IMPLEMENTATION OF VISION PICKING TECHNOLOGY TOWARDS WAREHOUSE PERFORMANCE OF LOGITICS FIELD IN MALAYSIA

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DECLARATION OF ORIGINAL WORK

I hereby declare that all the work of this thesis entitled "The implementation of vision picking technology towards warehouse performance of logistic field in Malaysia" was originally done by myself, except for certain explanations and passages where sources are cited. There is no portion of the work encompassed in this research project proposal has been submitted in support of any application for any other degree or qualification of this or any other institute or university of learning.

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DEDICATION

I would like to dedicate this research to my beloved parents who have always motivated and educated me until now. Furthermore, a big appreciation for my beloved supervisor and panel for guiding me throughout this research. With their care and support, I could complete my final year project (FYP) successfully.

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ABSTRACT

Abstract—Augmented Reality (AR), one of the most notable technologies of the Fourth Industrial Revolution (IR4.0), enhances the user's real-world experience by utilizing wearable technology and the capabilities of the computer-generated display, sound, text, and effects. Operations for order picking in warehouse management systems (WMS) significantly affect overall operational effectiveness. Because of how tedious the traditional picking process is to manage, picking performance may differ from expectations. Vision picking technology, a novel technology for order picking, is growing in acceptance and is now seen as a crucial technology supporting WMS. This thesis provides a brief overview of the application of vision-picking technology toward warehouse performance in the logistics field in Malaysia. This study also creates a taxonomy arrangement of literature reviews vision vision-picking technology in the warehouse of the logistic field, to show the focus of the major topic of the study, in addition to presenting the fundamental idea of vision-picking technology performance. The analysis will generate major key conclusions that are crucial to the perspective of implementing vision-picking technology to optimize the 3PL warehouse performance such as efficiency, productivity, and cost reduction. Implementation of vision picking is very important for the future development of the logistics field in our country to improve living standards.

Keywords: vision picking technology, warehouse performance, logistic field

ABSTRAK

Abstrak—Augmented Reality (AR), salah satu teknologi yang paling ketara dalam Revolusi Perindustrian Keempat (IR4.0), mempertingkatkan pengalaman dunia sebenar pengguna dengan menggunakan teknologi boleh pakai dan keupayaan paparan, bunyi, teks dan yang dijana komputer. kesan. Operasi untuk memilih pesanan dalam sistem pengurusan gudang (WMS) memberi kesan ketara terhadap keberkesanan operasi keseluruhan. Disebabkan betapa membosankan proses pemilihan tradisional untuk diurus, prestasi memilih mungkin berbeza daripada jangkaan. Teknologi pemilihan visi, teknologi baru untuk pemilihan pesanan, semakin diterima dan kini dilihat sebagai teknologi penting yang menyokong WMS. Tesis ini memberikan gambaran ringkas tentang aplikasi teknologi pemilihan visi ke arah prestasi gudang bidang logistik di Malaysia. Kajian ini juga mewujudkan susunan taksonomi kajian literatur teknologi pemilihan visi di gudang bidang logistik, untuk menunjukkan fokus topik utama kajian, di samping membentangkan idea asas teknologi pemilihan visi. Analisis tersebut akan menjana kesimpulan utama utama yang penting kepada prospek melaksanakan teknologi pemilihan visi untuk mengoptimumkan prestasi gudang 3PL seperti kecekapan, produktiviti dan pengurangan kos. Pelaksanaan vision picking adalah sangat penting untuk pembangunan masa depan bidang logistik di negara kita demi meningkatkan taraf hidup.

Kata kunci: teknologi pemilihan penglihatan, prestasi gudang, medan logistik

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AR	Augmented Reality
3PL	Third party logistic
PBL	pick-by light
PBV	Pick-by voice
WMS	Warehouse management system
VR	Virtual Reality
H1	Hypothesis One
H2	Hypothesis Two
H3	Hypothesis Three
SPSS	Statistical Package for Social Sciences
IT	Information technology

CHAPTER 1

1.0 INTRODUCTION

This chapter will begin with the background of the study based on vision picking technology performance and its effect on 3PL warehouse performance in the logistics field at Melaka Malaysia. Next, this chapter will identify the problem statement according to the research background. Thus, the research questions and research objectives of the research will be identified. Later, the scope and limitations of the study will be stated. Then, the significance of the study provides readers with information and details about how the study contributes to the various parties. The thesis outline is the last part of this chapter and will discuss the research flow from chapters one to five.

1.1 BACKGROUND OF THE STUDY

Increasing competition forces businesses to enhance their logistics capabilities. Warehouse performance is a crucial aspect of logistical performance. A successful warehouse operation will boost quality, delivery efficiency, customer happiness, and logistics system costs. Warehouses are special locations for handling and storing goods. Warehouses maintain goods to supply internal departments like production and manufacturing in supply-driven supply chains. Warehouses store commodities in demand-driven chains to satisfy the demands of external clients (Elisa Kusrini et all 2018).

Order picking can be claimed to have a major impact on logistics costs and customer satisfaction after the procedures of a warehouse workflow have been taken into consideration (Franzke, T. 2019). Order picking is the most labor-intensive process in manual warehouses, accounting for 55% to 65% of all operational warehouse costs, whereas order picking in automated warehouses is capital-intensive due to the high investment costs. This is the key justification given by logistics experts who prioritize warehouse upgrades by concentrating primarily on the order-picking procedure.

To meet the needs of the customers, logistics and manufacturing systems and the employees inside them must become more adaptable. There are numerous methods for picking orders in warehouses. Traditionally, workers carried out instructions using paper lists, which are simple for humans to understand but difficult to manage. Paperwork is not used in contemporary systems. They include portable data input devices that require significant handling effort even though they usually connect digitally to the warehouse management system (WMS) handling the data (they, 2018). Scanner, Pick-by-Light, and Pick-by-Light are common order-picking systems. In contemporary warehouses, pick-by-scan with or without scanning devices, pick-by-voice (PbV), or pick-by-light (PbL) technologies frequently replace worker support based on a customary paper list. Each of these technologies has unique benefits and drawbacks. PbV assists the employee by providing him with all instructions via the computer's voice output. These technologies, unfortunately, have trouble in loud industrial settings.

The most crucial element in developing a productive picking system is identifying the best solution or technological combination (zivanic, D. 2019). Pick-by-vision refers to a cutting-edge logistics concept made possible by the employment of smart glasses that, thanks to WLAN technology, enable the transfer of data straight from the server into the immediate field perspective of the picker. Smart glasses are an example of an AR device. When worn, the virtual worlds shown in the field perspective are connected to the real world the user sees. The screens, cameras, and microphones they are outfitted with make this feasible. When a picker picks up a product using a bar code scanner, his glasses will light up green if the goods is good or red if it is the incorrect item.

1.2 PROBLEM STATEMENT

The basic warehouse workflow consists of four essential tasks that need to be optimized in terms of their usage of money, time, space, and labor. Order Picking in the WMS According to van Gils (2018), order picking is the most important procedure in all warehouse operations and accounts for 55–65% of the costs. When preparing an order, order picking entails finding a specified item in storage using a list, loading the products into the appropriate carriage or vehicle, and transporting them to the designated location for the subsequent operations. Furthermore, it is regarded as the most significant and time-consuming task in warehouses. Due to its simplicity, low cost, and relative flexibility in changing volumes of the picking process, manual order picking, which often uses paper, has always come naturally to humans (Lu, 2016). However, the repetitive reading and verifying process wastes a lot of time and increases the likelihood of human error. This could lead to departures from the performance goals for picking in the warehouse. (Zivanic D 2019).

In Malaysia, the warehousing sector is taking on a more important position in the logistics service business. However, the Eleventh Malaysia Plan, 2016-2020, states that by 2020, the nation hopes to rank among the top ten countries in the World Bank's Logistic Performance Index (LPI) and become the most popular logistics gateway in Asia. The Malaysian Productivity Corporation (2017) asserted that compared to other industries, the warehouse sector is less likely to adopt innovations and changes that will boost efficiency and productivity. The lack of productivity performance in warehouse operations is the issue that this study investigates since it stands in the way of Malaysia's ambitious growth goals for the year 2020. This study's goal is to present vision-picking technology as a solution to this problem (Nur Hazwani Karima et all 2018).

Every business wants to improve earnings, and one of their key goals is to cut costs. The main expenses at a warehouse when picking operations are performed are travel expenses, which are proportional to the amount of distance that the picker must travel to pick up the item. We can see that order-picking operations, which might take up to 50% more time, are the most time-consuming. shows that with the correct technology, travel distance can be cut by 45%. Order batching issues are directly tied to stopping costs, which are correlated with the variety of choosing stops. The cost of picking depends on how many cartons are picked up at each stop. Closing costs are all the expenses connected to running the computer station. The adoption of vision-picking technology is quite low in Malaysia. This is because many warehouse companies lack the necessary expertise regarding vision-picking technology and assume it will be expensive (van Gils et all 2018).

In foreign nations, vision picking is used, with Coca-Cola, HBC, and DHL serving as effective examples of AR applications. Since 2019, Coca-Cola HBC has used the TeamViewer application xPick running on RealWear HMT-1 smart glasses in its distribution center in Thessaloniki, Greece. The glasses are used by the company's warehouse staff to deliver order data to customers along with the Coca-Cola HBC SAP production system and warehouse management system. Coca-Cola HB said that after the vision picking system had been in place for two months, picking performance had improved by about 6-8% overall, with picking accuracy using smart glasses reaching 99.9%. (Michael Sinclair, 2022). This means is it also can applicable in Malaysia which will boost warehouse performance.

This study will look at the vision-picking technology performance effects in a Malaysian 3PL warehouse performance. This is because the warehouse in Malaysia can only accommodate a specific number of pickers. After all, more pickers would result in a decline in productivity and a negative spiral when demand surges. Many workers today are required to work overtime, which not only affects the workforce but also costs a lot of money. Vision-picking technology would solve every issue that Malaysian 3PL warehouses are now facing.

1.3 RESEARCH QUESTION

There are three research questions to be listed to allow the researcher to choose the right research methodology and focus on the area related to the topic. The research questions are:

1. How implementation of vision-picking technology affect the efficiency of warehouses in the logistics field in Melaka?
2. How does the implementation of vision pick technology affect productivity warehouse in the logistics field in Malaysia?
3. Does the implementation of vision-picking technology reduce the cost of warehouses in the logistics field in Malaysia?

1.4 RESEARCH OBJECTIVES

The research objectives are developed based on the needs of the research question of the study. The entire study will be conducted by using these objectives.

1. To determine the efficiency of the logistic field warehouse in Malaysia by using vision-picking technology performance.
2. To investigate the productivity of the warehouse logistic field in Malaysia by using vision-picking technology performance.
3. To evaluate the cost reduction of vision-picking technology performance in the logistics field warehouse of Malaysia.

1.5 THE SCOPE OF STUDY

The scope of this study will emphasize the implementation of vision-picking technology and its performance towards logistic field warehouse performance in efficiency, productivity, and cost reduction. Within warehouses, vision picking or Augmented reality (AR) has been increasingly utilized by Foreign logistics companies over the past few years, as logistics companies look to make operations more efficient and cost-effective. AR such as head-mounted displays and smart glasses are increasingly making appearances in the warehouses of third-party logistics companies. These vison-picking can give workers crucial insights such as which directions to take to get to the designated item required, or hands-free barcode scanning to ensure order picking is efficient. This vision-picking can even aid warehouse technicians in detecting, diagnosing, and solving issues with machinery before a catastrophic failure occurs (Michael Sinclair, 2022). The respondents will be targeted as 3PL warehouse-related people around Melaka whether they know about the vision-picking technology and its performance. Next, the researcher will collect suggestions from the respondents about implementing vision-picking technology towards the performance of logistic field warehouses in Malaysia.

1.6 LIMITATION AND KEY ASSUMPTION

The limitation of this study is the lack of infrastructure and technology for implementing vision-picking technology at warehouses in Malaysia, which may cause respondents not to have sufficient viewpoints to answer the survey on warehouse performance. Therefore, it may lead to the results obtained varying greatly.

The limitation only focuses 3PL warehouse in Melaka which is in the logistic field and currently uses the old order-picking method which relates to the study. The limited generalization of the study's findings to other regions or settings may be due to the study's small sample size of the 3PL warehouse. The key assumption is similar difficulties arise in order picking and there is no development in technology-wise in the 3PL warehouse in Malaysia. This is because it affects the warehouse performance. The information gathered correctly captures the participant staff's experiences and viewpoints. The suggested answers to the problems mentioned are workable and efficient.

1.7 SIGNIFICANCE OF THE STUDY

The study aims to provide a comprehensive knowledge implementation of vision picking technology and its performance towards the performance of logistic field warehouses in Malaysia. This will explain how productive, efficient, and cost-saving warehouse performance is by using vision-picking technology performance. At the end of the research, it would benefit 3PL warehouses in Malaysia to have an interest in implementing vision-picking technology. They will gain relevant data and information that can be used to motivate warehouse owners in Malaysia to convert from the old picking method to the latest picking method with high technology. They also can better understand what difference that vision-picking technology will bring into warehouse performance compared to other picking methods.

1.8 KEY CONCEPT

A. Order picking

The picking order procedure entails taking the packing slip, which serves as written instructions for taking the products, and following it through to handing the checker the goods. Order The act of choosing involves selecting products from a shelf location in response to customer demand. For distribution warehouses to be successfully managed and run, the picking order function is essential. Order picking is the costliest activity in warehousing and can account for up to 65% of all operational costs for warehouses. Because of this, it is prioritized to increase productivity. Order picking is another task that requires a lot of labor, whether it is done manually or automatically in a warehouse. The product demand, warehouse configuration combined with routing techniques, and personnel experience are some of the elements that have an impact on the effectiveness of picking orders. Travel time, picking time, and remaining time are the three components of picking time.

