



**DEVELOPMENT OF 2D BARCODE AUDIT TRAIL
AND DATABASE MODEL SYSTEM FOR
LANDSCAPE NURSERY MANAGEMENT**

BY

HAZREE BIN AHMAD

**A thesis submitted in fulfilment of the requirement for the
degree of Master of Science (Halal Industry Science)**

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International Islamic University Malaysia**

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ABSTRACT

In the past, landscape nursery management as well as maintenance of plants has always been neglected and as such, emphasis should be given so that plants will always remain attractive. Basically, landscape nursery management and maintenance will focus on the management of human resources, choice of plant species and plant care concerning mulching, staking, weeding, irrigation, fertilizing, pruning, pest and disease control. Landscape nursery plants inventory, maintenance and management, will be made much easier if all those problems are maintained within one efficient and cost-effective integrated system. Therefore, there is a need to change the strategies in the landscape nursery management system to satisfy the needs of the more technologically advanced market. To put these strategies into reality, this research aimed to develop fully computerized audit trail and database model system for Landscape Nursery Management using 2D barcode to enable real-time monitoring and recording of landscape maintenance and management activities. The system will also enable monitoring of the human resources management as well as indexing plants for landscape inventory purpose. Sasapadu Nursery (Nilai, Negeri Sembilan) and Tien Cheng Nursery (Muar, Johor) were selected as the site studies to develop the system. The data on both nurseries components such as nursery spatial organization and built-up areas, plant inventories and human resources were collected and established. Consequently, a prototype version of model system was tested to view on default operation system. As a result, a model system was created to improve the audit trail and database upon landscape nursery management. In this system, from supplier to end customer, we can trace all the operation activities. Anticipated benefit from this research is a new kind of barcode that we refer to as 3D barcode can be developed. It encodes data in three dimensions: width, height and color. It can be printed on paper as well as displayed on screens of mobile or spatial devices. On top of that, for future research, one of the most promising new urban tree and nursery management techniques is the development of integrated landscape management system using barcode and RFID technology.

خلاصة البحث

في الماضي، كانت إدارة المشاتل المنظرية وكذلك صيانة النباتات مهملة كثيراً، فينبغي التأكيد على الاهتمام بها وصيانتها لكي تبقى النباتات جذابة دائماً. أساسياً، إدارة المشاتل المنظرية وصيانتها تركز على إدارة الموارد البشرية، واختيار أنواع النباتات ورعايتها فيما يتعلق بالتمهيد، والتسميد، والتعشيب، والري، والتسميد، والتشذيب، ومكافحة الآفات والأمراض. سيتم تسهيل عملية التخزين لنباتات المشاتل المنظرية إذا تم الحفاظ على كل هذه المشكلات ضمن نظام متكامل فعال من حيث التكلفة. لذلك، يجب تغيير الاستراتيجيات في نظام إدارة المشاتل المنظرية استجابةً لاحتياجات الأسواق التكنولوجية المتقدمة. لوضع هذه الاستراتيجيات في الواقع، يهدف هذا البحث إلى تطوير سجل المراجعة المحوسب بالكامل ونظام نموذج البيانات لإدارة المشاتل المنظرية باستخدام الشفرة الخيطية ثنائية الأبعاد لتمكين مراقبة وتسجيل أنشطة صيانة المناظر وإدارتها في الوقت الحقيقي. يمكن النظام أيضاً مراقبة إدارة الموارد البشرية بالإضافة إلى فهرسة النباتات لغرض تخزين المناظر. تم اختيار مشتل ساسافادو (نيلاي، نكري سميلين) ومشتل تين جين (موار، جوهر) كأمكنة مناسبة للدراسة لتطوير هذا النظام. وتم جمع البيانات في المشتلين بمكوناتهما مثل التنظيم المكاني للمشاتل والمساحات المبنية، وقوائم الجرد النباتية والموارد البشرية. وبالتالي، تم اختبار إصدار نموذج أولي من النظام لعرض على نظام التشغيل الافتراضي. ونتيجة لذلك، أنشئ نظام نمذجي لتحسين سجل المراجعة والبيانات الخاصة على إدارة المشاتل المنظرية. وفي هذا النظام، من المورد إلى العميل النهائي، يمكننا أن نتتبع جميع أنشطة التشغيل، فالاستفادة المتوقعة من هذا البحث هو نوع جديد من الشفرة الخيطية التي يمكننا إنشاءها أي الشفرة الخيطية ثلاثية الأبعاد. هذه الشفرة تشفر البيانات في ثلاثة أبعاد: العرض والطول واللون. ويمكن طباعتها على الورق وكذلك عرضها على شاشات الأجهزة المحمولة أو المكانية. علاوة على ذلك، بالنسبة للبحث في المستقبل، فمن أحد التقنيات المرجوة لإدارة الأشجار والمشاتل المتحضرة هو تطوير النظام المتكامل لإدارة المناظر الطبيعية باستخدام تكنولوجيا الشفرة الخيطية وتحديد تردد الراديو

