>Credibility perceptions will be enhanced if a system makes it easy to verify the accuracy of site content via outside sources.</p>                                                                                                                                                                                                                                                                                                                 |                              |

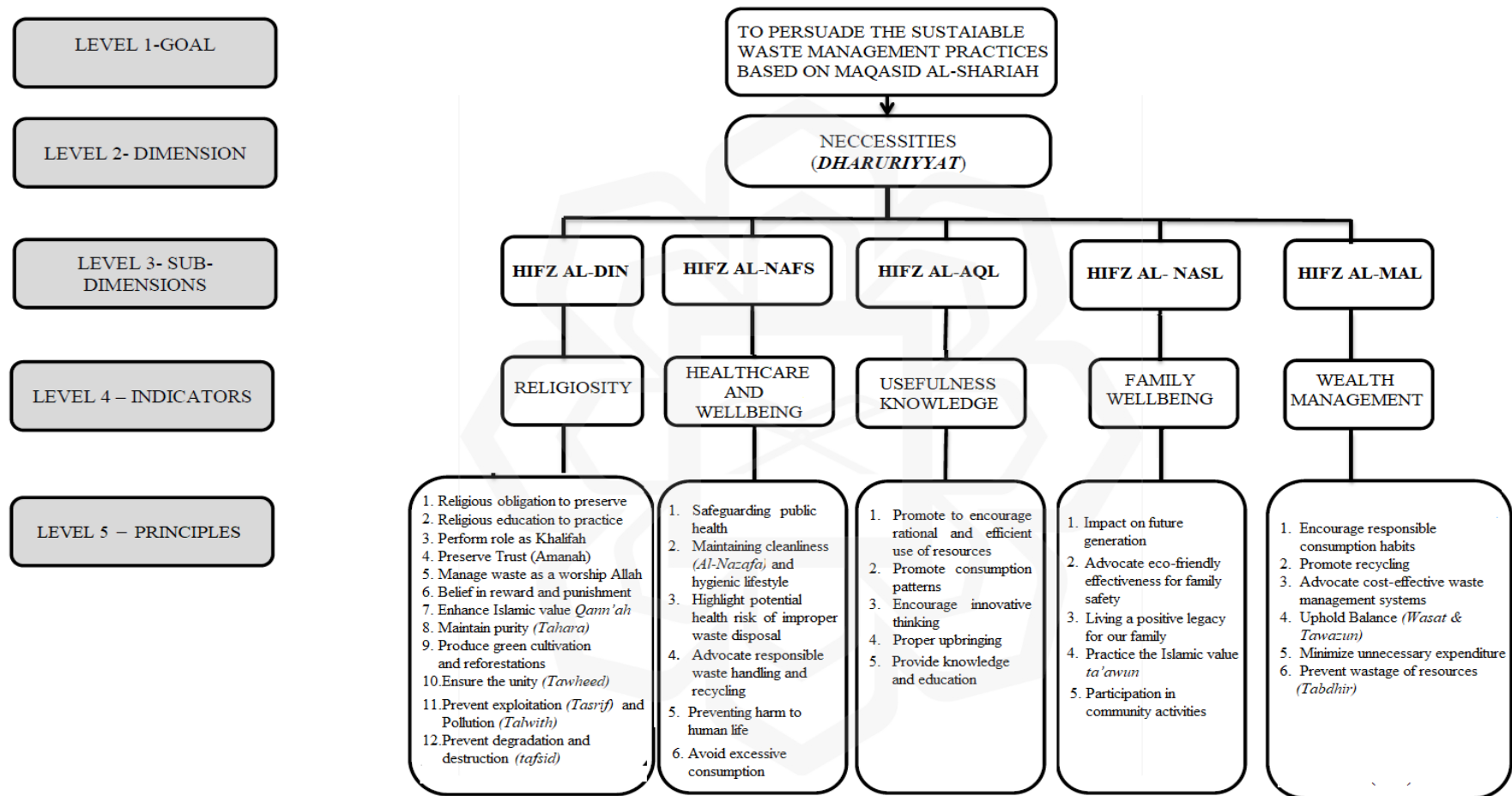


Figure 2: Framework for Waste Management Practices based on Maqasid al-Shariah

|                               |                                                                                                                                                                                                                                                                          |
|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Document No.<br><br><b>04</b> | <b>Expert Review on Persuasive Design Framework for Sustainable Waste Management Practices based on <i>Maqasid al-Shariah</i></b><br><br><b>Expert Review Form</b><br>Kulliyyah of Information Communication and Technology<br>International Islamic University Malaysia |
|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

## REVIEW ON PERSUASIVE DESIGN PRINCIPLES FOR SUSTAINABLE WASTE MANAGEMENT APPLICATION BASED ON MAQASID AL-SHARIAH

### Instruction for Expert

Based on the following scale, please provide your judgments that reflect your expert opinion about how **important** is the persuasive principle to be integrated into the design of application aiming to persuade people towards sustainable waste management practices based on Maqasid al Shariah.

| 1                | 2           | 3                    | 4         | 5              |
|------------------|-------------|----------------------|-----------|----------------|
| Very Unimportant | Unimportant | Moderately Important | Important | Very Important |

| No | Persuasive Principle | Description                                                                                                                                                                                                                   | Scale                                                                                                                                                            |   |   |   |   |
|----|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|
| 1. | <b>Reduction</b>     | The prototype displays a color-coding calendar for a garbage collection schedule making it easier for people to know specific day/date for specific type of waste collection (e.g., On May, for organic and recyclable waste) | 1                                                                                                                                                                | 2 | 3 | 4 | 5 |
|    |                      |                                                                                                                                                                                                                               | <b>Comments</b>                                                                                                                                                  |   |   |   |   |
|    |                      |                                                                                                                                                                                                                               | In your opinion, how <b>important</b> is this persuasive principle to persuade people towards sustainable waste management practices?<br>_____<br>_____<br>_____ |   |   |   |   |
| 2. | <b>Tunneling</b>     | The prototype guides user on how to achieve goal in maintaining cleanliness, prevent wastage of                                                                                                                               | 1                                                                                                                                                                | 2 | 3 | 4 | 5 |
|    |                      |                                                                                                                                                                                                                               | <b>Comments</b><br>In your opinion, how <b>important</b> is this persuasive principle to                                                                         |   |   |   |   |