B. Warehouse performance

Increasing competition forces businesses to enhance their logistics capabilities. Warehouse performance is a crucial aspect of logistical performance. A successful warehouse operation will boost quality, delivery efficiency, customer happiness, and logistics system costs. Warehouses are special locations for handling and storing goods. Warehouses maintain goods to supply internal departments like production and manufacturing in supply-driven supply chains. Warehouses in demand-driven chains keep products to satisfy the demands of other parties. The complexity of the logistic network has increased, and as a result, warehouse performance evaluation has become a crucial concern (Elisa Kusrini et all 2018)

C. Vision-picking technology

For a quicker, hands-free solution in industrial settings, the Pick-by-Vision/Vision picking system, which makes use of wearable technology, incorporates vision-guided technologies. This order-picking system combines virtual information and visuals with the operator's surroundings using smart glasses. The user wears the glasses, complies with instructions, and reads product barcodes all from the display of the glasses. Pick-by-Vision systems can be supported by non-AR hardware platforms including Head Mounted Displays (HMDs) and Smart Glasses as well as wearable AR devices.

D. Logistic Field

By industry, logistics can be divided into five categories: sales logistics, manufacturing logistics, recovery logistics, and recycling logistics. Before learning more about them, it is important to understand the many domains and types of logistics. The difference between recovery logistics and recycling logistics is that recovery logistics recovers items from consumers whereas recycling logistics recycles the goods that are gathered. In this thesis, the term "3PL" (third-party logistics) refers to outsourced logistics services, which comprise everything requiring the administration of one or more components of procurement and fulfillment activities. The term "3PL" is used in the business world to describe any service contract that includes the shipping or storage of items. A 3PL service might be a single supplier, such as shipping or warehouse storage, or it can be a system-wide group of services that can handle supply chain management.

1.9 SUMMARY

Chapter One focuses on providing an introduction to the overall research. This chapter studies the background, problem statement, research objectives, research questions, significance of the study, scope and limitations of the study, and thesis synopsis. Research questions are established from the research background and the problem statement, and research objectives are used to answer the research questions.

1.10 SYNOPSIS

First and foremost, chapter one focuses on providing an introduction to overall research. This chapter will include the study background, problem statement, research objectives, research questions, significance of the study, scope and limitations of the study, and thesis outline. Research questions are established from the research background and the problem statement, and research objectives are used to answer the research questions.

Secondly, chapter two will discuss the literature review of the studies and analyze the results of previous studies as a reference, reviewing dependent and independent variables. The vision-picking technology represents the dependent variable while logistic warehouse performance of the logistic field in Malaysia such as efficiency, productivity, and reduced cost. as efficiency, productivity, and reduced cost will represent independent variables in this research.

The third chapter will introduce the research framework and conceptual framework to develop research hypotheses. Then, the components of the research methodology will be discussed including the construction of the research design, data collection methods, data analysis technique, and sampling design. These components are used to generate results that respond to hypotheses in the research.

Furthermore, chapter four will focus on presenting the data analysis and analysis results using SPSS tools. The data analysis will include descriptive statistics, reliability analysis, normality tests, and validity. To collect the data, the distribution of questionnaires is carried out within one month.

Lastly, chapter five will discuss the results from the collected data and provide a comprehensive recommendation for future researchers and a conclusion for this research. A discussion of research hypotheses and research objectives, limitations of the study, suggestions for future research, and overall conclusions will be included in this chapter. The discussion of research hypotheses and research objectives is based on the data results generated by the SPSS tool.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

In this chapter, the literature review of the study focuses on the implementation of vision-picking technology towards warehouse performance in Malaysia. This chapter will provide relevant information and knowledge to readers by explaining the greater detail of independent and dependent variables. The independent variable in this research is the warehouse performance such as efficiency, productivity, and cost saving. The dependent variable of this study is vision-picking technology. This chapter intends to allow the researcher to explore and apply theories related to the research topic, thereby providing a detailed discussion of the research title and variables.

2.2 VISION PICKING

Vision picking is a type of picking technique that can be based on augmented reality (AR) technology, among other technologies, and works by giving the order picker, who is wearing an HMD, visual instructions. In augmented reality (AR), digital information is superimposed over the pre-existing psychological reality. It combines actual and virtual information. AR uses a 3D environment to function and serves as a virtual reality medium for real-time interactions between people and objects. According to W. He et al. (2019), combining actual and virtual environments, real-time interactions, and enabling spatial relationships between the two environments are the three main qualities that characterize augmented reality. The information required for the choosing process is shown by pick-by-vision systems in various ways (text, symbols, graphics, and guiding indications). The computer acting as the scene generator, a type of input device, and a tracking system are the main components of a general pick-by-vision system (Elisa Kusrini et al. 2018). The HMD is controlled by a handheld-sized mobile computer that is worn on the user's body. The adjustment/confirmation button, the user's voice, or the movements of the user's head are how the computer and order picker communicate. There are two types of pick-by-vision systems: systems without a system for tracking and systems with a tracking system.

Without tracking, pick-by-vision systems display each item line of a picking order statically on the HMD. Since the HMD displays all picking-related information, carrying a pick list is no longer necessary. The picker of orders has spare hands. He receives information via a visual channel regarding the product's item number, amount, storage shelf, and occasionally even an image of the item. The user's position in a workspace and the direction of his or her head must be continuously tracked by a tracking system for sophisticated information representation. Along with the data from pick-by-vision systems without tracking, pick-by-vision systems with tracking systems offer a dynamic visualization for navigating the warehouse. Because required instructions are always available to the user on the HMD, pick-by-vision systems are acknowledged as having great potential for reducing errors (Rammelmeier et al., 2011).

2.3 TECHNOLOGY

Augmented reality (AR) technology is used in vision picking which combines digital information with the real environment. It makes use of technology techniques such as multimedia, 3D modeling, real-time tracking and registration, intelligent interactions, sensing, and others. The idea behind it is to imitate the real world before adding computer-generated virtual information to it, such as text, images, 3D models, music, and videos. Because of how well the two sorts of knowledge complement one another, the real world is better.

Internationally recognized research institutes, universities, and businesses have recently made investments in the study of AR and published many publications and scientific research findings. These findings support the viability and inventiveness of augmented reality as a tool for human-computer interaction. As computer software and hardware have become more powerful, augmented reality (AR) has gradually moved from the theoretical study stage of the laboratory to the stage of mass and industry application. As a link between the digital and physical worlds, AR gives people a new way to perceive and interact with their surroundings. Additionally, reputable organizations like the American Times Weekly have listed it as one of the top ten emerging technologies for the future. In the realm of Internet research, cloud computing has recently attracted a lot of attention. It offers a potential distributed architecture pattern for complicated interactive physical effects computing by transferring storage and complex computation from the client to a cloud computing environment (Yueqing Chen et al. 2019).

Sales and logistics are interdependent on one another. The effectiveness and speed of the delivery of goods in a warehouse-customer connection is the key factor in the relevance of logistics for overall sales. Logistics 4.0 is the outcome of recent technological advancements that have transformed and digitized numerous procedures throughout the logistics process [12]. improved computer vision techniques, like augmented reality, are another example of how technology has improved. It can affect and streamline crucial warehouse procedures like product collection, sorting, and loading. By making it simpler for employees to pick items, demonstrating to them how to sort the range, assisting employees in loading items in the best order possible, and identifying and alerting employees to the risk of harm when distributing items, this technology makes the warehouse smarter (Kress et al., 2021). IoT, which enables us to link devices, things, and people to the Internet, enables us to accomplish all of this. This will make data and information much more easily accessible in warehouses. Although there are numerous applications for augmented reality in the logistics sector, vision-picking technology is the most popular. As previously indicated, an HMD display, such as different kinds of smart glasses, mediates pick-by vision.

Although Malaysians typically accept new technologies slowly, there is no denying the value and importance of technologies like augmented reality (AR), virtual reality (VR), and artificial intelligence (AI). Gaming, tourism, retail, and other industries in Malaysia are gradually embracing augmented reality technology. Marketing and entertainment are two industries in Malaysia where augmented reality is widely used. By implementing their marketing strategies in their Malaysian subsidiaries, international corporations are introducing AR technology to Malaysians. Additionally, new Malaysian businesses operating in industries related to augmented reality are growing every day. A Malaysian warehouse is prepared to adopt augmented reality.

Unfortunately, compared to other sectors like healthcare, defense, and education, supply chain and logistics have adopted augmented reality (AR) to a far smaller extent due to Malaysian society's delayed adoption of the technology. If the industries are not prepared to embrace The Fourth Industrial Revolution, which included AR as one of the nine pillars, Malaysia may face economic difficulties. Users may not have completely appreciated the potential of AR before engaging in VR as a result of the widespread adoption of VR, which overshadowed the benefit of AR. Therefore, compared to AR, VR is significantly more well-established in Malaysian users' knowledge and perception. AR reduces picking errors and helps the company's product reach the consumer efficiently and effectively from the warehouse. In addition, the rate of AR acceptance among Malaysian users has been steadily increasing, and there are increasingly more studies being done on the topic of marketing. As a result, Malaysia's logistic sectors must also alter to keep up with the rapid trend associated with The Industrial Revolution 4.0(Choon Ching Ng & Chandrashekar Ramasamy 2018).

Malaysia's warehousing sector is rising to prominence as a major player in the logistics service industry. However, the Eleventh Malaysia Plan, 2016-2020, states that by 2020, the nation hopes to rank among the top ten countries in the World Bank's Logistic Performance Index (LPI) and become the most popular logistics gateway in Asia. The Malaysian Productivity Corporation (2017) asserted that compared to other industries, the warehouse sector is less likely to adopt innovations and changes that will boost efficiency and productivity. The lack of productivity performance in warehouse operations is the issue that this study looks into since it stands in the way of Malaysia's ambitious growth goals for the year 2020.

2.4 VISION PICKING TECHNOLOGY

According to V. N. Herzog et al. (2018), vision-picking technology uses head-mounted displays or virtual reality glasses to provide visual help for the order-picking process. Processing orders using tools that enhance the reality perceived through the device with visual components are part of unauthorized picking activity. The four primary warehouse functions of logistics and operations management—receiving, storing, picking, and shipping—are thought to benefit from the use of AR. Application of AR picking techniques for WMS, including the use of vision picking technologies, in order picking. Preparing and processing the input data, suggesting the best picking route, providing an AR directions system, choosing the software and hardware resources, converting the picking routes into process maps for use in the AR software, and carrying out the picking process are all included in the process (Shaliza Jumahat et al., 2022). An operator must communicate during a pick-by-vision task via voice, look, or gestures. Smart glasses and other augmented reality devices employ virtual arrows to direct users to the location of the item for pickup before listing the total number of products that require to be picked up. The operator can access virtual data from the AR system, such as the name, number, and location of the goods (W. Tang and F. Liu 2018)

Users of vision-picking technology are entirely liberated from handheld RF equipment and have access to real-time digital order data. The workers are guided by the smart glasses' speech and visual signals. Additionally, the glasses include navigational capabilities that can determine where a worker is in a warehouse. In essence, total error-free picking is ensured via an apparent display of order information and target position. This boosts output, accuracy, and fulfillment rates more quickly. It continuously improves quality control by tracking lots and serial numbers automatically. Users don't need to do any further actions because image capturing ensures correctness (Shaliza Jumahat et al. 2022). Additionally, vision selection is simple to use and learn, which helps speed up employee onboarding.

2.4.1 ORDER PICKING

According to N. Ilankovi et al. (2020), order picking is the most important step in all warehouse operations and accounts for 55–65 percent of costs. When preparing an order, order picking entails locating a specified item in storage using a list, loading the goods into the appropriate carriage or transport vehicle, and transporting the products to the designated location for subsequent operations. In addition, according to W. Fang and Z. An, it is regarded as the most significant and labor-intensive task in warehouses. According to E. Ardjmand et al. (2018), order picking can be divided into four categories: piece picking, cluster picking (sometimes referred to as bulk or batch picking), zone picking, and wave picking.

Due to its usual use of paper and its inherent simplicity, low cost, and relative adaptability to shifting picking volume, manual order picking has always been instinctual for humans. However, the repetitive reading and verifying process wastes a lot of time and increases the likelihood of human error. As a result, choosing performance may differ from that which was expected. Additionally, it appears that warehouse workers perform most of the effort when collecting orders. Large orders from numerous customers must be fulfilled, so the warehouses work in multiple shifts to gather orders. From a financial perspective, up to 55% of the warehouse's operating expenses are related to collecting orders. Because it significantly lowers overall storage costs, it is crucial to optimize time and the picking route to lower order picking expenses. (W. Fang et al. 2019).

Since order picking is typically a costly procedure in the warehouse, optimizing it can save overhead expenses and raise WMS performance in terms of labor productivity, total processing times, and space utilization. To optimize the picking process, a warehouse administrator must select the proper picking and automation technology. The finest alternative for that important technology is to adopt augmented reality. Due to its interactive 3D visualization, quick object tracking, effective inventory monitoring, and automation technology, the adoption of AR in WMS have recently been increasingly prominent in optimizing order picking (Shaliza Jumahat et al. 2022).

2.5 WAREHOUSE

Increasing competition forces businesses to enhance their logistics capabilities. Warehouse performance is one of the key elements of logistic performance, according to A. Gialos and V. Zeimpekis (2020), a good warehouse performance will increase quality performance, delivery time, customer happiness, and lower costs in the logistics system. Warehouses are special locations for handling and storing goods. Warehouses maintain goods to supply internal departments like production and manufacturing in supply-driven supply chains. Warehouses store commodities in demand-driven chains to satisfy the needs of external clients.

The term "warehousing operation" describes a group of tasks with the storage and protection of items at its core. It covers the entire process, from receiving the items in the warehouse to delivering them to customers as needed. It consists of three main activities: the entry of commodities, storage of goods, and distribution of goods. We must devote a significant amount of people, material, and financial resources to gathering and handling information during warehouse operations. How can they be saved? Since there is internal communication between the various operations, the bar code will function and be an effective, cost-effective method of data collection.