APPROVAL PAGE

I certify that I have supervised and read this study and that in my opinion, it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a thesis for the degree of Master of Science in Halal Industry Science

.....
Rashidi Othman
Supervisor

.....
Khairusy Syakirin Has-Yun
Hashim
Co-Supervisor

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a thesis for the degree of Master of Science in Halal Industry Science

.....
Mohd Ramzi Mohd Hussain
Internal Examiner

.....
Mat Naim Abdullah
External Examiner

This thesis was submitted to the International Institute For Halal Research And Training and is accepted as a fulfilment of the requirement for the degree of Master of Science in Halal Industry Science

.....
Yumi Zuhani Has-Yun Hashim
Deputy Dean, Academic &
Student Affairs, International
Institute For Halal Research And
Training

This thesis was submitted to the International Institute For Halal Research And Training and is accepted as a fulfilment of the requirement for the degree of Master of Science in Halal Industry Science

.....
Hamzah Mohd Salleh
Dean, International Institute For
Halal Research And Training

DECLARATION

I hereby declare that this thesis 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.

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CHAPTER ONE

INTRODUCTION

1.1 RESEARCH BACKGROUND

The average trend growth of landscape nursery industry has started since the 1950's. According to Hanim (2000), the growth has tremendously changed ever since the Malaysian government has proposed "The Most Beautiful Garden Nation" campaign in 1997. Since then, the industry has emerged in such a colourful way. Towards the vast growth, specific issues have been highlighted regarding the landscape nursery, including quality standards, specification, regulatory, main power, and maintenance, causing a big hindrance towards the industry. However, the solutions for these issues had always emphasized only on a specific part of the industry, for example, on construction (Roziya et al, 2009).

Barcode technology is always one of the best solutions in overcoming database management issue. Various related databases such as regulatory, maintenance, and quality standard can be linked by a barcode technology. According to Ohbuchi et al. (2004), barcode technology has already been used all around the world and helps a lot of industries to improve their inventory system. The commonly used barcode is a linear barcode. The barcode technology has gone through an inevitable evolution. The application of 2D barcode technology in the industry is still minimal. The application of 2D barcode in financial business is limited to information perspective (Gao et al, 2009). Therefore, the integration of 2D barcode with a database system can be practised in the landscape nursery industry.

1.2 PROBLEM STATEMENT

The development in urban areas leads to deforestation. Therefore, the government has been running a campaign called “Hijaukan Bumi Kita” (*Reforest our Earth*) as one of the steps to create *City in a Garden*. According to Venhaus (2012) and Carpenter (2012) every developer should take into account the aspect of the landscape in urban areas development. However, most of the landscape nursery industry in Malaysia is yet ready to change or upgrade, especially in their management system. Therefore, this research seeks to emphasise a 2D barcode for nursery management system solutions. Since the early 1950’s, landscape nursery has become a big industry in Malaysia. The growth of this industry is slightly faster since Malaysia is a tropical and humid country. But unfortunately, the management of this business has remained conventional until nowadays. The lack of inventories and databases, maintenance and manpower are always being issues to the entire industry players. Even though not all of the nurseries in Malaysia have faced the problems, most of them are still struggling to improve it.