|                                                                                                                                                                                       |                        |                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                              |   |   |   |   |   |                 |  |  |  |  |                                                                                                                                                                                       |  |  |  |  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|---|-----------------|--|--|--|--|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--|--|--|
|                                                                                                                                                                                       |                        | resources, prevent extravagance and so on.                                                                                                                                      | persuade people towards sustainable waste management practices?<br><br><br><br>                                                                                                                                                                                                                                                              |   |   |   |   |   |                 |  |  |  |  |                                                                                                                                                                                       |  |  |  |  |
| 3.                                                                                                                                                                                    | <b>Tailoring</b>       | The prototype provides information about garbage and recycling items collection schedules based on user home address.                                                           | <table><tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td colspan="5"><b>Comments</b></td></tr><tr><td colspan="5">In your opinion, how <b>important</b> is this persuasive principle to persuade people towards sustainable waste management practices?<br/><br/><br/></td></tr></table>                                    | 1 | 2 | 3 | 4 | 5 | <b>Comments</b> |  |  |  |  | In your opinion, how <b>important</b> is this persuasive principle to persuade people towards sustainable waste management practices?<br><br><br>                                     |  |  |  |  |
| 1                                                                                                                                                                                     | 2                      | 3                                                                                                                                                                               | 4                                                                                                                                                                                                                                                                                                                                            | 5 |   |   |   |   |                 |  |  |  |  |                                                                                                                                                                                       |  |  |  |  |
| <b>Comments</b>                                                                                                                                                                       |                        |                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                              |   |   |   |   |   |                 |  |  |  |  |                                                                                                                                                                                       |  |  |  |  |
| In your opinion, how <b>important</b> is this persuasive principle to persuade people towards sustainable waste management practices?<br><br><br>                                     |                        |                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                              |   |   |   |   |   |                 |  |  |  |  |                                                                                                                                                                                       |  |  |  |  |
| 4.                                                                                                                                                                                    | <b>Personalization</b> | The prototype offers personalized users' preferred languages. The user profile could be personalized with personal photos, addresses, and payment options for recyclable waste. | <table><tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td colspan="5"><b>Comments</b></td></tr><tr><td colspan="5">In your opinion, how <b>important</b> and relevant is this persuasive principle to persuade people towards sustainable waste management practices?<br/><br/><br/></td></tr></table>                       | 1 | 2 | 3 | 4 | 5 | <b>Comments</b> |  |  |  |  | In your opinion, how <b>important</b> and relevant is this persuasive principle to persuade people towards sustainable waste management practices?<br><br><br>                        |  |  |  |  |
| 1                                                                                                                                                                                     | 2                      | 3                                                                                                                                                                               | 4                                                                                                                                                                                                                                                                                                                                            | 5 |   |   |   |   |                 |  |  |  |  |                                                                                                                                                                                       |  |  |  |  |
| <b>Comments</b>                                                                                                                                                                       |                        |                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                              |   |   |   |   |   |                 |  |  |  |  |                                                                                                                                                                                       |  |  |  |  |
| In your opinion, how <b>important</b> and relevant is this persuasive principle to persuade people towards sustainable waste management practices?<br><br><br>                        |                        |                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                              |   |   |   |   |   |                 |  |  |  |  |                                                                                                                                                                                       |  |  |  |  |
| 5.                                                                                                                                                                                    | <b>Self-monitoring</b> | The prototype shows different types of garbage user recycled by each month and shows the user's performance on different categories on waste disposal to achieve the goal.      | <table><tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td colspan="5"><b>Comments</b></td></tr><tr><td colspan="5">In your opinion, how <b>important</b> is this persuasive principle to persuade people towards sustainable waste management practices based on <i>Maqasid al-Shariah</i>?<br/><br/><br/></td></tr></table> | 1 | 2 | 3 | 4 | 5 | <b>Comments</b> |  |  |  |  | In your opinion, how <b>important</b> is this persuasive principle to persuade people towards sustainable waste management practices based on <i>Maqasid al-Shariah</i> ?<br><br><br> |  |  |  |  |
| 1                                                                                                                                                                                     | 2                      | 3                                                                                                                                                                               | 4                                                                                                                                                                                                                                                                                                                                            | 5 |   |   |   |   |                 |  |  |  |  |                                                                                                                                                                                       |  |  |  |  |
| <b>Comments</b>                                                                                                                                                                       |                        |                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                              |   |   |   |   |   |                 |  |  |  |  |                                                                                                                                                                                       |  |  |  |  |
| In your opinion, how <b>important</b> is this persuasive principle to persuade people towards sustainable waste management practices based on <i>Maqasid al-Shariah</i> ?<br><br><br> |                        |                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                              |   |   |   |   |   |                 |  |  |  |  |                                                                                                                                                                                       |  |  |  |  |

|    |                   |                                                                                                                                                                                                                               |                                                                                                                                                                           |   |   |   |   |
|----|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|
| 6. | <b>Simulation</b> | The prototype shows the impacts of waste being recycled on the environment. In this example, the application informs that the user has saves 10 trees, 10KWh energy and 10 ft3 landfills by recycling of the waste generated. | 1                                                                                                                                                                         | 2 | 3 | 4 | 5 |
|    |                   |                                                                                                                                                                                                                               | <b>Comments</b>                                                                                                                                                           |   |   |   |   |
|    |                   |                                                                                                                                                                                                                               | In your opinion, how <b>important</b> is this persuasive principle to persuade people towards sustainable waste management practices?                                     |   |   |   |   |
|    |                   |                                                                                                                                                                                                                               | <hr/> <hr/> <hr/>                                                                                                                                                         |   |   |   |   |
| 7. | <b>Rewards</b>    | The prototype offering rewards point after completing a certain level of recycling.                                                                                                                                           | 1                                                                                                                                                                         | 2 | 3 | 4 | 5 |
|    |                   |                                                                                                                                                                                                                               | <b>Comments</b>                                                                                                                                                           |   |   |   |   |
|    |                   |                                                                                                                                                                                                                               | In your opinion, how <b>important</b> is this persuasive principle to persuade people towards sustainable waste management practices?                                     |   |   |   |   |
|    |                   |                                                                                                                                                                                                                               | <hr/> <hr/> <hr/>                                                                                                                                                         |   |   |   |   |
| 8. | <b>Reminder</b>   | The prototype notifies and reminds users about their task to reduce extravagance to achieve goal. For example: to dispose daily for maintaining cleanliness.                                                                  | 1                                                                                                                                                                         | 2 | 3 | 4 | 5 |
|    |                   |                                                                                                                                                                                                                               | <b>Comments</b>                                                                                                                                                           |   |   |   |   |
|    |                   |                                                                                                                                                                                                                               | In your opinion, how <b>important</b> is this persuasive principle to persuade people towards sustainable waste management practices based on <i>Maqasid al-Shariah</i> ? |   |   |   |   |
|    |                   |                                                                                                                                                                                                                               | <hr/> <hr/> <hr/>                                                                                                                                                         |   |   |   |   |