Receiving, putting away, internal replenishment, order picking, gathering and sorting, packing, cross-docking, dispatching, and shipping are the basic warehouse procedures. Other processes are categorized as outward processes, whereas receipt and storage are considered incoming activities. Along with these procedures, there are value-added services that are optional but are dependent on the type of warehouse and the services offered. In various warehouses, products that often arrive as larger-scale units undergo reorganization and repackaging to produce smaller-scale units. Large milk packages that arrive in a warehouse as pallet quantities are a common example at the warehouse that was seen. They are then divided into smaller amounts in the proper order (Elisa Kusrini et al. 2018).

Processes that take place in warehouses are crucial for the movement of items along the supply chain. The term "warehousing" itself refers to the handling, transportation, loading, unloading, packing, processing, and storage of goods between the production and consumption of commodities as well as other various functions. Order picking is a significant process in a warehouse because it consumes 70% of the time and 55% of the costs. One, two, or three dimensions may be used in the order selection procedure (E. Ardjman et all 2018). This paper's primary goal is to investigate, how vision pick technology in a warehouse influences warehouse performance in Malaysia.

The warehousing industry in Malaysia is growing in significance within the logistics service industry. According to the Eleventh Malaysia Plan, 2016-2020, by 2020, the country aspires to be among the top ten nations in the World Bank's Logistic Performance Index (LPI) and to become the most well-liked logistics gateway in Asia. According to the Malaysian Productivity Corporation, the warehouse industry is less likely than other industries to implement innovations and reforms that will increase productivity and efficiency (Nur Hazwani Karima et all 2018). The implementation of vision-picking technology may help overcome this problem.

2.6 WAREHOUSE PERFORMANCE

It is challenging to improve warehouse performance in worldwide operations, especially in a climate of escalating rivalry, increasingly sophisticated consumers, and erratic demand and supply in extensive supply chain networks. The increasing demand for value-added services, automated processes, and information technology (IT) is evidence of this, according to recent trends in Prioritising warehouse performance measures. The claim is that companies are implementing strategies like manufacturing postponement and centralized distribution to boost their operational performance in response to competitive constraints in business.

In the context of supply chains, warehouse performance was emphasized as a crucial task since it supports strategic performance. This may be so because measurements can make it easier to comprehend how organizational action affects its results. It's because warehouses now require complicated management and not only play a key connecting function in the supply chain in terms of cost. Therefore, it is crucial to constantly research how good performance can be done. Productivity, flexibility, and outbound logistics; productivity, delivery competence, responsiveness, service capability through storage, transportation, cost control, and time control; economic and technical-related performance like inventory accuracy, timely delivery service, individual order fulfillment, flexible value-added service, and responsiveness Cost, throughput, space utilization, and service are three essential logistics service competencies. (Laosirihongthong et all 2018). There are three performance focuses in this study

2.6.1 WAREHOUSE PERFORMANCE EFFICIENCY

Efficiency is one of the performance factors that is stressed and studied the most, despite only being considered in terms of financial metrics. It defined efficiency as a ratio of outputs to inputs, which has no intrinsic value whether it is compared to productivity measurements from earlier periods or measured from comparable facilities producing the same items. Initiatives to increase productivity are meant to show advancements in the physical consumption of energy. To promote and assess, for instance, initiatives to efficiently generate more products with fewer inputs. The significance of creating a system to gauge warehouse effectiveness is to ascertain whether the company's production is rising or falling. (Noorul Shaiful Fitri Abdul Rahman et all 2021).

In most publications, time-related performance indicators are utilized to assess combinations of various order-picking planning difficulties to manage order-picking activities more effectively. These order-picking times can be stated in terms of costs by multiplying each time-dependent component by a constant cost, such as the cost of travel per time unit. Although order-picking time is frequently used as a proxy for cost, time-related measures can also let managers know whether due dates and operating time windows can be met, while cost performance indicators can also include non-time-related cost elements to compare different order-picking systems, such as fixed equipment costs associated with batch or zone order picking systems. Having vision-picking technology will increase efficiency (Nadya Amanda Istiqomah et al 2020).

2.6.2 WAREHOUSE PERFORMANCE PRODUCTIVITY

Warehouse productivity is defined as the ratio of actual production to actual resource consumption (Nadya Amanda Istiqomah et al., 2020). Choosing the inputs necessary to produce the result is the main definition of productivity. IJPPM 72,4 964 productivity is influenced by two factors: the efficiency of transforming primary materials into wholesale deliveries and its dependability. We discovered that to satisfy certain priorities and objectives, each component of the warehousing phase called for the completion of specific tasks. As a result, it interacts with warehouse services including rooms, amenities, and people as well as information systems to carry out the results of warehouse operations (Nantee & Sureeyatanapas, 2021).

Order choosing is one of the most expensive procedures since it can be difficult to choose the proper item from the right section and in the right quantity. By guiding the operator through the picking process and directing them to the proper pick spots in the shortest amount of time, augmented reality technology integrated with mobile devices can alleviate these problems. Productivity eventually rises because of this with automated capabilities that handle the majority of the operations, AR tools improve operational productivity by enabling you to work on multiple orders at once. The improved accuracy and effectiveness of warehouse operations lower all additional expenses for order picking, tracking, and location, saving numerous labor hours and corporate resources. Customers can anticipate their supplies to arrive considerably more quickly and with less downtime for their assets as a result (Shaliza Jumahat et al.2022).

2.6.3 WAREHOUSE PERFORMANCE REDUCES COST

Cost is a crucial component of any profitable enterprise. Since maintaining a large inventory has expenses and maintaining a little inventory might be expensive as well (Elisa Kusrini et al. 2018), the cost of maintaining inventory needs to be revised. To produce a precise sales estimate on which to base how much inventory to keep on hand, dependable processes should be used. A higher performance is made possible by the supply chain strategy where the procurement department is involved in the early stages of product development. Including marketing and purchasing in the other processes, particularly in the early and design stages, helps increase customization and eliminate hidden market uncertainty. It stated that reasons other than those generally acknowledged affect inventory level, such as the fear of lost sales, the "make to stock production" plan, or tentative worries.

Error in picking items from a warehouse is prone to mistakes. The operator is led through the warehouse using AR to find the desired item. Rework can be eliminated by lowering the error rate. Cutting down on waiting time and increasing system accuracy, enhances processes. where costs can be cut. Additionally, vision-picking technology completely automates item tracking while retaining accuracy and relevance through real-time inventory data streams, boosting visibility and quality control of warehouse operations, and lowering costs (Shaliza Jumahat et al., 2022).

2.7 RESEARCH FRAMEWORK

2.7.1 DEPENDANT VARIABLE

2.7.1.1 VISION PICKING TECHNOLOGY PERFORMANCE

Due to the importance of order picking as a warehouse process, numerous studies have already been published that concentrate on the optimization of this process, drilling down on facility layout design, storage assignment, zoning, batching, and routing methods, the number and size of orders, the types of functional areas, the choice of material handling equipment, and the warehouse operating. The latter are crucial variables that have been taken into account when choosing and refining manual order-picking systems. However, over the past ten years, the use of automated order-picking systems, such as AS/RS systems or automated guided vehicles, has provided another method for increasing productivity, reducing costs, and efficiency

2.7.2 DEPENDANT VARIABLE

2.7.2.1 EFFICIENCY

A warehouse that operates effectively makes the most of its available space, optimizes its processes, and motivates worker efficiency. Customers receive their shipments on plan when warehouse tasks go effectively, and the company's bottom line is secure. There are still operational changes that may be made to improve a warehouse's performance, even when it routinely provides clients with accurate and on-time shipments. In a normal warehouse, there is a lot of activity going on all the time, so there is always room for efficiency improvement.

Order picking time is frequently used as a stand-in for cost, time-related measures can also help managers determine whether operating time windows and due dates can be met, and cost performance indicators can also include non-time-related cost components that contrast various order picking systems, such as fixed equipment costs related to batch or zone order picking systems. The use of vision-picking technologies will boost effectiveness (Nadya Amanda Istiqomah et al 2020).

2.7.2.2 PRODUCTIVITY

Order selection is one of the most expensive processes since it might be challenging to select the right item from the appropriate department in the appropriate amount. Augmented reality technology integrated with mobile devices can solve these issues by instructing the operator through the selection process and pointing them to the appropriate pick areas in the shortest amount of time. With automated capabilities that handle most of the processes, productivity gradually increases as a result. AR technologies also increase operational productivity by allowing you to work on several orders at once. As warehouse operations become more accurate and efficient, all additional costs for order picking, tracking, and location decrease, saving a significant amount of worker hours and corporate resources. As a result, customers may anticipate their supply to come much more swiftly and with less asset downtime (Shaliza Jumahat et al.2022).

2.7.2.3 COST REDUCTION

Cost is a crucial component of any profitable enterprise. Since maintaining a large inventory has expenses and maintaining a little inventory might be expensive as well (Elisa Kusrini et al. 2018), the cost of maintaining inventory needs to be revised. To produce a precise sales estimate on which to base how much inventory to keep on hand, dependable processes should be used Pick-by-vision technology, which provides 99,99% accuracy and reduces the delivery of the wrong item, can result in cost savings. This results in higher customer satisfaction, better inventory control, and a more contented and effective workforce. Pick-by-vision technology requires a small but necessary initial expenditure, but over time, the potential advantages may outweigh the expenses.

2.8 PROPOSED FRAMEWORK

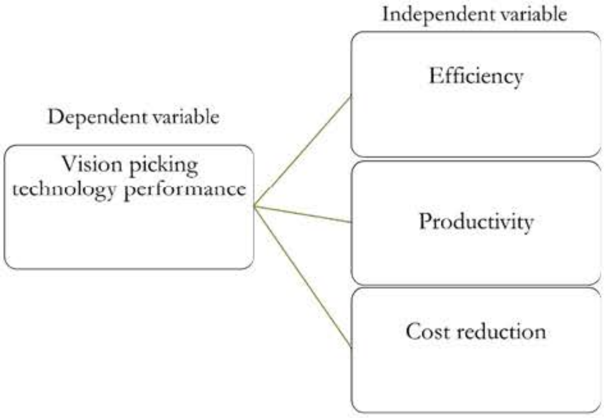

Figure 2.1

2.9 HYPOTHESIS TESTING STUDY

H1: There is a significant relationship between warehouse performance efficiency and vision-picking technology performance.

H2: There is a significant relationship between warehouse performance Productivity and vision-picking technology performance.

H3: There is a significant relationship between warehouse performance cost reduction and vision-picking technology performance.

2.10 SUMMARY

This chapter has explained the literature review about the topic of this research, the independent variable (efficiency, productivity, and cost reduction), and the dependent variable (vision-picking technology), based on the study from previous related research. As a result, it will enable readers to understand how the independent variables relate to the dependent variable. A better understanding of these variables, would help the researcher construct a research framework and develop research hypotheses in the next chapter

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

In this chapter, the theoretical framework will be used to identify the theory or concept that can support the research. The conceptual framework then establishes the relationship between the independent variables and the dependent variable. Then, the development of hypotheses will be conducted as it will provide forecasted research outcomes in response to the research question.

This chapter will also discuss the method used to analyze the data in the research. Its purpose is to inform readers about how the research is carried out. To provide a suitable framework for this research, this chapter will start with the research design. The quantitative method is then selected to determine the associations between the independent and dependent variables in this study. After that, determine the study's population and size. Then, one of the sampling strategies will be chosen for this study. After the sample size is determined, methods of collecting data will be determined to collect the necessary information. Finally, a data analysis tool is constructed to evaluate the information gathered from respondents and generate the best outcomes.

3.2 RESEARCH FRAMEWORK AND RESEARCH HYPOTHESIS

3.2.1 RESEARCH FRAMEWORK

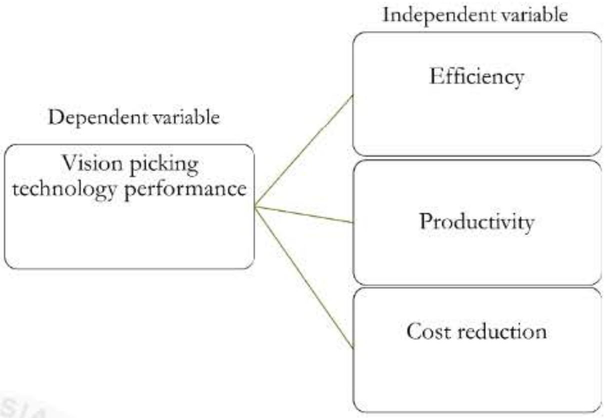

Figure 3.1

Figure 3.2 above shows the conceptual framework of this research. The conceptual framework shows the research path of this study and it is firmly ingrained. The conceptual framework above shows the relationship between the independent variables and the dependent variable. There are three independent variables in this study which are Efficiency, Productivity, and Cost reduction from the attributes of Implementation of vision picking technology towards warehouse performance. The dependent variable in this study is vision-picking technology.

3.2.2 RESEARCH HYPOTHESIS

H1: There is a significant relationship between warehouse performance efficiency and vision-picking technology.

H2: There is a significant relationship between warehouse performance Productivity and vision-picking technology.

H3: There is a significant relationship between warehouse performance cost reduction and vision-picking technology.

3.3 GENERAL CONSTRUCTION OF RESEARCH DESIGN

The research design is used to provide a suitable structure for investigating research. In the research design, it can be considered as a framework that is used to identify and describe the relationship between independent and dependent variables in research. The researcher will combine the different research methods and techniques in collecting and analyzing the data that could lead to the study's success.

The research design also helps to reduce research question errors. The major two types of research design are descriptive research and explanatory research. (Saunders et al, 2019). Descriptive research was used in the study, as it can help the researcher get a comprehensive understanding of the research topic, and ensure the data is high quality and accurate. The tool of descriptive research contains observation, case studies, and surveys. To conduct this research, the survey may be better suited to the topic of Implementation Vision Picking Technology Towards Warehouse Performance

In general, the research design is used to construct an ideal research framework to answer research questions with the collected data (Saunders et al, 2019). Research designs mainly use quantitative, qualitative, or mixed methods. In this research, the quantitative method is utilized to investigate the association between the independent and dependent variables. Furthermore, the importance of research design features such as validity and reliability are highlighted in this research to improve the reliability of data.