1.2.1 Lack of Inventory and Database System

A well-kept and up-to-date nursery inventory helps to assess, whether the nursery is operating as planned or whether the demands are met. A poor inventory can lead to a scenario, in which the proper parts are not available for a product because of the failure to check the inventory database system. Besides, it can cause a loss in cost-effectiveness, since the potential product for trees example were too big and old over time due to reasons beyond our control. The poor inventory and database system will also result in bad planning. (Bingi P et al., 1999).

1.2.2 Lack of Maintenance Management System

The nursery should be treated as a hospital and not a store. Proper maintenance will lead to an excellent production. Krishnan et al. (2014) and Ryszkowski (2001) stated that the most common problems in maintenance are:

- i. the containers were not correctly filled
- ii. the containers are not in an upright position
- iii. soils or sands used in germination beds were not changed after each production cycle
- iv. the sowing seed is too deep
- v. lousy transplanting causing delays in a transplant to container beds
- vi. poor watering system (sources and watering)
- vii. poor root pruning for transplanting
- viii. inadequate attention paid to root pruning in transplanted containers before transporting to field

1.2.3 Lack of Human Resources Management

According to Abdullah, (2011) and Zweig (1991), most firm or nurseries do not have a proper system in managing their employees. Logbook for attendance and leave is still widely used. Job schedule is also based on daily necessities and not from a proper planner or according to a job description. With this routine, it is difficult for the employer to monitor every single worker, and to plan for the future operation. In addition, the Key Performance Index (KPI) for an employee cannot be evaluated since there is no indicator for the employers to refer. Hence, the employee can cheat on their routine or simply resign.

1.3 RESEARCH QUESTIONS

Referring to the problem statement mentioned above, the specific questions to be addressed in this research are outlined as follows:

- i. What are the components of Landscape Nursery Management?
- ii. How to incorporate the components of Landscape Nursery Management in the barcode technology?
- iii. What are the systems that can be proposed to improve the previous systems or methods?

1.4 RESEARCH AIM AND OBJECTIVES

The aim of this research is mainly to develop an audit trail and database information system for Landscape Nursery Management using 2D barcode. Listed below are the objectives of this research:

1. To identify the components (inventory, database, and maintenance) in landscape nursery management.
2. To design a system requirement based on the components gathered.
3. To develop and implement the system as required.

1.5 HYPOTHESIS

Landscape Nursery Management can be well-organised by using Information Technology such as a 2D barcode technology.

1.6 RESEARCH METHODOLOGY

In brief, this section will explain on how the research will undergo three main methods to fulfil the three objectives. The three methods are:

1. Nursery Component & Plant Material Studies.
2. Development Database System and Barcoding System.
3. System Development Life Cycle (SDLC).

For the first method it will include data collection and finding a reference sources. It will comprise an observation and direct interview which involve two sites. For second and third method it will include a lot of technical issue and will explain detail in Chapter three.

1.7 SIGNIFICANCE OF THE RESEARCH

In the past, landscape nursery management as well as maintenance of plants has always been neglected and as such emphasis should be given so that plants will always remain attractive. Basically landscape nursery management and maintenance will focus on management of human resources, choice of plant species and plant care with respect to mulching, staking, weeding, irrigation, fertilizing, pruning, pest and disease control. Landscape plants inventory, maintenance and management will be made much easier if all those problems are maintained within one efficient and cost effective integrated system especially in urban setting. Therefore, there is a need to change the strategies in the landscape nursery management system to satisfy the needs of the more technologically advanced market. To put these strategies into reality, the objectives that need to be achieved are to develop fully computerized audit trail system using 2D barcoding system to enable real time monitoring and recording of landscape nursery maintenance and management activities. The system will also enable monitoring of the human resources management as well as indexing plants for landscape inventory purpose.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

In this chapter, it discussed on several issue regarding this thesis. The main part in this chapter is deliberate previous research or issue. For the first part in this chapter, the application of QR in industry nowadays and the needs of it certain field. Furthermore, it will explore in landscape industry in detail. Lastly, the meaning and application of barcode together with it technology.