|     |                   |                                                                                                                                                                                                                                                                           |                                                                                                                                                                           |
|-----|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 9.  | <b>Suggestion</b> | The prototype that provides suggestion for reducing waste.                                                                                                                                                                                                                | 1    2    3    45                                                                                                                                                         |
|     |                   |                                                                                                                                                                                                                                                                           | <b>Comments</b>                                                                                                                                                           |
|     |                   |                                                                                                                                                                                                                                                                           | In your opinion, how <b>important</b> is this persuasive principle to persuade people towards sustainable waste management practices based on Maqasid al Shariah?         |
|     |                   |                                                                                                                                                                                                                                                                           | _____                                                                                                                                                                     |
| 10. | <b>Liking</b>     | <b>Liking principle:</b><br>A system that is visually attractive for its users is likely to be more persuasive.<br><br><b>Example:</b><br>The prototype has good usability and positive user experience - user friendly.                                                  | 1    2    3    45                                                                                                                                                         |
|     |                   |                                                                                                                                                                                                                                                                           | <b>Comments</b>                                                                                                                                                           |
|     |                   |                                                                                                                                                                                                                                                                           | In your opinion, how <b>important</b> is this persuasive principle to persuade people towards sustainable waste management practices based on <i>Maqasid al-Shariah</i> ? |
|     |                   |                                                                                                                                                                                                                                                                           | _____                                                                                                                                                                     |
| 11. | <b>Authority</b>  | <b>Authority principle:</b><br>A system that leverages roles of authority will have enhanced powers of persuasion.<br><br><b>Example</b><br>The prototype facilitates residents to submit waste collection and public cleansing complaints to Waste Management authority. | 1    2    3    45                                                                                                                                                         |
|     |                   |                                                                                                                                                                                                                                                                           | <b>Comments</b>                                                                                                                                                           |
|     |                   |                                                                                                                                                                                                                                                                           | In your opinion, how <b>important</b> is this persuasive principle to persuade people towards sustainable waste management practices?                                     |
|     |                   |                                                                                                                                                                                                                                                                           | _____                                                                                                                                                                     |

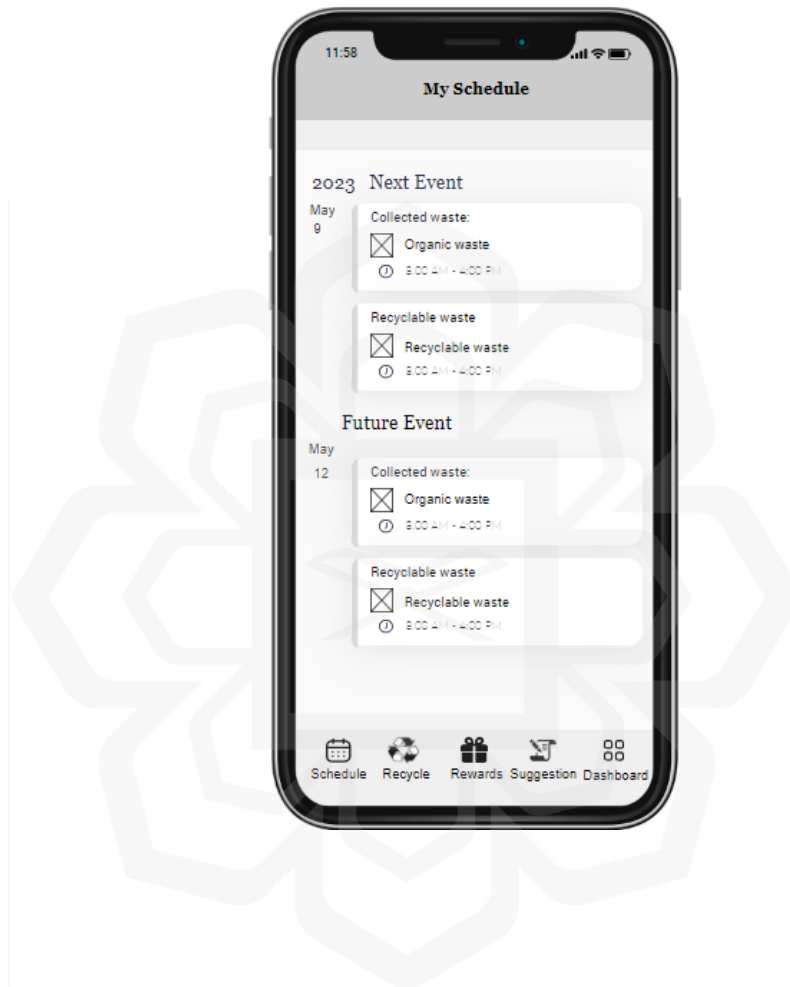
|     |                      |                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                       |   |   |    |
|-----|----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|---|---|----|
| 12. | <b>Verifiability</b> | <b>Verifiability Principle:</b><br>Credibility perceptions will be enhanced if a system makes it easy to verify the accuracy of site content via outside sources.<br><br><b>Example</b><br>The prototype provides the name of waste management organization (e.g. KDEB Waste Management Sdn. Bhd.), a link to their website and contact information to verify the accuracy. | 1                                                                                                                                     | 2 | 3 | 45 |
|     |                      |                                                                                                                                                                                                                                                                                                                                                                             | <b>Comments</b>                                                                                                                       |   |   |    |
|     |                      |                                                                                                                                                                                                                                                                                                                                                                             | In your opinion, how <b>important</b> is this persuasive principle to persuade people towards sustainable waste management practices? |   |   |    |
|     |                      |                                                                                                                                                                                                                                                                                                                                                                             | _____                                                                                                                                 |   |   |    |
|     |                      |                                                                                                                                                                                                                                                                                                                                                                             | _____                                                                                                                                 |   |   |    |