3.3.1 QUANTITATIVE STUDY

The quantitative method will be used to conduct the research methodology, as it can help the researcher in identifying data more scientifically. The purpose of applying this method is to determine the correlations between the independent and dependent variables by collecting quantitative data. The quantitative data will be collected in numerical form for later data analysis (Noyes et al., 2019). However, the data obtained must be objective, measurable, and statistically data.

Furthermore, the quantitative method generally will require a bigger number of respondents when compared to the qualitative method (Taguchi, 2018). By using the quantitative method, the relationship between dependent and independent variables will be easier to identify and determine by the researcher. The other advantage of adopting the quantitative method is that it can provide a large amount of data from selected respondents quickly (Taguchi, 2018). Finally, the quantitative method is highly beneficial to business organizations since it allows them to make key decisions and gain insights from numerical data (Noyes et al., 2019).

3.3.2 TIME FRAME OF STUDY

Mohajan (2018) defines the time frame of study as containing two types which are longitudinal and cross-sectional. The longitudinal study refers to the researcher's repeated study over a long-term period. The cross-sectional refers to the researcher must utilization of the limited time to carry out the study including data collection, explaining the relationship between independent variables and dependent variables, finalizing results, and so on. The time horizon of this research is a cross-sectional study. Within the limited time, the researcher needs to analyze the collected data and conclude this study.

3.4 RESEARCH METHOD

The exact methods that researchers apply to collect data and information for their studies are known as methods of research. On the other side, research methodology explains the general approach and framework that directs the research process, including the choice and use of research methods. The two main categories of methods of research are quantitative methods and qualitative approaches. Numerical data must be gathered and analyzed as part of quantitative research procedures. Focusing on collecting and analyzing non-numerical data, such as observations, interviews, and textual or visual data, methods for qualitative methods.

3.4.1 SURVEY METHOD

A survey method is a procedure, instrument, survey, or technique you might use to interview a certain number of people to collect data for the project. It typically makes it simpler for research subjects to get in touch with the person or organization conducting the study. Depending on the type of study you're conducting and the kind of data you ultimately want to collect, survey methodologies might be either qualitative or quantitative. For instance, you can use Form Plus to design and manage an online survey that lets you gather statistical data from respondents. I conduct surveys online using tools like Google Forms. In this thesis, we will use qualitative where will focus on a group of 3PL warehouse-related people to collect information.

3.4.2 RESEARCH INSTRUMENT

A research instrument is a tool used to collect, measure, and analyze data related to vision-picking technology toward warehouse performance in the logistics field in Malaysia. These tools are most commonly used in health sciences, social sciences, and education to assess patients, clients, students, teachers, and staff. The research instrument facilitates the exchange of information between researchers and participants, allowing for data collection that addresses research objectives or hypotheses.

3.4.3 QUESTIONNAIRE

A questionnaire is a collection of questions or items used to learn more about the experiences, or opinions of respondents. Quantitative data can be gathered via questionnaires. Since there are many questions are included in questionnaires, the researcher will choose to ask the respondents close-ended questions to facilitate subsequent data analysis and processing. Questionnaires have the advantage of being reasonably affordable when conducting research and allowing all aspects of the topic to be covered. In this research, I will conduct surveys using an online form as it is the most efficient and cheapest method. As a result, the questionnaire will be used to collect data for this research, with close-ended questions will be prepared using Google Forms (Saul Mcleod, 2023).

When utilizing this kind of research tool, surveys are requested from each targeted respondent. To confirm that the hypothesis is true and pertinent to this study, data will be gathered and examined subsequently. The questionnaire will also be written and prepared in English. The questionnaire for this study has three sections: A, B, and C. Respondents will be asked to answer several questions in each segment (Pritha Bhandari,2021).

In Section A, the demographic information of the respondents allows the researcher to know the respondents' gender, age range, education level, employment in the warehouse, and type of picking they used. Section B will involve a total of 5 statements about the usage of vision-picking technology in the logistics field in Malaysia. Section C will involve a total of

15 statements about warehouse performance such as efficiency, productivity, and cost reduction. All the questionnaires were adopted from Pritha Bhandari (2021).

Sections B and C will use a 5-point Likert scale for respondents to answer because it is an ordered scale for assessing vision-picking technology in Malaysia and opinions on statements. To determine the respondent's agreement level with the statement, they have to answer them on a scale of 1 to 5, where 1 denotes strong disagreement while 5 denotes strong agreement.

5 Point Likert Scale				
1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

Table 3.1: 5 Point Likert Scale

3.4.4 SCALING

Scaling is the process of measuring and allocating numbers to items by predetermined guidelines. In other terms, scaling is the process of placing the measured things on a continuous sequence of numbers, or the scale, to which the objects are assigned. The scaling used in this thesis 5point Likert scale as shown in Table 3.4

3.4.5 DATA ANALYSIS

The process of gathering modeling, and analyzing data using various statistical and logical approaches is known as data analysis. Businesses rely on analytic techniques and technology to derive insights that aid in practical and strategic decision-making. Quantitative methods not only associated with this study are even related to statistical analysis in data analysis sessions. The researcher will use the analysis of data with rationale to understand, clarify and analyse the data through the questionnaires. To analyze the data, a researcher using a software program called Statistical Social Package for the Social Science (SPSS)

3.5 DATA COLLECTION METHODS

3.5.1 PRIMARY DATA

Data collection is a method of gathering all relevant information to solve research problems. Primary data collection and secondary data collection are the two types of data collection procedures. Primary data collection is gathering raw information from main sources such as surveys, questionnaires, interviews, and focus groups (Snyder, 2019). The researcher acquired the primary data through the distribution of questionnaires to get the respondents because it is a method for collecting primary data. The primary data sources are typically selected and adjusted specially to fulfill the objectives or requirements of a given research project. Thus, it enables researchers to reach a huge number of respondents with a cost-efficient method to collect the data required high reliability at the lowest cost.

3.5.2 SECONDARY DATA

Secondary data collection refers to gathering data that has previously been obtained from someone. The sources of secondary data include journal articles, books, and online websites (Saunders et al., 2019). Researchers assess and research each other secondary data sources as proof to aid the findings and results of this study. Secondary data is information that has previously been gathered from primary sources and made easily accessible for researchers to use in their investigations. Secondary data is the data collected for this study as an example of expert knowledge on issues, pamphlets, and books related to topics and information acquired to conduct this study. The researchers collect relevant online journal articles, including published reports and statistics, from online databases. Secondary data is research data that has previously been gathered and can be accessed by researchers.

3.5.3 INDEPENDENT VARIABLES

3.5.3.1 EFFICIENCY

Vision-picking technology solutions increase operational efficiency by allowing employees to work on many orders simultaneously thanks to automated features that manage the operations. As warehouse operations become more accurate and efficient, all additional costs for discovering, picking orders, and tracking decrease, resulting in significant labor time and corporate resource savings. Additionally, as a result, clients may anticipate their supplies to arrive far quicker and with less asset downtime. This also technology employs augmented reality to pinpoint the locations of the products and the quickest path to get there. This greatly increases picking accuracy and reduces the likelihood of picking mistakes. Additionally, it lessens travel time, which makes up around 50% of picking time (Shaliza Jumahat et all 2022). This will prevent you from paying order pickers to stroll rather than quickly and effectively fill orders.

3.5.3.2 PRODUCTIVITY

Due to vision-picking technology being a hands-free order-picking method and the capacity to increase worker productivity, vision-picking is quickly gaining favor. The capacity of Pick-by-vision technology to increase picker productivity is one of its main advantages. Pickers can work more productively since they can concentrate on selecting and packing products rather than constantly checking a choosing list. This enables pickers to fulfill more orders in less time, increasing throughput and increasing customer satisfaction (Shaliza Jumahat et al 2022).

3.5.3.3 COST REDUCTION

The traditional selection method is prone to mistakes. The usage of AR aids in directing employees through a warehouse to the requested item. Rework is avoided by reducing error rates. By speeding up turnaround times and improving system correctness, this improves processes. Additionally, automation fully automates item tracking while preserving relevance and accuracy based on inputs from real-time inventory data, improving visibility and quality control of warehouse operations (Shaliza Jumahat et al 2022). This vision-picking technology, which provides 99,99% accuracy and reduces the delivery of the wrong item, can result in cost savings. This results in higher customer satisfaction, better inventory control, and a more contented and effective workforce.

3.5.4 DEPENDENT VARIABLE

3.5.4.1 VISION PICKING TECHNOLOGY PERFORMANCE

Pick-by-vision in AR uses head-mounted displays or smart glasses as a visual aid for the order-picking process. It's a paperless picking operation that necessitates processing orders using tools that give users a visual layer on top of the reality they observe. Vision-picking technology has significantly changed how warehouses are managed through augmented reality, helping numerous organizations improve their accuracy and productivity. A user or the picker's operator must interact via voice, sight, or gesture to execute a pick-by-vision operation. The AR device directs the user to the location of the items to be gathered using virtual arrows and then shows them how many items need to be collected. Virtual information about the goods, such as their names, numbers, and positions, is visible to the user (Shaliza Jumahat et al 2022). The user will be able to locate the products and complete the picking task fast thanks to this procedure. Following the operation, the AR system administration would keep an eye on the warehouse's operational management, order administration, and commodities management. Due to the importance of order picking as a warehouse process, numerous studies have already been published that concentrate on the optimization of this process, drilling down on facility layout design, storage assignment, zoning, batching, and routing methods, the number and size of orders, the types of functional areas, the choice of material handling equipment, and the warehouse operating. The latter are crucial variables that have been taken into account when choosing and refining manual order-picking systems. However, over the past ten years, the use of automated order-picking systems, such as AS/RS systems or automated guided vehicles, has provided another method for increasing productivity, reducing costs, and efficiency.

3.6 RELIABILITY

According to Saunders et al. (2019), reliability is the extent to which data collection techniques will yield consistent findings. Reliability also includes the questionnaire structure; a reliable questionnaire can result consistently at different conditions or different times. Furthermore, the reliability of this research will be improved if prior researchers' questionnaires are adopted and adjusted. For this analysis, the researcher used the Cronbach alpha

No	Coefficient of Cronbach's Alpha	Reliability Level
1	More than 0.90	Excellent
2	0.80-0.89	Good
3	0.70-0.79	Acceptable
4	0.6-.69	Questionable
5	0.5-0.59	Poor
6	Less than 0.59	Unacceptable

Table 3.2: Cronbach alpha

3.7 PILOT STUDY

The pilot study is defined as a small-scale trial that allows the researcher to modify a better questionnaire design to minimize the issues when respondents answer the questions (Saunders et al., 2019). The researcher will select a few respondents who are related to the study to conduct the pilot test before the questionnaire is distributed to respondents. The purpose of performing the pilot test is to test the reliability of the data and validity of the questionnaire.

3.8 NORMALITY TEST

The normality test is frequently used by researchers since it is an important step in determining measures of central tendency and statistical methods for data analysis. A normality test is performed to determine whether the sample data is drawn from a population with a normal distribution. Parametric tests are used when the data follow a normal distribution; otherwise, non-parametric tests are used when the data does not follow a normal distribution.

The measurements of skewness and kurtosis are two numerical shape metrics. The asymmetry of a random variable's probability distribution concerning its mean is measured by skewness. It indicates that a frequency distribution lacks equivalence. Skewness can be either positive negative, or unclear. If the skew is 0, the data is completely symmetrical. Kurtosis also shows the percentage of the probability distribution curve that correlates to the sharpness of the peaks. When compared to a normal distribution, it is a peak or flatness a measure of information. It also describes the clustering of observations around the distribution center.

3.9 DESCRIPTIVE STATISTICS

Multiple statistical techniques were applied to evaluate the study questions in the second step. To regulate some factors while scientifically examining others, descriptive statistics were employed to assess the contributions of each warehouse people into a variation. Demographic information from the survey, including gender, race, age, qualification, current picking method, position in the company, and industry, was examined throughout the study using descriptive statistics. These findings were confirmed by descriptive statistical analysis.

3.10 CORRELATION ANALYSIS

In this study, there are three independent variables. The variables are perceived trust, perceived ease of use, and facilitating conditions. Finding the interactions between independent and dependent variables reveals that vision-picking implementation affects efficiency, cost, and productivity. The correlation coefficient, often denoted by "r," is the main measure used in correlation analysis. It ranges from -1 to +1, with 0 indicating no correlation, -1 indicating a perfect negative correlation, and +1 indicating a perfect positive correlation.

3.11 REGRESSION ANALYSIS

The strength of the connection between the independent and dependent variables is then ascertained using the Pearson connection analysis (Okwonu et al., 2020). The coefficient's sign may indicate whether there is no link between the two variables, a positive correlation, or a negative correlation, given that the value is between 1 and 1 (Schober et al., 2019). 0 indicates there is no relationship, 1 indicates a perfect positive correlation, and 1 indicates a perfect negative correlation. The results of the analysis will show whether there is a relationship between the dependent variable (DV), which represents vision-picking technology, and the independent variable (IV), which represents the variables's warehouse performances after implementing vision-picking technology. According to Lothor et al. (2018), the researcher must decide the intensity and direction of the association between the independent variable (IV) and dependent variable (DV) if there is a correlation. The results of the analysis will be presented, and a discussion will follow. The conclusion can be worked on in the

meanwhile.