2.2 APPLICATION OF QR CODE IN INDUSTRY

Quick Response (QR) code was created in 1994 (Ji Qianyu, 2014) and has served so many purposes since then. It is also called the matrix code used as the information storage system. According to Hicks et al. (2014) and Ngee (2010), some information that can be attached to this code are digits, texts, internet links, and many other types of information. This information can be read with the help of QR scanners or mobile phones. The developing technologies and changing needs of the society dictate the format of the QR codes. Nowadays, the QR code is a great use for so many purposes such as business cards, information stands, leaflets, goods identification, information provided on notice boards, and advertising brochures. One of the fascinating usages of the QR code is the usage of it in the green areas of the cities. These areas may serve their purpose as either educational, recreational, or artistic. The QR code can also be utilised as a code to introduces the research data. So the QR code can best described as one of the best solution to solve database and audit trail problem occurs in every company.

Barcodes have been utilised for record keeping in botanic gardens, but the success of its implementation is highly questionable. It was also reported that the use of barcodes in living collections are considered obsolete. It is quite hard to believe; the level of success barcodes has achieved in almost any professional logistic or auto-ID application. A research team once tried to find the “sweet spots” of barcode usage and applied the system at the Hortus Botanicus Amsterdam. According to Manning (1999), integrating the barcode with the list-making system in the collection management software was proven as an advantageous device in improving the quality and accuracy of the inventory.

2.3 LANDSCAPE NURSERY INDUSTRY IN MALAYSIA

Landscape nursery has garnered high interest across the globe where the researchers are interested in developing such topic. Based on Hopper (2011) and Roziya et al. (2009), landscape nursery component can be divided into softscape and hardscape. The softscape consists of soil, trees, plants, flowers, and colour schemes, while stones, rocks, patios, gates, and driveways are considered hardscape. Plant soil, trees, plants, flowers, as well as hardscape such as flowerpot are the product in the landscape nursery. The trend of landscape nursery has improved from a small scale to a big scale industry, since 1950's (Strom et al., 2013). However, the business model remains the same as it only acts solely as a medium to improve the products.

Managing database, inventory system, and the maintenance of the nursery are some of the aspects that need to be improved in the landscape nursery business. Ibrahim et al. (2009) and Walliss & Rahmann (2016) stated that a bad inventory system might cause poor system management, and this is one of the aspects that landscape nursery in Malaysia needs to work on. The poor inventory system can potentially lead to a

significant loss to the business owner. Hence, having a proper inventory system will increase efficiency as well as cost effectiveness.

Apart from the inventory, the database management system is also very crucial in the landscape nursery as it is highly related to the future business goal planning. Waller (2001) and Marsh (2005) stated that a proper database is essential to ensure that the operation and the stock are adequately maintained. He also expressed the utmost importance of proper and detailed types and categories of a feature in nursery management.

Moreover, maintenance plays an essential role in the success of the production and operation area. According to Davidson et al. (2000) and Margaret et al. (2007), it is imperative to ensure that the nursery has a good maintenance system as it leads to better-quality products. However, it is stated by Webb (1998) that it is important to highlight that most nurseries in Malaysia entirely lack in this department, and most of them do not have a proper maintenance system to monitor the business process. It is quite common that the nurseries in Malaysia still apply the “trust in your workers” method, and this is not a good sign as the industry nowadays is heading to the utilisation of ISO practice (Hasan et al., 2017). It is crucial that all the operations are accordingly recorded and closely scrutinised to improve the effectiveness of the business model (Ibrahim et al., 2009).