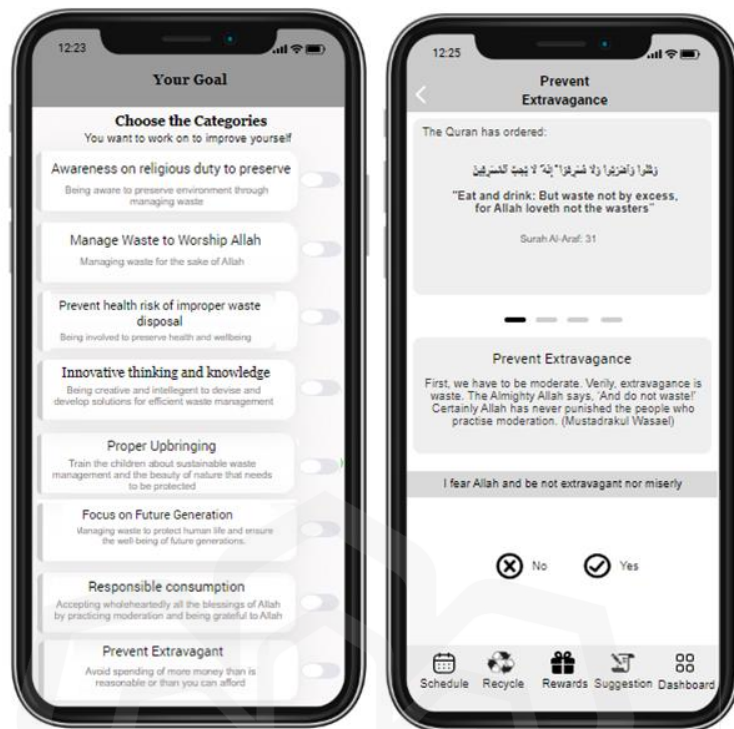
## APPENDIX VII: DETAILED SCREENSHOTS OF MEDIUM-FIDELITY PROTOTYPE TAHARA

### a. Primary Task Support

#### i. Reduction



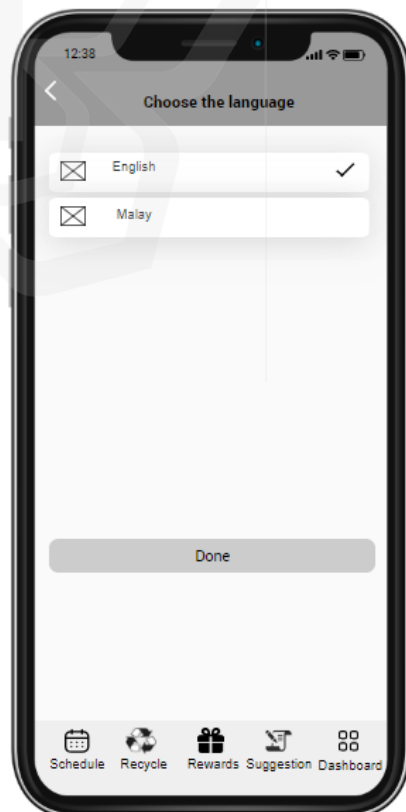
## ii. Tunnelling



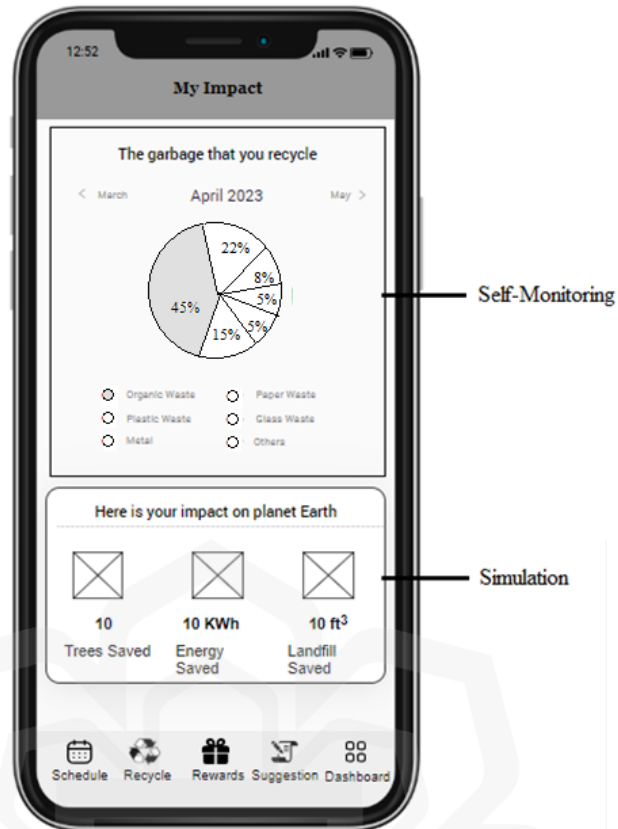
## iii. Tailoring



## iv. Personalization

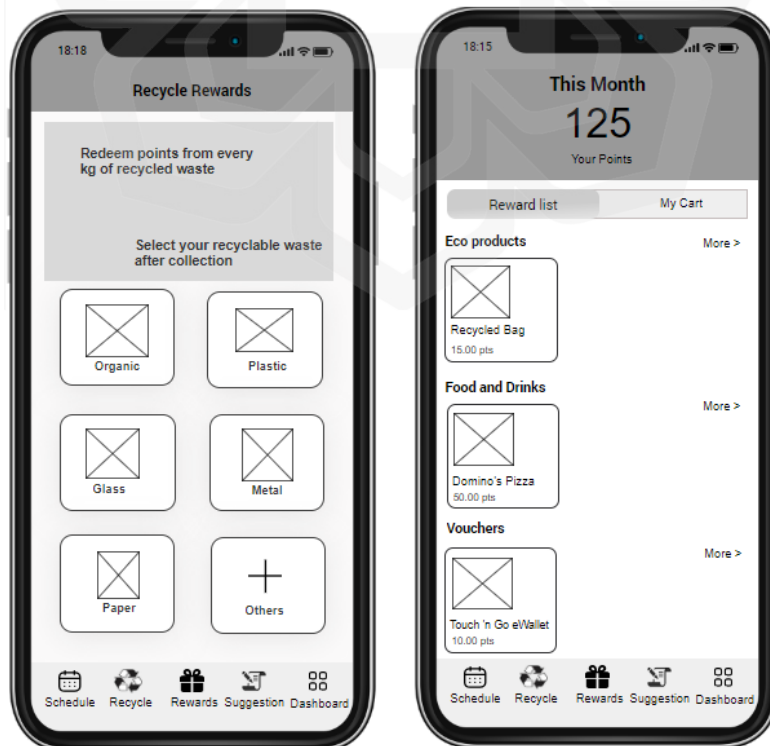


## v. Self-monitoring and Simulation

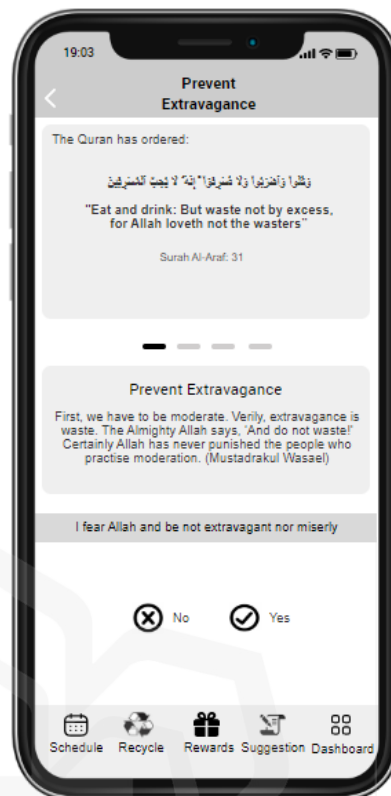


## b. Dialogue Support

### i. Rewards

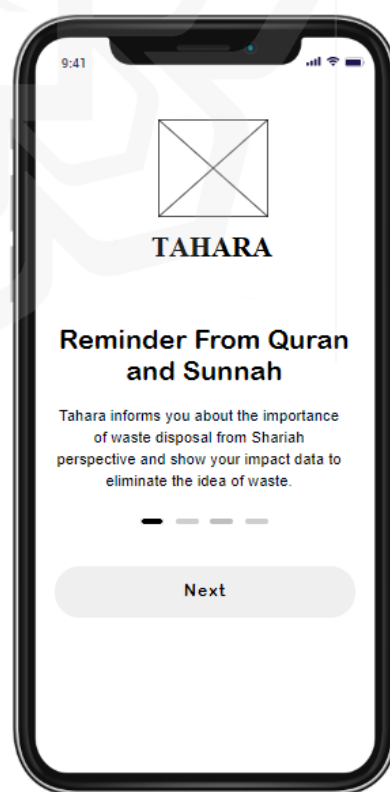
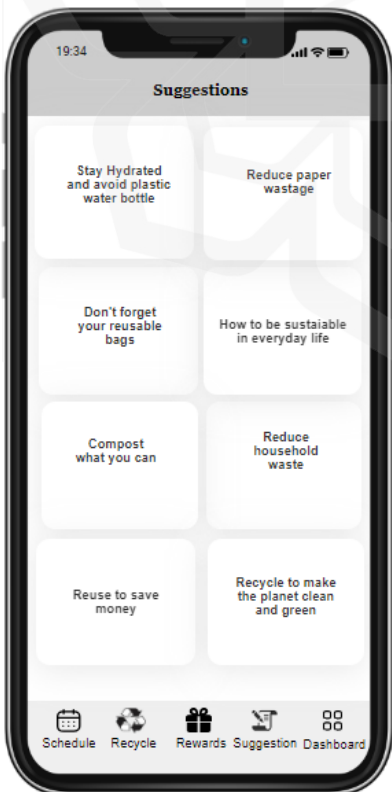