Correlation	Value
Positive correlation	1
No correlation	0
Negative correlation	-1

Table 3.3: The Pearson Correlation analysis

3.12 RESEARCH LOCATION

This research will be conducted in Melaka Malaysia which is in Southeast Asia. According to the Logistics Sector Malaysia in Melaka (2022), the population of Malaysia related to logistics is estimated to be around 112100. The targeted respondents are individuals from Melaka, Malaysia who are owners, employees, and others related to the logistics field of the 3PL warehouse. The reason that Melaka, Malaysia's 3PL warehouse is the research location is its population is sufficient for the researcher to conduct this study. Based on the Department of Statistics Malaysia (2021), the individual's internet usage has increased to 89.6 percent in 2020. Hence, the estimated number of customers increases as internet usage increases. Which will lead to an increase in 3PL's warehouse operation in Malaysia. Its high-tech warehouse environment makes it a highly developed country for its economic growth. As a result, Malaysia can be regarded as a highly developed country in the 3PL's warehouse business in the logistics field around Malaysia.

3.13POPULATION AND SAMPLING

In research, the phrase "population" refers to a large group of people, objects, organizations, and other units that share common characteristics drawn by the researcher (Saunders et al., 2019). In other words, a group of individuals with similar characteristics is identified from other individuals to conduct a certain study. Since this research will be conducted in Malaysia, the population of people related logistics field in Malaysia is considered to be the population for this research which has around 112 100 people (Department of Logistics Sector in Malaysia, 2021).

Sampling refers to how the researcher selects a group of individuals and collects data from them in a study (McCombes, 2022). The selection of the sample will generally be drawn from the population in the research. Since the population in this study is a group of people who work in warehouses and related picking tasks, then the sample will be chosen from this population. The sampling technique will reduce the cost, time, and energy required to complete a study.

3.13.1 SAMPLE TECHNIQUES

Research greatly benefits from sampling techniques. It is a key element in determining how accurately your study or survey results will turn out. Probability sampling techniques are used in this research for sample selection. The sample technique enables to reduction of a large population to a managerial size by selecting a sample from the population. Figure 3.4 below shows the four different probability sampling techniques which are simple random sample, systematic sample, stratified sample, and cluster sample.

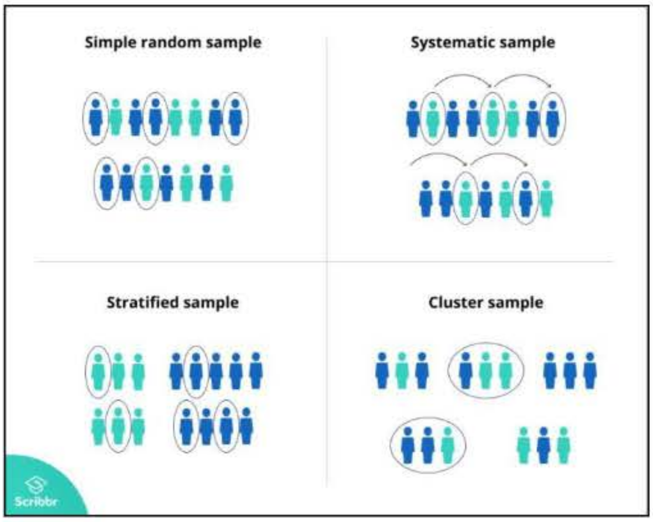

Figure 3.2: Probability Sampling Methods

Source: McCombes, 2022

The most basic sampling approach is simple random sampling, where all individuals in the population have the same probability of being selected for research (McCombes, 2022). Since the quantitative method is implemented for this research, simple random sampling is used as the sampling technique because all individual in the population has the same probability of being selected ensuring it is unbiased.

3.13.2 SAMPLE SELECTION

Sampling is the method by which a researcher picks a group of people and gathers data from them when conducting a study (McCombes, 2022). The research's target population is frequently utilized to choose the sample. The sample will be taken from the people related to the logistics field in Malaysia because it is the population for this study. According to the Logistics Sector of Malaysia (2021), the population of people related to 3PL warehouses and logistics in Malaysia is around 112100. As the population number is identified, the researcher will select the appropriate sample size for this study based on Krejcie and Morgan's table. According to Table 3.3 below, the sample size would be 384 respondents from a population of around 112100 to answer the survey. Therefore, the researcher will randomly select 384 respondents related to 3PL Warehouse in the logistics field

N	S	N	S	N	S	N	S	N	S
10	10	100	80	280	162	800	260	2800	338
15	14	110	86	290	165	850	265	3000	341
20	19	120	92	300	169	900	269	3500	346
25	24	130	97	320	175	950	274	4000	351
30	28	140	103	340	181	1000	278	4500	354
35	32	150	108	360	186	1100	285	5000	357
40	36	160	113	380	191	1200	291	6000	361
45	40	170	118	400	196	1300	297	7000	364
50	44	180	123	420	201	1400	302	8000	367
55	48	190	127	440	205	1500	306	9000	368
60	52	200	132	460	210	1600	310	10000	370
65	56	210	136	480	214	1700	313	15000	375
70	59	220	140	500	217	1800	317	20000	377
75	63	230	144	550	226	1900	320	30000	379
80	66	240	148	600	234	2000	322	40000	380
85	70	250	152	650	242	2200	327	50000	381
90	73	260	155	700	248	2400	331	75000	382
95	76	270	159	750	254	2600	335	1000000	384

Table 3.4: Krejcie and Morgan's table

3.14 APPROACH AND STRUCTURE OF DATA ANALYSIS

Data analysis is known as the technique used to analyze collected data and convert it into valuable information as well as derive statistical conclusions (Wagner, 2019). Depending on the business and the goal of the study, there are numerous ways and strategies to conduct the analysis. In this study, the researcher used methods and structures like a pilot test, descriptive analysis of a demographic profile, and statistical analysis of independent and dependent variables to evaluate the data that was gained. Furthermore, the approaches used are Statistical Package for Social Sciences (SPSS) version 29.

3.14.1 STATISTICAL PACKAGE FOR SOCIAL SCIENCE (SPSS)

Data analysis can be described as the techniques used to examine gathered data, transform it into useful information, and draw statistical inferences (Wagner, 2019). As it was frequently used by many researchers to conduct statistical data analysis and process the varied data, the Statistical Package for the Social Sciences (SPSS) would be employed in this study as a tool for analyzing the data collected from respondents (Wagner, 2019). Based on the research's variables, statistical software called SPSS enables the evaluation of intricate cause-and-effect linkages (Wagner, 2019). Using the SPSS program, which conducts a variety of analyses including Chi-Square tests, and multiple regression analysis, it is possible to determine the link between independent and dependent variables (Wagner, 2019). After that, the data from Google Forms will be sent to SPSS for more analysis and output development. The generated results are then put through a reliability test to make sure they are reliable. Additionally, to cover the respondent profiles, ANOVA, descriptive statistics like mode, median, mean, variance, and standard deviation will be generated. the results to form a conclusion or inference about the population and respond to the research hypothesis. As a result, the correlation test can be used to determine the association between the variables and to decide whether the null hypothesis should be rejected or retained.

3.15 SUMMARY

In summary, this chapter has explained the research method, sampling design, data collection method, and data analysis tool in constructing this research. The methodology choice of this research is the quantitative method. The questionnaire will be used to collect primary data and distributed online through Google Forms. The secondary data is obtained through books, journals, and online data. The data analysis tools are SPSS software. To ensure the validity and reliability of data, the pilot test is conducted before the questionnaire is distributed to respondents. Then, use the results from the data analysis to form a conclusion in response to the research hypothesis.

CHAPTER FOUR

DATA ANALYSIS

4.1 INTRODUCTION

In this chapter, the analysis of quantitative research regarding the implementation of vision picking technology towards warehouse performance of the logistic field in Malaysia which is located at Malacca was discussed. The data was collected to analyze to meet the objectives that have been set. The data analysis was conducted using Statistical Package for Social Sciences (SPSS) version 29. Five main sections will be discussed in this chapter. It included pilot test analysis results, analysis of respondent's demographic information, descriptive analysis,

4.2 PILOT TEST

Pilot testing was conducted before the data collection process and distribution of the questionnaire to target respondents. The objective of conducting a pilot test is to evaluate the validity of the questionnaire and the data's reliability (Hamilton, 2022). To create a better questionnaire design and reduce issues for respondents answering the questionnaire and data screening issues, it is necessary to conduct a pilot test to ensure that the research can be carried out smoothly (Saunders et al, 2019). Hence, the researcher chose 30 respondents to conduct the pilot test.

Case Processing Summary

		N	%
Cases	Valid	30	96.8
	Excluded[a]	1	3.2
	Total	31	100.0

a. Listwise deletion based on all variables in the procedure.

Table 4.1: Case processing summary

Source: SPSS output

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.988	.988	20

Table 4.2: Reliability Statistics (Pilot Test)

Source: SPSS output

The questionnaire included 20 items, and none of the 30 respondents had missing data. The research data is only considered reliable when Cronbach's Alpha value is greater than 0.7. (Saunders et al., 2019). Based on the Table above, the value of Cronbach's Alpha for all the items in this research is 0.98, which is higher than 0.7, thus the data obtained is reliable with excellent internal consistency.

4.3 DESCRIPTIVE STATISTICS ON DEMOGRAPHIC BACKGROUND

Descriptive statistics is one of the methods to evaluate, define, display, and interpret collected data using tables, graphs, and overview calculations (Saunders et al., 2019). In this research, the researcher has used descriptive statistics to analyze the demographic data of respondents collected from questionnaires. Based on the table, there are five categories of the demographic profile of respondents which include gender, age, race, type of employment in the warehouse, and picking method in their warehouse. The questionnaires were distributed through Google Forms to target respondents and there was a total of 80 respondents after the data collection.

4.3.1 GENDER

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	33	41.3	41.3	41.3
	Male	47	58.8	58.8	100.0
	Total	80	100.0	100.0	

Table 4.3: Gender of Respondents

Source: SPSS Output

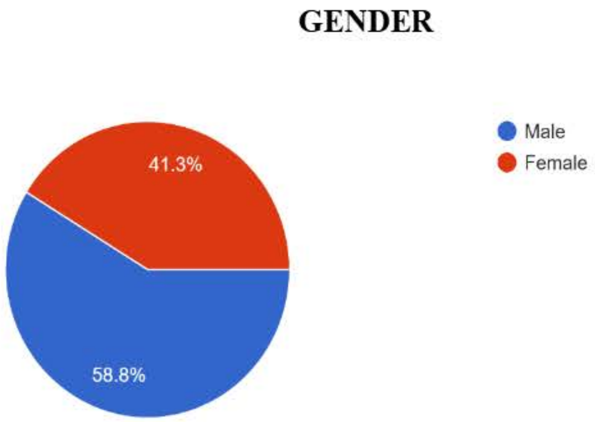

Figure 4.1: Gender Pie Chart

Source: Google Form Output

Table 4.3 shows the gender frequency distribution of respondents in this study. From the table above, there are 47 male respondents (58.8%) and 33 female respondents (41.3%) among the total 80 respondents. In this study, respondents were randomly selected and randomly assigned however the proportion of male respondents is slightly higher than that of female respondents in this research, with a difference of 17.5%.

4.3.2 AGE

Age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	20-29 years old	23	28.7	28.7	28.7
	30-39 years old	28	35.0	35.0	63.7
	40-49 years old	25	31.3	31.3	95.0
	50-59 years old	4	5.0	5.0	100.0
	Total	80	100.0	100.0	

Table 4.4: Age of Respondents

Source: SPSS Output

AGE RANGE

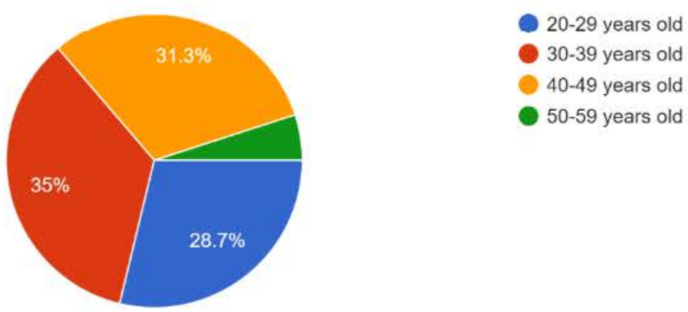

Figure 4.2: Age Pie Chart

Source: Google Form Output

The respondents were classified according to age into four categories which were: "20–29 years old", "31–39 years old", "40-49 years old", and "50-59 years old", as illustrated in Table 4.4. Figure 4.2 shows the distribution of the ages of the respondents. The age group with the highest number of respondents was the 30-39 years age group at 35% or equal to 28 respondents, the second highest was the 40-49 years age group at 31.3% or equal to 25 respondents, and the third highest was 20–29 years old age group at 28.7% or equal to 23 respondents. The lowest was the 50-59 years old age group at 5% which is equal to 36 respondents.

4.3.3 RACE

Race

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Chinese	24	30.0	30.0	30.0
	Indian	22	27.5	27.5	57.5
	Malay	23	28.7	28.7	86.3
	Others	11	13.8	13.8	100.0
	Total	80	100.0	100.0	

Table 4.5: Race of Respondents

Source: SPSS Output

RACE

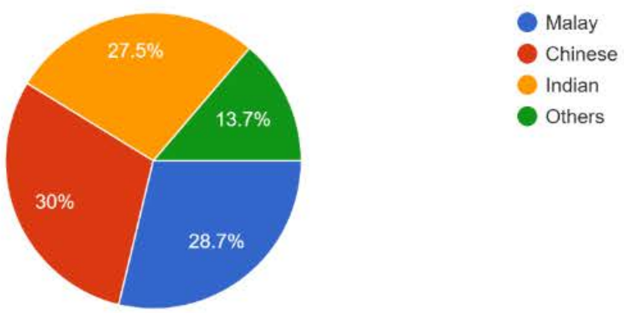

Figure 4.3: Race Pie Chart

Source: Google Form Output

Table 4.5 shows the race breakdown of these participants. It has been divided into four categories which were Malay, Chinese, Indian, and others. Chinese respondents made up the highest percentage of respondents which is 30% or equal to 24 respondents. The second highest was Malay at approximately about 28.7% or equal to 23 participants. Next, 27.5%, or equivalent to 22 of the participants, were contributed by the Indian participants. Lastly, other participants presented about 13.7%, or equal to 11 respondents. The race breakdown of these respondents is illustrated in Figure 4.3.