One of the most recent solutions regarding the improvement of the inventory system is the barcode technology (Sriram et al., 1996). The industry players commonly use the barcode technology due to its nature to ensure that the business applies a sufficient and systematic inventory system. According to Vena et al. (2013) the barcode system has been developed from time to time throughout the decade, and various studies were conducted to improve the system. The first barcode invented was utilised only for

the products in a small market, where the bull arrow concept was used. It was firstly developed in 1950 by Woodland. Based on Hong-Ying (2009), due to its high demand, barcode has evolved vastly in recent years. International Business Machine (IBM) invented a widely utilised the barcode called 1-Dimensional (1D). 2-Dimensional (2D) barcode was then introduced, and this system allows the user to carry more data compared to the 1D barcode (Gao et al., 2007). Barcode is believed able to solve many issues that are faced by the landscape nursery owners. According to Turner et al. (2003), medical sectors are among the heavy users of 2D barcode that serves to monitor their database.

Wang et al. (2009) reported that database management could be monitored and printed out just with the utilisation of a smartphone. Eventually, according to Ratnasingham & Hebert (2009), the database management helps to avoid various issues such as late delivery, misleading report or stock, and many others. Apart from those, barcode also plays a huge role in improving the effectiveness of the workers. Barcode can be utilised to monitor the job scope and the implementation of work (J. Gao et al. 2009), and it can be easily performed by the “check-in barcode”.

2.3.1 Types of Nurseries

There are several types of landscape nurseries. According to Ekanem et al., (2000), landscape nursery can be classified into five major businesses, categorised according to their marketing or business strategy. Below are the descriptions for five types of nurseries:

2.3.1.1 Retailers

Smith (1997) mentioned that the retailers aim to ensure that they can sell the products directly to the end consumer, mainly homeowners. The practice is usually conducted through retail nurseries or garden centres. Retail nurseries are expected to produce their own plant material, while the garden centres purchase their stock from a wholesale nursery. It is crucial for the retail nurseries to be strategically located in a place that is accessible for consumer access. Urban or high traffic areas are the preferred location for this type of business. Apart from that, a proper space and excellent facilities are necessary for the production, and they can be located either on-site or in the nearby area (Phan & Vogel, 2010).

2.3.1.2 Mail-Order

Similar to the retailers, mail-order nurseries also targeted the end consumers. The difference is their plants are sent directly to the consumer, not sold at a retail outlet. This brings a more significant opportunity compared to retailers as it allows communication across the globe. Plant enthusiasts around the world can easily be the customers of these nurseries. Based on Simon et al. (1965) and Burton et al. (2010), due to high shipping costs and packaging issues, most mail-order nurseries only sell bare root or small container-grown plants. However, if the plants are deemed of high value, larger plants are also available at the mail-order nurseries.

2.3.1.3 Wholesalers

Research done by Nishimura (2005) and Tajudin et al. (2014) mentioned that, wholesalers are the places that produce plants in large batches, and since the production amount is quite high, the prices are remarkably lower. Their primary customers are retailers, landscapers, and other nurseries that grow and resell the material at a larger size. This type of production is quite beneficial when the number of plants is limited, and they are all grown in large numbers.

2.3.1.4 Re-wholesalers

Re-wholesalers are designated to place large orders of numerous plants from wholesale producers, and at the end of the day, they resell the plants to landscapers who need vast diversity in their requests but in small quantities.

2.3.1.5 Landscape Nurseries

Landscape nurseries usually produce plants that serve their own in-house landscaping business. Some landscape nurseries have their own retail outlet (Garber & Bondari, 1992).

2.4 NURSERY COMPONENTS BUILT-UP AREA

It is possible for the nurseries to grow plants in tunnels, on container fields, open fields, or even greenhouses. Open field nurseries usually cater to grow shrubs, ornamental trees, herbaceous plants, and plants meant for the wholesale trade or for amenity plantings. Container field nurseries produce shrubs, herbaceous perennials, and small trees to be sold to the garden centres. It is essential to have a basic structure in the built-