### ii. Reminder



iii. Suggestion

iv. Liking



c. Credibility Support

i. Authority

ii. Verifiability



## APPENDIX VIII: DETAILED SCREENSHOTS OF HIGH-FIDELITY PROTOTYPE TAHARA

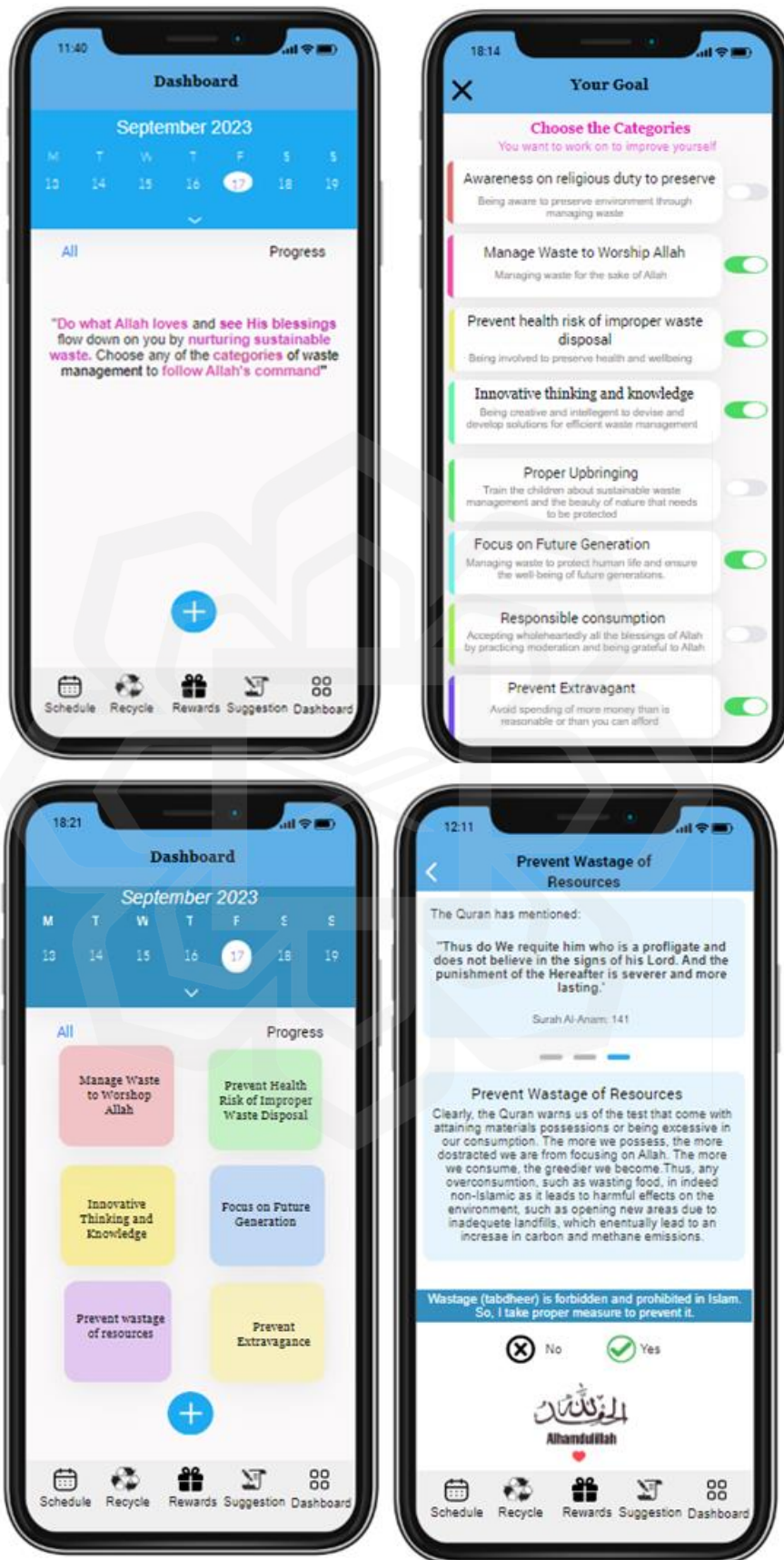
### a. Primary Task Support

- i. Tailoring
- ii. Reduction and Maqasid hifz al-din, nafs, nasl, aql, and mal

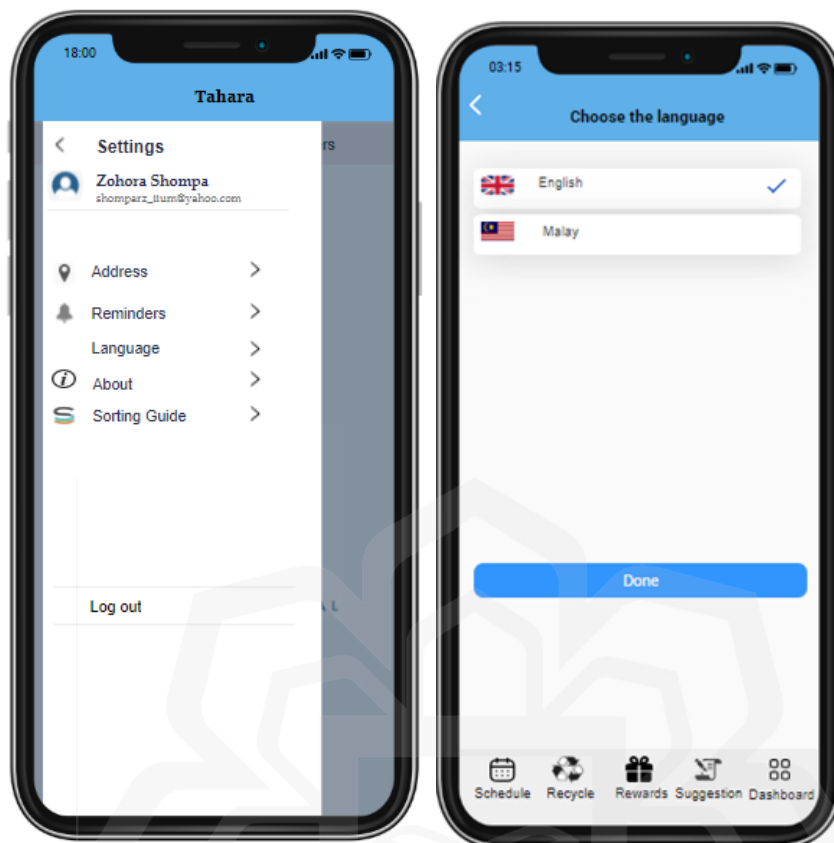