4.3.4 EDUCATION

Education

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Degree	37	46.3	46.3	46.3
	Diploma	18	22.5	22.5	68.8
	Masters	11	13.8	13.8	82.5
	PhD	6	7.5	7.5	90.0
	SPM	8	10.0	10.0	100.0
	Total	80	100.0	100.0	

Table 4.6: Education of Respondents

Source: SPSS Output

EDUCATION

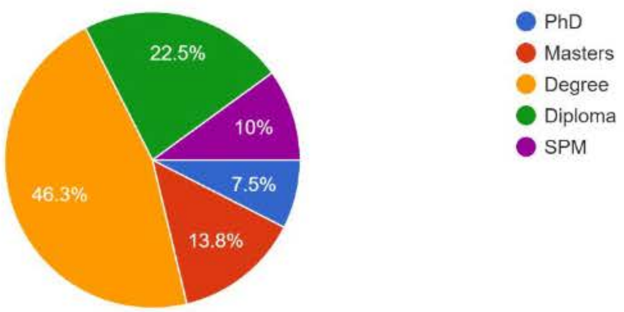

Figure 4.4: Education Pie Chart

Source: Google Form Output

Next, the participants were also asked about their education level. Out of the total 80 respondents, the highest frequency was Degree, which accounted for about 46.3% or the equivalent of 37 respondents. The second highest was 22.5% which was diploma level, or equal to 18 respondents. The third highest was Masters, which represents 13.8% or equal to 11 respondents. This is followed by SPM at 10% or equal to 8 respondents, and the rest of the education level contributed Ph.D. to the remaining percentage which is 7.5% equal to 6 respondents, as illustrated in Table 4.6 and Figure 4.4.

4.3.5 EMPLOYMENT

Employment

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Forklift driver	10	12.5	12.5	12.5
	Manager	12	15.0	15.0	27.5
	Warehouse clerk	25	31.3	31.3	58.8
	Warehouse operator	12	15.0	15.0	73.8
	Warehouse specialist	21	26.3	26.3	100.0
	Total	80	100.0	100.0	

Table 4.7: Employment of Respondents

Source: SPSS Output

EMPLOYMENT

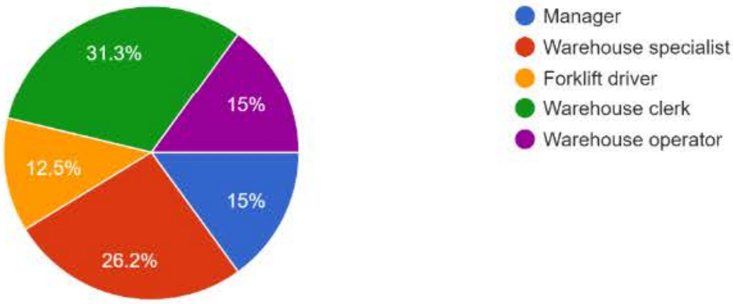

Figure 4.5: Employment Pie Chart

Source: Google Form Output

In this research, the employment status of respondents in the warehouse has been separated into six different groups including manager, warehouse specialist, forklift driver, warehouse clerk, and warehouse operator. There are 25 warehouse clerks equal to 31.5%, 21 warehouse specialists equal to 26.2%, warehouse managers and operators who share the same amount of respondents 12 equal to 15%, and 10 respondents forklift drivers who at least 12.5%.

4.3.5 PICKING METHOD

Picking

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Barcode scanning	38	47.5	47.5	47.5
	Pick by label	11	13.8	13.8	61.3
	Pick by light	8	10.0	10.0	71.3
	Pick by paper	13	16.3	16.3	87.5
	Pick by voice	10	12.5	12.5	100.0
	Total	80	100.0	100.0	

Table 4.8: Picking methods used by respondent

Source: SPSS Output

PICKING METHOD

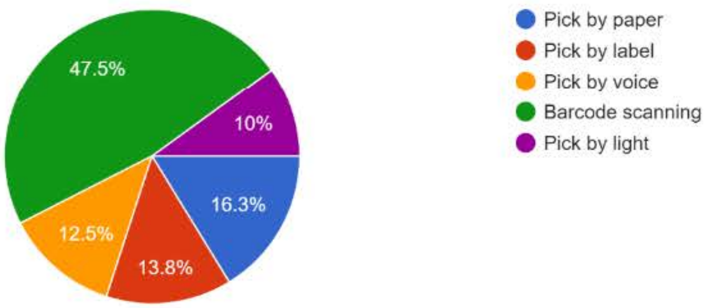

Figure 4.6: picking method Pie Chart

Source: Google Form Output

Table 4.4 shows the classification of the picking methods used by these participants. It has been divided into six categories which were pick by paper, pick by label, pick by voice, barcode scanning, and pick by light. Barcode scanning respondents made up the highest percentage of respondents which is 47.5% or equal to 38 respondents. The second highest was pick by paper at approximately about 16.3% or equal to 13 participants. Next, 13.8%, or equivalent to 11 of the participants, were using pick by label method. Second least is pick by voice were selected which is 12.5% equal to 10 Lastly, pick by light participants presented about 10% or equal to 8 respondents. The race breakdown of these respondents is illustrated in Figure 4.6

4.4 RELIABILITY ANALYSIS

The reliability analysis will be used to determine the accuracy and consistency of sample data in the questionnaire by performing a reliability test and determining the result of Cronbach's Alpha. To test the reliability of this research, Cronbach's Alpha will be the indicator for this research.

Case Processing Summary

		N	%
Cases	Valid	80	100.0
	Excluded[a]	0	.0
	Total	80	100.0

a. Listwise deletion based on all variables in the procedure.

Table 4.9: Case Processing Summary

Source: SPSS Output

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.961	.962	20

Table 4.10: Reliability Test

Source: SPSS Output

In the questionnaire, there is a total of 26 items including 6 demographic questions, 15 independent variable questions, and 5 dependent variable questions. The total number of sample data collected is 80 samples and there is no missing data. Since the research data is only considered reliable when Cronbach's Alpha value is greater than 0.7. (Saunders et al., 2019). According to Table 4.11, the value of Cronbach's Alpha for all items in this study is 0.961, which is greater than 0.7, indicating that the data gathered from the samples is reliable and has excellent internal consistency. All the items in the survey have very high reliability due to Cronbach's Alpha being above 0.9. All the variables in this analysis are reliable.

4.5 NORMALITY

Skewness and kurtosis analysis are used to determine whether the data is normal or non-normal based on rules of thumb. Skewness is a measure of distribution symmetry, whereas kurtosis is a measure of distribution peakiness or flatness. According to Saunders et al, an ideal distribution has a skewness and kurtosis values equal to zero (2019). If the skewness value is 1 and the kurtosis value is 2, the distribution is considered mild, but it is still within an acceptable range. Values that fall outside of these bounds indicate that the data is abnormal (Saunders et al., 2019). The SPSS normality test results are shown below:

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
DV	.149	80	<.001	.873	80	<.001
IV1_EFFICIENCY	.145	80	<.001	.878	80	<.001
IV2_PRODUCTIVITY	.169	80	<.001	.888	80	<.001
IV3_COST_REDUCE	.195	80	<.001	.864	80	<.001

a. Lilliefors Significance Correction

Table 4.11: Normality Test

Source: SPSS Output

The result of the Skewness and Kurtosis analysis, as shown in Table 4.12 above, is between ± 1. All variables have negative skewness values, indicating that the distribution has too many high scores. Furthermore, all kurtosis values are positive, indicating that the distribution is peaked and has thick tails. Finally, because the skewness and kurtosis are both less than one, the data is considered normally distributed.

4.6 DESCRIPTIVE ANALYSIS

This section describes the descriptive analysis. Descriptive analysis is used to describe the basic features of the data in this research. It provides simple summaries of Mean and Standard Deviation (SD). The Mean and Standard Deviation (SD) are displayed to demonstrate how the information is commonly spread around the mean. In addition, Standard Deviation (SD) indicates how different or deviating the data is from the mean in 0 20 40 60 80 100 120 140 Platform Other Website Blog Magazine Book 89 the research. It enables the researcher to explore all the questionnaire questions by incorporating information into this analysis. The results of the descriptive analysis for independent variable structures (efficiency, productivity, cost reduction), and dependent variable (vision) will be explained in the following sections.

4.6.1 DESCRIPTIVE ANALYSIS OF DEPENDANT VARIABLE VISION PICKING TECHNOLOGY PERFORMANCE

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
@1. Weareawareofvisionpickingtechnologyinthemarket	80	1	5	4.20	.920
@2. UsageofvisionpickingtechnologyinMalaysiaisverylow	80	1	5	4.33	.759
@3. Weintendtolearnhowtousevisionpickingtechnologyina	80	2	5	4.38	.769
@4. Weconsidervisionpickingtobemyfirstchoicefororderpi	80	1	5	4.30	.877
@5. Wewouldrecommendvisionpickingtechnologytobeusedinm	80	1	5	4.09	.930
Valid N (listwise)	80				

Table 4.12: Descriptive Analysis of Vision Picking Technology Performance

Source: SPSS Output

Table 4.7 presents the descriptive analysis of the vision-picking technology performance construct. The result showed that the highest-scored item was ‘We intend to learn how to use vision-picking technology in a warehouse’, with a mean score of 4.38. The second highest was ‘Usage of vision-picking technology in Malaysia is very low.’, with a score of 4.33. The third highest was ‘We consider vision picking to be my first choice for order-picking methods in the Warehouse.', with a score of 4.30. Next, 'We are aware of vision-picking technology in the market.' has a score of 4.20, and the lowest score was 'We would recommend vision-picking technology to be used in my company warehouse', with a score of 4.08. In short, all items have excellent scores.

4.6.2 DESCRIPTIVE ANALYSIS OF EFFICIENCY

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Using vision-picking technology increases pick rates.	79	1	5	4.19	.863
Using vision-picking technology minimizes travel time.	79	1	5	4.16	.980
Using vision pick technology never let pickers arrive at an empty location.	79	2	5	4.22	.811
Multiple orders can be picked at the same time by having vision-picking technology.	79	2	5	4.29	.787
Vision-picking technology improves accuracy.	79	2	5	4.16	.854
Valid N (listwise)	79				

Table 4.13: Descriptive Analysis of Efficiency

Source: SPSS Output

Table 4.8 indicates the descriptive analysis of the efficiency construct, which stimulates the vision-picking technology toward warehouse performance. The result showed that the highest-scored item was 'Multiple orders can be picked at the same time by having vision-picking technology' with the highest mean score of 4.30. The second highest score was 'Using vision pick technology never let pickers arrive at an empty location.' with a score of 4.09. The third-ranking was 'Using vision-picking technology increases pick rates' with a score of 4.19. The fourth and fifth were 'Using vision-picking technology minimizes travel time' and 'Vision-picking technology improves accuracy' which share the same score of 4.16.

4.6.3 DESCRIPTIVE ANALYSIS OF PRODUCTIVITY

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Using vision picking technology orders are picked on time for a vehicle departure.	79	2	5	4.06	.806
Vision picking technology is very effective for 3PL orders where 100s of orders are in a single line.	79	2	5	4.24	.788
Real-time stock updates lead to fast and accurate replenishment by implementing vision-picking technology.	79	1	5	4.20	.853
There is a smaller process of picking orders where time can be saved by using vision-picking technology.	79	1	5	4.19	.921
Vision-picking technology boosts productivity more compared to other picking methods.	79	2	5	4.15	.907
Valid N (listwise)	79				

Table 4.14: Descriptive Analysis of Productivity

Source: SPSS Output

Table 4.9 indicates the descriptive analysis of the productivity construct which led to the implementation of vision-picking technology towards warehouse performance. The outcome showed that the highest-scored item was 'Vision picking technology is very effective for 3PL orders where 100s of orders are in a single line' with a mean score of 4.25. The second highest was 'Real-time stock updates lead to fast and accurate replenishment by implementing vision-picking technology.' With a mean score of 4.20. The third highest score was 'There is a smaller process of picking orders where time can be saved by using vision-picking technology' with a score of 4.19, followed by 'Vision-picking technology boosts productivity more compared to other picking methods' with a mean of score 4.16 and the lowest score was 'Using vision picking technology orders are picked on time for a vehicle departure' with a score of 4.08. In short, all items were of good value.

4.6.4 DESCRIPTIVE ANALYSIS OF COST REDUCTION

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
The cost of repacking and re-delivery can be avoided by implementing vision-picking technology.	79	2	5	4.05	.830
Using vision pick technology to reduce the labor cost of handling and checking items on their return.	79	2	5	4.20	.774
The cost of recovering the item can be reduced by implementing vision-picking technology.	79	1	5	4.27	.902
The cost of picking replacement items can be avoided by having vision-picking technology.	79	2	5	4.18	.828
Overall, vision-picking technology can lead to cost savings by reducing wrong item delivery.	79	1	5	4.32	.825
Valid N (listwise)	79				

Table 4.15: Descriptive Analysis of Cost Reduction

Source: SPSS Output

Table 4.10 illustrates the descriptive analysis of Cost reduction. Based on the result, it showed that the highest-scored item was 'Overall, vision-picking technology can lead to cost savings by reducing wrong item delivery' with a mean score of 4.33. The second highest was 'The cost of recovering the item can be reduced by implementing vision-picking technology.' with a score of 4.28. The third highest belonged to 'Using vision pick technology to reduce the labor cost of handling and checking items on their return' with a mean score of 4.20. This is followed by 'The cost of picking replacement items can be avoided by having vision-picking technology.' with a score of 4.17. Lastly, the lowest was 'The cost of repacking and re-delivery can be avoided by implementing vision-picking technology' with a score of 4.06. Briefly, all items have good scores.