iii. Tunnelling, and Maqasid hifz al-din, nafs, aql, nasl, and mal



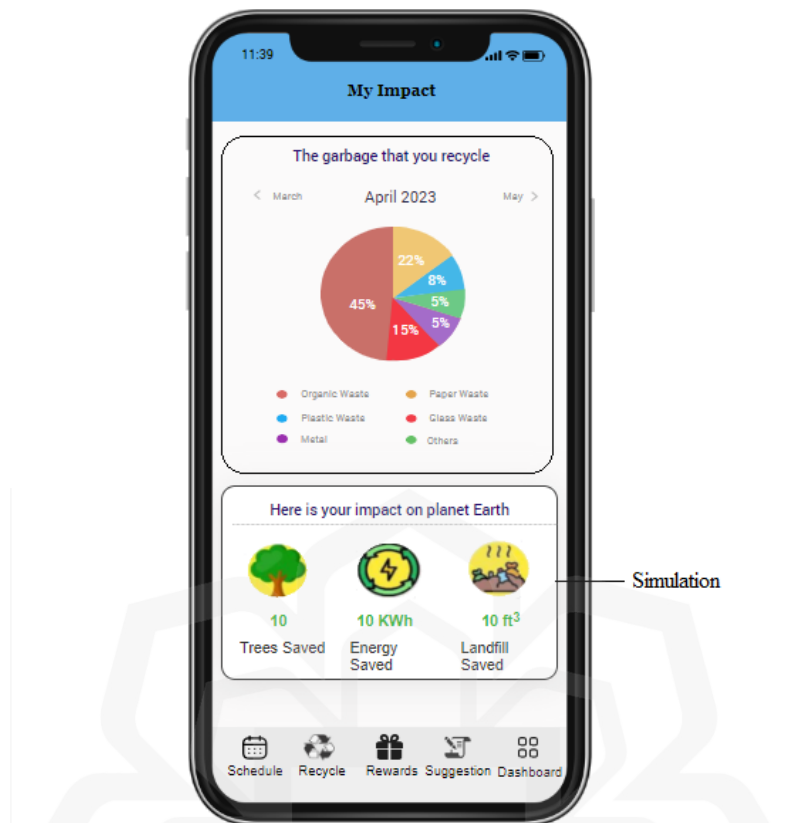
iv. Personalization



vi. Self-monitoring and Maqasid hifz al-din

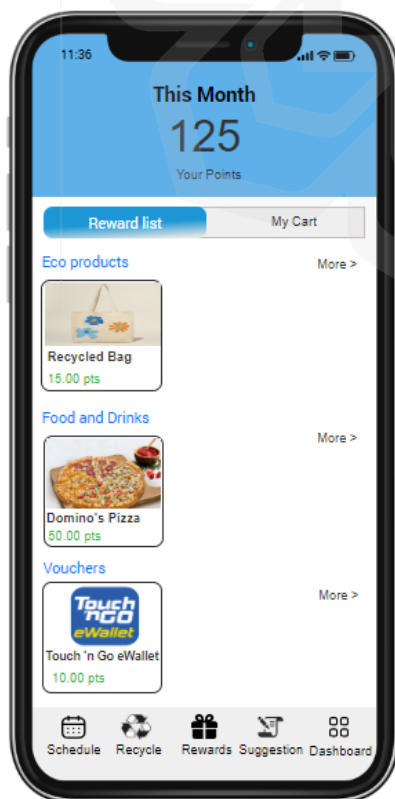


v. Simulation and Maqasid hifz al-nafs

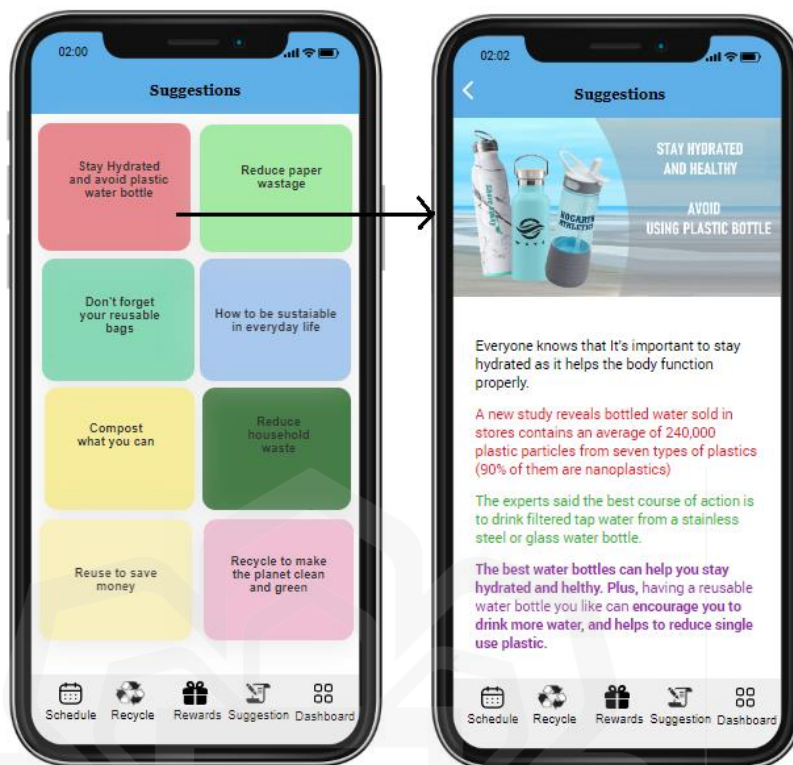


b. Dialogue Support

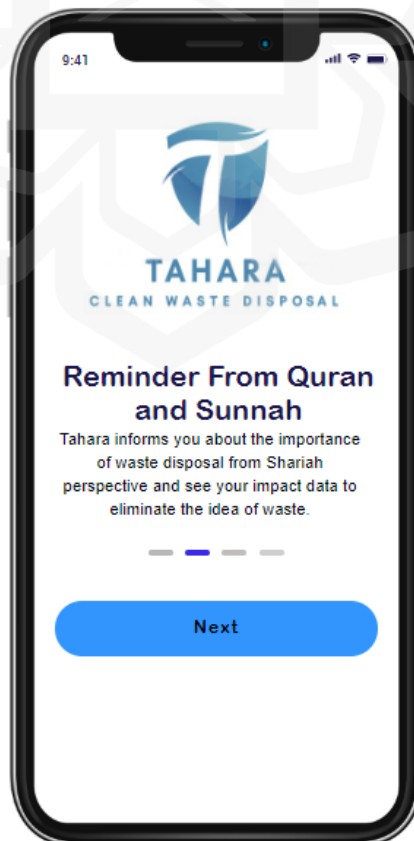
- i. Rewards and Maqasid hifz al-din      ii. Reminder and Maqasid hifz al-din



ii. Suggestion and Maqasid hifz al-din and mal

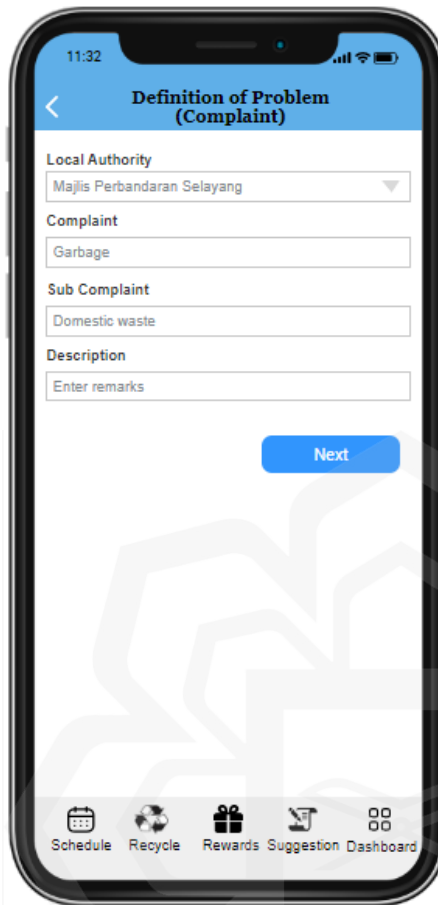


iv. Liking



### c. Credibility Support

#### i. Authority



11:32

< Definition of Problem (Complaint)

Local Authority  
Majlis Perbandaran Selayang

Complaint  
Garbage

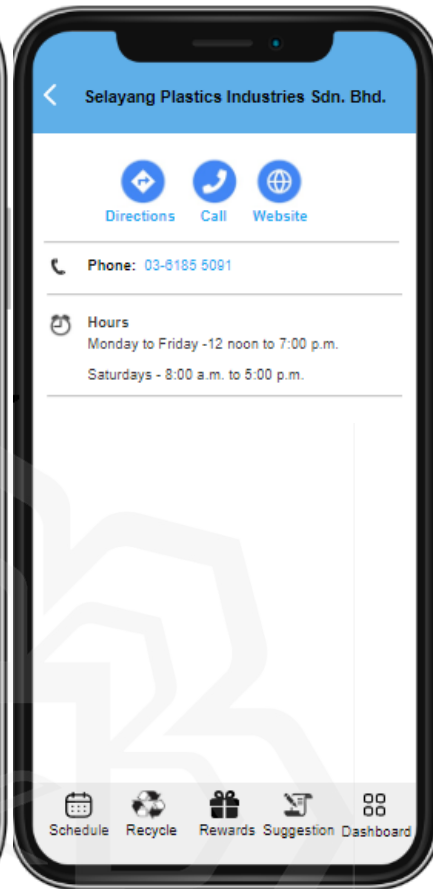
Sub Complaint  
Domestic waste

Description  
Enter remarks

Next

Schedule Recycle Rewards Suggestion Dashboard

#### ii. Verifiability



< Selayang Plastics Industries Sdn. Bhd.

Directions Call Website

Phone: 03-6185 5091

Hours  
Monday to Friday - 12 noon to 7:00 p.m.  
Saturdays - 8:00 a.m. to 5:00 p.m.

Schedule Recycle Rewards Suggestion Dashboard

## APPENDIX IX: CONSENT FORM USED IN STUDY 7

### Consent for Participation in Research

Thank you for your agreement to participate in this usability testing session.

#### Purpose of Study

The purpose of this study is to get user feedback on our *Tahara* app, a sustainable waste management application developed based on *Maqasid al-Shariah*. The application is intended to encourage behavioral change toward sustainable waste management practices among the Malaysian Community. Your participation in this study will help us to improve the usability and persuasiveness of the application.

#### Procedures

You are required to complete a list of tasks using *Tahara* app. Then afterwards, we will ask few questions regarding your experience of using the application. We will record the session and we will take notes to record your comments. We will not request, and you should not provide, any sensitive personal information in this study.

#### Confidentiality

Your participation will be completely confidential, and you will remain completely anonymous throughout this process. The data gathered within this interview will not be subject to any public disclosure and would be only use as part of a PhD research project. We may use recordings and notes for internal purposes as we continue to improve our app. We may also anonymize your responses and aggregate them with the responses of other participants in order to share study results externally.

#### Your Rights

Your participation in this study is voluntary. If you have any questions or concerns about this study, feel free to contact our researcher, Sr. Zohora at [shomparz\\_iium@yahoo.com](mailto:shomparz_iium@yahoo.com)

#### Your Consent

I give my consent:

- For the session to be recorded
- To use this recording for internal purpose only, for the purpose of improving the prototype being tested.

By signing below, you acknowledge that you have read and understood the information in this Participant Consent Form.

Signature: \_\_\_\_\_

Name: \_\_\_\_\_

Date: \_\_\_\_\_

## APPENDIX X: QUESTIONNAIRE USED IN STUDY 7

### PART A: PRE-STUDY QUESTIONNAIRE

#### Background Information

Instruction: Please tick (✓) the correct answer about yourself.

1. Gender:  
☐ Male ☐ Female
2. Age: \_\_\_\_\_ years old.
3. Level of education:  
☐ Diploma  
☐ Bachelor degree  
☐ Master degree  
☐ PhD  
☐ Other (please specify): \_\_\_\_\_
4. Occupation: \_\_\_\_\_
5. Years of experience using smartphone: \_\_\_\_\_ years.
6. How often do you use your smartphone in a day?  
☐ Rarely  
☐ Occasionally/Sometimes  
☐ Almost every time  
☐ Frequently use
7. Types of waste generated in your household "(can choose more than one):  
☐ Food  
☐ Plastics  
☐ Glass  
☐ Metal  
☐ Paper/ Cardboard  
☐ Clothing materials  
☐ Electronic waste (e.g., batteries, old phone)  
☐ Others (please specify): \_\_\_\_\_
8. Do you use different bins for different type of waste?  
☐ Yes, I separate different type of waste.  
☐ No, I did not separate waste.
9. How did you dispose your household waste? (Can choose more than 1)  
☐ Garbage trucks pick up waste at home  
☐ Using community bins  
☐ Recycling

- ☐ Composting (decomposition of organic materials such as food and yard waste)
- ☐ Burning
- ☐ Thrown at open places
- ☐ Other (please specify):\_\_\_\_\_