4.7 CORRELATION ANALYSIS

Correlations

		DV_VISION_PICKING_TECHNOLOGY_PERFORMANCE	IV1_EFFICIENCY	IV2_PRODUCTIVITY	IV3_COST_REDUCTION
DV_VISION_PICKING_TECHNOLOGY_PERFORMANCE	Pearson Correlation	1	.812**	.758**	.749**
	Sig. (2-tailed)		<.001	<.001	<.001
	N	80	80	80	80
IV1_EFFICIENCY	Pearson Correlation	.812**	1	.759**	.773**
	Sig. (2-tailed)	<.001		<.001	<.001
	N	80	80	80	80
IV2_PRODUCTIVITY	Pearson Correlation	.758**	.759**	1	.801**
	Sig. (2-tailed)	<.001	<.001		<.001
	N	80	80	80	80
IV3_COST_REDUCTION	Pearson Correlation	.749**	.773**	.801**	1
	Sig. (2-tailed)	<.001	<.001	<.001	
	N	80	80	80	80

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

Table 4.16: Pearson's Correlation

Source: SPSS Output

Pearson's Correlation test is a parametric test to determine the strength and direction of the relationship between independent and dependent variables. The table shows the correlations between the independent and dependent variables. The independent variables in this research are efficiency, productivity, and cost reduction while the dependent variable is vision-picking technology performance.

According to Table 4.13 above, the Pearson correlation coefficient for efficiency on vision-picking technology performance is 0.812. It indicates that there is a strong positive relationship between efficiency and vision-picking technology performance. Therefore, the p-value less than 0.01 in this analysis means it is highly accepted and significant. Since the correlation is lower than 0.01 level in a 2-tailed paired test it has proven the efficiency for all two perceptions is accepted in this scenario. Therefore, when efficiency increases, the vision-picking technology performance will increase.

Second, the Pearson correlation coefficient for the productivity of vision-picking technology performance is 0.758. It indicates that there is a strong positive relationship between productivity and vision-picking technology performance. Therefore, the p-value less than 0.01 in this analysis means it is highly accepted and significant. Since the correlation is lower than 0.01 level in a 2-tailed paired test it has proven the efficiency for all two perceptions is accepted in this scenario. As a result, as productivity increases, the vision-picking technology performance will increase.

Finally, the Pearson correlation coefficient for the cost reduction on vision-picking technology performance is 0.749. It indicates that there is a strong positive relationship between cost reduction and vision-picking technology performance. Therefore, the p-value less than 0.01 in this analysis means it is highly accepted and significant. Since the correlation is lower than 0.01 level in a 2-tailed paired test it has proven the efficiency for all two perceptions is accepted in this scenario. Therefore, when cost reduction increases, vision-picking technology performance will increase.

4.8 REGRESSION ANALYSIS

Regression analysis in SPSS is a statistical technique to examine the relationship between one dependent variable and one or more independent variables. Regression analysis is a statistical method used to evaluate the strength of a cause-and-effect relationship between independent and dependent variables (Saunders et al., 2019). As a result, the objective of conducting regression analysis in this study is to determine the significant relationship between the independent variables (efficiency, productivity, cost reduction) and the dependent variable (vision-picking technology performance).

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.846[a]	.715	.704	1.93729

a. Predictors: (Constant), IV3_COST_REDUCTION, IV1_EFFICIENCY, IV2_PRODUCTIVITY

Table 4.17: Model Summary Regression Analysis

Source: SPSS Output

R-square is a method for calculating the percentage of variation of a dependent variable explained by the independent variables in a regression model. Based on the table above, the correlation coefficient (R) is 0.846 which indicates there is a strong relationship between those variables. Furthermore, the coefficient of the determinant (R square) is 0.715, indicating that the variation in vision-picking technology performance is 71.5% influenced by the three independent variables (efficiency, productivity, and cost reduction), while 28.5% is explained by other factors that are not considered in this research.

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	716.715	3	238.905	63.656	<.001[b]
	Residual	285.235	76	3.753		
	Total	1001.950	79			

a. Dependent Variable: DV_VISION_PICKING_TECHNOLOGY_PERFORMANCE

b. Predictors: (Constant), IV3_COST_REDUCTION, IV1_EFFICIENCY, IV2_PRODUCTIVITY

Table 4.18: ANOVA

Source: SPSS Output

According to Table 4.15 above, the result of the F-test value is 63.656 with a significant level of 0.000 which is lower than 0.05. Therefore, the result shows that the regression model is a fit and there is a significant relationship between efficiency, productivity, cost reduction, and vision-picking technology performance in the warehouse. Moreover, the null hypothesis would be rejected because the significant level of the regression model is less than 0.05.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.962	1.426		1.376	.173
	IV1_EFFICIENCY	.497	.105	.492	4.744	<.001
	IV2_PRODUCTIVITY	.252	.110	.251	2.281	.025
	IV3_COST_REDUCTION	.172	.116	.168	1.484	.142

a. Dependent Variable: DV_VISION_PICKING_TECHNOLOGY_PERFORMANCE

Table 4.19: Coefficients of Regression Analysis

Source: SPSS Output

The efficiency variable is significant at the p-value of less than 0.01. Whereas it is accepted at the significance level of 0.001 The t-value of efficiency is at 4.744. The regression shows that the efficiency variable is an important variable too where the t value is high compared to other variables. However, the p-value is lower among the others.

The productivity variable is significant at the p-value of 0.025. Whereas it is accepted at the significance level of 0.05. The t value of productivity is at 2.281. The regression shows that the productivity variable is an important variable too where the t value isn't as high as the other variables. The p-value also isn't as high as the others.

The cost reduction variable is significant at the p-value of 0.142. Whereas it is not accepted at the significance level of 0.1. The t value of efficiency is at 1.484. The regression shows that the efficiency variable is an important variable too where the t value isn't as high as the other variables. However, the p-value is higher among the others.

4.9 HYPOTHESIS TESTING STUDY

Based on the table regression analysis, the relationship can be summarized in the following equation from the analysis, multiple regression equation:

Y = b0 + b1X1 + b2X2 + b3X3

Where:

Y = Vision-picking technology performance

b0 = Regression constant

X1 = Efficiency

X2 = Productivity

X3 = Cost reduction

Y= 1.962 + 0.497(X1) + 0.252(X2) + 0.172(X3)

Based on the linear equation above, there was a positive and negative relationship for the independent variable toward the vision-picking technology performance.

1. Efficiency

H0 = There is no relationship between efficiency and vision-picking technology performance

H1 = There is a significant relationship between warehouse performance efficiency and vision-picking technology performance.

The results of the regression of efficiency against vision-picking technology performance will be seen at the top of the table. The significant value of efficiency is less than 0.01 which is < 0.05, then the appropriate basis for decision-making in the regression analysis can be concluded efficiency has a significant relationship to vision-picking technology performance. Therefore, the researcher accepted the alternative hypothesis (H1) and rejected the null hypothesis (H0). Order picking time is frequently used as a stand-in for cost, time-related measures can also help managers determine whether operating time windows and due dates can be met, and cost performance indicators can also include non-time-related cost components that contrast various order picking systems. The use of vision-picking technologies will boost effectiveness (Nadya Amanda Istiqomah et al 2020).

2. Productivity

H0 = There is no relationship between productivity and vision-picking technology performance.

H2: There is a significant relationship between warehouse performance Productivity and vision-picking technology performance.

The results of the regression of productivity against vision-picking technology performance will be seen at the top of the table. The significant value of productivity $0.025 < 0.05$, then the appropriate basis for decision-making in the regression analysis can be concluded productivity has a significant relationship to vision-picking technology performance. Therefore, the researcher accepted the alternative hypothesis (H2) and rejected the null hypothesis (H0). Augmented reality technology integrated with head-mounted displays can solve these issues by instructing the operator through the selection process and pointing them to the appropriate pick areas in the shortest amount of time. With automated capabilities that handle most of the processes, productivity gradually increases as a result. AR technologies also increase operational productivity by allowing you to work on several orders at once (Shaliza Jumahat et al.2022).

3. Cost reduction

H0 = There is no relationship between cost reduction and vision-picking technology performance.

H3: There is a significant relationship between warehouse performance cost reduction and vision-picking technology performance.

The results of the regression of cost reduction against vision-picking technology performance will be seen at the top of the table. The significant value of productivity is 0.142 > 0.05, then the appropriate basis for deciding within the regression analysis can be concluded that edges failed to have a significant relationship towards vision-picking technology performance. Therefore, the researcher rejected the alternative hypothesis (H3) and accepted the null hypothesis (H0). Cost is a crucial component of any profitable enterprise. Since maintaining a large inventory has expenses maintaining a small inventory might be expensive as well (Elisa Kusrini et al. 2018). The respondent may think that the implementation of vision-picking technology adds more cost to the company's expenses.

Hypothesis	**Significant Value**	**Result**
H1: There is a significant relationship between warehouse performance efficiency and vision-picking technology performance.	P<0.001 (P<0.05)	Support
H2: There is a significant relationship between warehouse performance Productivity and vision-picking technology performance.	P<0.001 (P<0.05)	Support
H3: There is no significant relationship between warehouse performance cost reduction and vision-picking technology performance.	P<0.001 (P>0.05)	rejected

Table 4.20: Hypothesis testing

4.10 SUMMARY

This chapter presents the results and knowledge analysis of this study. The researchers performed nine styles of tests, together with descriptive analysis, correlation analysis, reliability analysis, reliability, and multiple regression analysis. The complete check was analyzed using SPSS version 29.00. once the analysis was done using the SPSS software system, the researchers understood the information to identify the relationship between the dependent and independent variable and therefore the test hypotheses that were tested within the previous chapter. However, suggestions and conclusions are going to be mentioned in Chapter 5.

There is one hypothesis that has been rejected and two hypotheses are accepted. One hypothesis was rejected due to various significant values in which the value of $p > 0.05$. The unsuccessful hypothesis is number one while other hypotheses are accepted.

CHAPTER 5

DISCUSSION AND CONCLUSION

5.1 INTRODUCTION

In Chapter 5, the researcher will discuss the results from the collected data and give a conclusion about the overall study. The discussion of research hypotheses and the discussion of research objectives are based on the results generated by SPSS. Furthermore, this chapter will also list the limitations faced when conducting the research and provide a few recommendations for future research and the overall conclusions of the study.

5.2 SUMMARY OF RESEARCH

This thesis explores the significance of Augmented Reality (AR) technology, specifically vision picking, in enhancing warehouse performance within the logistics sector in Malaysia during the Fourth Industrial Revolution (IR4.0). Acknowledging the challenges in traditional order-picking processes, the study emphasizes the adoption of vision-picking technology as a crucial component in Warehouse Management Systems (WMS). The research aims to provide insights into the impact of vision picking on operational effectiveness, emphasizing efficiency, productivity, and cost reduction in 3PL (third-party logistics) warehouses. Through a comprehensive literature review and taxonomy arrangement, the analysis seeks to draw key conclusions essential for implementing vision-picking technology, underscoring its role in optimizing warehouse performance and contributing to the future development of the logistics field in Malaysia.

5.3 SUMMARY OF FINDINGS

Demographic Elements	Highest Group	Percentage (%)
Gender	male	58.80
Age	30-39	35.00
Race	Chinese	30.00
Education Level	Bachelor's Degree	46.30
Occupation in warehouse	Warehouse Specialist	26.20
Picking Method	Barcode scanning	47.50

Table 5.1: The summary of Demography

Source: SPSS Output

Based on Table 5.1, the study shows that all these elements have an important role in the willingness of the respondents. The study Implementation of vision picking technology towards logistic field warehouse performance. This research shows the gender dominant in this study is male at 58.80% and the age group around 30-39 years old at 35%. Besides, the race that holds the majority of this study will be Chinese with 30%. The education level with the highest holder in this study will be a Bachelor's degree with 46.30%, then the occupation that holds on high majority will warehouse specialist that fulfilled the allocated percentage which is 26.2 %, and among the working environment respondents the private servant holds 36% out of 60%. Besides, the barcode scanning picking method highest value with 27.67%. Here all the elements show the highest values and this is how it affects the vision-picking technology performance.

Section B here is about the implementation of vision-picking technology in the 3PL warehouse in Malaysia. This section holds 5 questions about vison-picking which uses the Likert scale method. All the questions hold a majority Strongly agree, which means the respondents agree that vision-picking technology performance affects the warehouse performance. This will bring awareness among the respondents about the impact of vison-picking technology and why it needs to be implemented in Malaysia for warehouse performance.

Section C explains the warehouse performance which is the efficiency, productivity, and cost reduction. The Likert scale method has been used in the questionnaire to analyze warehouse performance efficiency, productivity, and cost reduction that are influenced by vision-picking technology performance. Here, the Cronbach alpha analysis was conducted to check the reliability and internal accuracy referred to by the respondents. The value of Cronbach's alpha is 0.961 which means it is highly reliable and with high internal consistency. Besides, the shows that the respondents agree that efficiency, productivity, and cost reduction cause vision-picking technology performance.

According to the hypothesis of this study, the hypothesis has achieved and proved efficiency and productivity have a strong connection with vision-picking technology performance. The third hypothesis was not achieved and illustrated in this analysis a negative relationship between cost reduction and vision-picking technology performance. It shows that the study proved the hypothesis.

5.4 DISCUSSION ON MAJOR FINDING

1) To determine the efficiency of the logistic field warehouse in Malaysia by using vision-picking technology performance.

There is efficiency as the independent variable that has been used to examine logistic field warehouses in Malaysia by using vision-picking technology performance. According to Table 4.13 above, the Pearson correlation coefficient for efficiency on vision-picking technology performance is 0.812. It indicates that there is a strong positive relationship between efficiency and vision-picking technology performance. The significant value of efficiency is less than 0.01 which is < 0.05, then the appropriate basis for decision-making in the regression analysis can be concluded efficiency has a significant relationship to vision-picking technology performance. From the analysis result of the study in Chapter 4, the researcher has found out that the vision-picking technology influences the efficiency of the 3PL warehouse in Malaysia since the independent variable is accepted after the researcher runs the data in the SPSS.