10. Which of the following difficulties that you have experienced in order to reduce, reuse and recycle your household waste? "(can choose more than one)

- ☐ I don't know how to reduce my household waste
- ☐ I don't know how I can reuse my waste for other purpose.
- ☐ I don't know how to recycle my household waste.
- ☐ I am not interested to reduce, reuse and recycle waste.
- ☐ I did not have time to sort my waste and sent it to recycling center.
- ☐ I don't have enough space at home to keep reusable and recyclable waste.
- ☐ Recycling requires too much effort.
- ☐ Recycling center is too far. There is not much recycling facilities or recycle bin around my housing area.
- ☐ Others (please state):\_\_\_\_\_

11. How often you used a waste management app to manage your household waste?

- ☐ Never use
- ☐ Rarely
- ☐ Occasionally/Sometimes
- ☐ Almost every time
- ☐ Frequently use

## **PART B: TESTING PROTOCOL FOR DIGITAL PROTOTYP EVALUATION**

### **Instructions:**

You are now required to explore and complete the following task in our application. In this evaluation, I am interested in what you think while you perform the tasks. I am going to ask you to talk aloud as you work on the task. What I mean by “talk aloud” is that I want you to tell me everything you are thinking from the first time you hear the task until you finish it. If you are silent for a long period of time, I will remind you to talk. After the think-aloud tasks, I will also ask you a couple of questions about your opinion of the *Tahara* application.

Please remember that you can skip any question or stop at any time if you feel uncomfortable. Are you ready? I will start the recording now.

**Task 1:** These are the welcome messages about the app. Please click “next” button to continue.



**Task 2:** You are new user. Please sign in with your account.

**Task 3:** This is the home page of *Tahara* app. Type of your home address and then search. Then you see a waste collection schedule based on your home address.

**Task 4:** At the main Menu select “Recycle”. At first, you will see the type of recycle waste materials to be collected. Click any waste material and find out how to request a pick up your recycling waste.

- At the recycle page, click “collection history”. Find out what do you see here.
- Next, click on the “Drop off Location” by selecting a name of waste item and find out the best option to dispose of waste, and name of recycling center near your house and their contact information.
- Further, at the Recycle page click “Impact” button and monitor your performance and your contribution towards the environment.

**Task 5:** Go to “Rewards” button. And find out more how to claim your redeem points and get rewards.

**Task 6:** Go to “suggestion” page and find out more an alternative way to reduce your waste.

**Task 7:** Next go to “Dashboard” and click “+” button to select any of the categories of waste disposal to follow Allah’s command and to improve yourself. Select any of the categories and find out the reminder and importance of practicing waste management from Quran and sunnah. And find out how you can improve your behavior in waste management practices.

**Task 8:** At the Dashboard click the “progress” button and see your progress about the selected categories of waste disposal.

**Task 9:** At the settings, check your preferred languages, reminders, profile, and addresses options.

Thank you for completing the tasks. I would now like to ask you some questions regarding your experience of using *Tahara* app.

## PART C: POST-STUDY INTERVIEW

Based on your experience, please rank the following features of *Tahara* app from 1 to 5. (1 strongly agree and 5 strongly disagree).

| No. | Questions                                                                                                                                                                                            | Strongly agree |   |   | Strongly disagree |   | Comments |
|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|---|---|-------------------|---|----------|
|     |                                                                                                                                                                                                      | 1              | 2 | 3 | 4                 | 5 |          |
| 1.  | I liked to use <i>Tahara</i>                                                                                                                                                                         |                |   |   |                   |   |          |
| 2.  | <i>Tahara</i> app has good and attractive user interfaces.                                                                                                                                           |                |   |   |                   |   |          |
| 3.  | The information provided by <i>Tahara</i> app was clear and easy to understand.                                                                                                                      |                |   |   |                   |   |          |
| 4.  | It is easy for me to know specific day/date for specific type of waste collection in <i>Tahara</i> app – which helps me to manage my household waste.                                                |                |   |   |                   |   |          |
| 5.  | The <i>Tahara</i> app guides me from Shariah to manage my waste such as preventing wastage of resources, preventing extravagance, and so on.                                                         |                |   |   |                   |   |          |
| 6.  | The <i>Tahara</i> app provides information about garbage and recycling items collection schedules based on my home address which helps to manage my household waste.                                 |                |   |   |                   |   |          |
| 7.  | The <i>Tahara</i> app shows my performance on waste disposal which motivates me to dispose my household waste appropriately.                                                                         |                |   |   |                   |   |          |
| 8.  | The <i>Tahara</i> app informs my contribution towards the environment by recycling the waste generated which makes me even more motivated to recycle more items.                                     |                |   |   |                   |   |          |
| 9.  | The <i>Tahara</i> app offers rewards points after completing a certain level of recycling – which makes more motivated to recycle more waste.                                                        |                |   |   |                   |   |          |
| 10. | The <i>Tahara</i> app send me notifications and reminders from Quran and Sunnah about the importance to minimize waste – which encourage me to dispose waste appropriately and maintain cleanliness. |                |   |   |                   |   |          |
| 11. | The <i>Tahara</i> app increases my knowledge about the importance of waste management practices to protect the environment.                                                                          |                |   |   |                   |   |          |

|     |                                                                                                                                                                                                                                                                              |  |  |  |  |  |  |
|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--|--|--|--|--|
| 12. | The <i>Tahara</i> app provides suggestion on alternative ways to reduce waste                                                                                                                                                                                                |  |  |  |  |  |  |
| 13. | The <i>Tahara</i> app offers personalized reminders, choose category for waste disposal, personalized with personal photos in profile, addresses. These personalized features makes the app very convenient to use and helpful for me to manage my household waste disposal. |  |  |  |  |  |  |
| 14. | The <i>Tahara</i> app facilitates residents to submit waste collection and public cleansing complaints to Waste Management authority.                                                                                                                                        |  |  |  |  |  |  |
| 15. | The <i>Tahara</i> app provides the name of local waste management organization, a link to their website, and contact information to verify the accuracy. This feature makes me trust on the app.                                                                             |  |  |  |  |  |  |
| 16. | Overall, I think this <i>Tahara</i> app is persuasive and encourage me towards sustainable waste management behaviour.                                                                                                                                                       |  |  |  |  |  |  |

1. Would you interested to use *Tahara* app to manage your household waste? Why /Why not?
2. What did you LIKE most about *Tahara* app?
3. Is there anything that you DISLIKE about *Tahara* app? What are they?
4. Do you consider *Tahara* app PERSUASIVE to change your behaviour towards sustainable waste management practices? Why /Why not?
5. Which feature(s) in *Tahara* app that you think could improve your waste management behavior?
6. Do you feel that there are other features that should be added to improve the persuasiveness of *Tahara* app at encouraging sustainable waste management behaviour? What are they?
7. Do you feel that the design of *Tahara* app is a perfect design? Why / why not?
8. Do you have any feedback or suggestion to improve *Tahara* app?

*That's all. Thank you very much for your participation.*