The reason order-picking time is frequently used as a stand-in for cost, time-related measures can also help managers determine whether operating time windows and due dates can be met, and cost performance indicators can also include non-time-related cost components that contrast various order-picking systems. The use of vision-picking technologies will boost effectiveness (Nadya Amanda Istiqomah et al 2020). This shows the awareness of the vision-picking-technology performance of efficiency among Malaysian 3PL logistic people is very good.

2. To investigate the productivity of the warehouse logistic field in Malaysia by using vision-picking technology performance.

The second objective of this study is to research the productivity of the warehouse logistic field in Malaysia by using vision-picking technology performance. Productivity, serving as the independent variable, has been investigated in the context of logistics warehouses in Malaysia, focusing on the performance of vision-picking technology. The Pearson correlation coefficient for the productivity of vision-picking technology performance is 0.758. It indicates that there is a strong positive relationship between productivity and vision-picking technology performance. The significant value of productivity 0.025 < 0.05, then the appropriate basis for decision-making in the regression analysis can be concluded productivity has a significant relationship to vision-picking technology performance. The findings in Chapter 4 reveal that the utilization of vision-picking technology significantly impacts the productivity of 3PL warehouses in Malaysia, as indicated by the acceptance of the independent variable in the SPSS data analysis conducted by the researcher.

The integration of augmented reality technology with head-mounted displays offers a solution to address these challenges by guiding operators through the selection process and directing them to the optimal pick areas with maximum productivity. Through the incorporation of automated functionalities that manage a significant portion of the processes, there is a gradual improvement in productivity. Additionally, augmented reality technologies contribute to enhanced operational productivity by enabling simultaneous work on multiple orders, as highlighted in the research conducted by Shaliza Jumahat et al (2022).

3. To evaluate the cost reduction of vision-picking technology performance in the logistics field warehouse of Malaysia.

The cost reduction independent variable has been used to test the vision-picking technology performance towards the logistics field warehouse performance. The results of the regression analysis of cost reduction against vision-picking technology performance will be seen at from the table. The significant value of productivity is $0.142 > 0.05$, then the appropriate basis for deciding within the regression analysis can be concluded that edges failed to have a significant relationship towards vision-picking technology performance. From the analysis results of the study in Chapter 4, the researcher has found out that the independent variable is not affected by vision-picking technology performance.

Cost constitutes a vital element for the success of any profitable business. While holding a substantial inventory incurs expenses, it is noteworthy that maintaining a smaller inventory might also result in higher costs, as indicated by Elisa Kusrini et al. in 2018. Respondents might perceive the integration of vision-picking technology as an additional expense for the company, potentially influencing their perception of the overall cost implications associated with its implementation. The reasons for the lack of impact may stem from various factors, including the complexity of cost structures in warehouses, potential implementation challenges, or insufficient alignment between the specific features of vision-picking technology and the cost reduction objectives. (M. H. Stoltz, et all 2018)

5.5 IMPLICATIONS OF STUDY

Based on research findings, efficiency, productivity, and cost reduction are the independent variable that shows significance with the dependent variable vision-picking technology performance. From the data analysis, efficiency and cost reduction the significant. This clearly shows that this is the main reason for the third-party logistics warehouse should implement vision-picking technology. If the warehouse management doesn't want to adapt to new technology, the warehouse will continue to carry on picking method in the old method. Warehouse management should consider implementing vision-picking technology for several compelling reasons. Firstly, vision picking enhances operational efficiency by providing real-time guidance to warehouse workers, reducing errors, and speeding up the order fulfillment process. This technology contributes to increased accuracy and productivity, ultimately leading to improved customer satisfaction. Additionally, vision picking minimizes training time for new employees, as the intuitive visual instructions streamline the learning curve. Furthermore, the technology facilitates a hands-free approach, allowing workers to focus on tasks without the need for constant reference to paper or handheld devices. Overall, the implementation of vision-picking technology can result in a more streamlined, accurate, and efficient warehouse operation, positively impacting both costs and customer service.

However, from this research, it has one independent variable rejected which is cost reduction. This shows that cost reduction is not affected by vision-picking technology based on the research. This rejection is based on the outcomes of the data analysis conducted using the SPSS system. The reasons for the lack of impact may stem from various factors, including the complexity of cost structures in warehouses, potential implementation challenges, or insufficient alignment between the specific features of vision-picking technology and the cost reduction objectives. These findings suggest a need for further investigation and refinement in understanding the nuanced relationship between vision-picking technology performance and cost reduction within the context of logistics field warehouses.

5.6 LIMITATIONS OF STUDY

Although the research provides some useful insights and knowledge in the logistics field, limitations will affect the knowledge and practical inferences drawn from this study. The first limitation is of this study is the geographical restriction, respondents from the Melaka 3PL warehouse might not sufficient to represent the implementation of vision-picking technology toward warehouse performance in Malaysia. When the development of vision-picking technology is different in each state, it may cause deviations in warehouse performance in each state. The establishment of infrastructure and facility of vision-picking technology in some developed regions will lead to a higher vision-picking technology performance which will lead to an increase in warehouse performance. Therefore, the consistency and accuracy of the results might be affected when there is a similar study was conducted in another geographical area of Malaysia.

The second limitation of this study is only focus on three warehouse performances affected by vision-picking technology performance. In addition to this, there are some effects of vision-picking technology such as accuracy, training simplification, workforce flexibility, and relative advantage that were not discussed in this study. Hence, it is recommended that other factors be involved in future research to investigate other Warehouse performances that are affected by vision-picking technology performance.

Lastly, the time constraint is also one of the limitations of this study. The researcher only has about one month to distribute the questionnaire through Google Forms. Social media tools such as Facebook, Instagram, and WhatsApp were used for the distribution of the questionnaire, but this may affect the credibility of the data. Therefore, this research has failed to obtain the actual sample size according to the Table of Krejcie and Morgan in the limited time given.

5.7 RECOMMENDATIONS FOR FUTURE RESEARCH

After identifying the limitations of this study, the researchers made some suggestions for future research similar to this study. The first recommendation is that the next researchers distribute and collect data from every state of Malaysia as the respondents from different states will provide different perceptions on the implementation of vision-picking technology. When there is more time given, it is recommended that future studies choose larger sample sizes to improve the accuracy of data.

Besides that, researchers who would like to conduct similar research can apply qualitative research to obtain better results in future studies. The researcher can conduct qualitative research through interviews and laboratory experiments to obtain specific information about. In general, interviews will increase the participation of respondents and receive feedback, which will also help to determine more key warehouse performance affected by vision-picking except for productivity, efficiency, and cost reduction. As a result, the next researcher can provide an objective and accurate assessment based on the results generated from qualitative research.

Moreover, it is suggested that future researchers include one of the examples of vision-picking technology, such as wearable devices, computer vision, augmented display, and others in the study to specify which type of vision-picking technology, will create a more impact on warehouse performances. When the future study specifies the fixed type of vision-picking technology to use that will have a great impact on warehouse performance, it will help Therefore, they can choose which one is the better.

Lastly, future researchers are also recommended to include more warehouse performance other than efficiency, productivity, and cost reduction in future studies to investigate other warehouse performances that will be affected by vision-picking technology. relative advantage refers to the extent to which vision-picking technology is considered a better idea or an alternative picking method. Compatibility refers to vision-picking technology suitable for great warehouse performance.

5.8 CONCLUSION

In conclusion, the implementation of vision-picking technology for warehouse performance in the logistics field is essential in Malaysia nowadays because of the rapid growth of e-commerce and higher demand for faster and more accurate picking in warehouses. Vision-picking technology is one of the innovative solutions to overcome the current challenges of large volumes of orders and order-picking operations, which might take up to 50% more time, are the most time-consuming. shows that with the correct technology, travel distance can be cut by 45%. The vision-picking technology option can bring a lot of benefits to logistics service companies like reduced error and labor costs. Therefore, it is important to encourage the 3PL warehouse to use vision-picking technology instead of increasing the number of labor to overcome the current problem of high orders in the warehouse.

Through the findings of this research, most of the respondents agree that the efficiency and productivity of 3PL warehouse performance are affected by vision-picking technology. Hence, the 3PL warehouse management should construct and be prepared with the infrastructure to operate, and be able to do maintenance of the vision-picking technology system. However, the pickers should continuously provide feedback after using vision-picking to provide insights for the warehouse management on how to improve the vision-picking technology, thereby increasing warehouse performance.

Based on the research findings, efficiency is the most influenced by warehouse performance by vision-picking technology. Therefore, 3PL warehouse companies can focus on constructing technology expertise and preparation such as infrastructure for technology integration, employee training programs, and others. Besides that, logistics companies should implement real-time monitoring systems to track the performance of vision-picking technology and other automated processes. This allows for quick identification of issues and facilitates prompt corrective actions to maintain peak efficiency.

In terms of productivity, warehouse management can implement or upgrade WMS that is capable of seamlessly integrating with vision-picking technology. A sophisticated WMS can optimize inventory management, order processing, and overall warehouse workflow. This benefits real-time order processing where the orders are received, the WMS continuously processes them in real-time. It considers various factors such as order priority, deadlines, and item locations within the warehouse.

Furthermore, from the findings found that cost reduction is not a warehouse performance influenced by vision-picking technology performance. The effectiveness of vision-picking technology may be hindered by implementation challenges, such as inadequate training, resistance from warehouse staff, or difficulties in integrating the technology with existing systems. These challenges can impact its ability to deliver cost-reduction benefits. An external perception, such as fluctuations in demand, changes in market conditions, or unforeseen disruptions, could overshadow the potential cost reduction benefits associated with vision-picking technology, making it challenging to establish a significant relationship. essential to conduct a thorough examination of the specific circumstances surrounding the warehouse operation and the implementation of vision-picking technology to understand why a significant relationship with cost reduction may not be observed in the regression analysis. Additional research, data collection, and a deeper exploration of contextual factors could provide more insights into the relationship between cost reduction and vision-picking technology performance.

Implementing vision-pick technology in warehouses faces challenges such as high initial costs, complex integration with existing systems, potential employee resistance requiring thorough training, evolving technological maturity and reliability concerns, environmental factors affecting visibility, scalability issues, data security and privacy considerations, regular maintenance, and potential downtime, regulatory compliance obligations, and the imperative to justify a clear return on investment. Overcoming these challenges requires careful planning, effective communication, and continuous evaluation to ensure successful implementation and optimal utilization of the technology for improved warehouse performance.

Since technology continues to advance over the years, the environment of the warehouse in the picking process is currently evolving and changing rapidly. Picking methods like autonomous mobile robots (AMRs) are one of the most recent or innovative picking methods in well-developed countries. However, the research model's construction did not take account into the impact of vision-picking technology performance in other sector warehouses. Hence, future studies have to explore the implementation of vision-picking technology in other types of warehouses or explore more better picking method than vision-picking.

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APPENDIX B

Gantt chart of Final year project 1

WEEK/ ACTIVITIES	1	2	3	4	5	6	7	8	9	10	11	12	13
FYP talk									MID SEMESTER BREAK				
Search for FYP topic													
Meeting with supervisor													
Topic discussion													
Title confirmation													
Show slide of iv and dv													
RO & RQ Construction													
Submission Chapter 1													
Submission Chapter 2													
Doing Chapter 3													
Trial Slide presentation for viva with SV													
Slide confirmation with Sv													
Presentation 1													
Revised of FYP 1													

Gantt Chart of Final Year Project (FYP) 2

WEEK/ ACTIVITIES	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Create Questionnaire	■	■							MID SEMESTER BREAK							
Distribute Questionnaire			■	■	■											
Collect Questionnaire						■										
Analysis Data							■	■								
Submission Chapter 4										■	■					
Submission Chapter 5												■	■			
Proposal Correction														■		
Slide Preparation															■	■
Submission of FYP 2																■
Presentation 2																■

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Bachelor of Supply Chain Management and Logistics (Hons).

Faculty of Technology Management and Technopreneurship

Universiti Teknikal Malaysia Melaka (UTeM)

Research by Project Survey Questionnaire:

IMPLEMENTATION OF VISION PICKING TECHNOLOGY TOWARDS WAREHOUSE PERFORMANCE OF LOGISTIC FIELD IN MALAYSIA

Dear respondent from Malaysia's 3PL warehouse,

You are invited to participate in my research regarding the IMPLEMENTATION OF VISION PICKING TECHNOLOGY TOWARDS WAREHOUSE PERFORMANCE OF LOGISTIC FIELD IN MALAYSIA ". My name is Thivek A/L P. Sinathamby and I am a student studying for a Bachelor of Technology Management (Supply Chain Management and Logistics) with Honours at Universiti Teknikal Malaysia Melaka (UTeM). The purpose of my survey is to understand the implementation of vision-picking technology in the 3PL warehouse and its effect. It is an academic study to gain knowledge about what and how implementation vision picking technology towards warehouse performance of the logistic field in Malaysia.

***Note: This survey is only for people those related 3PL warehouse and this survey is only for academic purposes.**

I would be appreciated for your cooperation in spending about 5 minutes to finish my survey. This survey consists of Sections A, B, and C which require the respondent to answer it in the best accordance to their perspective and knowledge. Your survey responses areconfidential and only used for academic purposes. I am thankful for your cooperation in completing my survey. Thank you.

For further clarification or inquiries, please contact:

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Section A: Demographic

Instructions: This section is intended to obtain general information on respondents. Please answer the question in your best accordance. Your answers will remain anonymous.

Category	Options
Gender	1. Male 2. Female
Age Range	1. 20-29 years old 2. 30-39 years old 3. 40-49 years old 4. 50 years old and above
Race	1. Malay 2. Chinese 3. Indian 4. Others
Education level	1. PHD 2. Master 3. Degree 4. Diploma 5. SPM 6. Others

Type of Employment in Warehouse	1. Owner 2. Manager 3. Warehouse specialist 4. Forklift operator 5. Warehouse clerk 6. Labor 7. Others
Picking Method	1. Pick by paper 2. Pick by label 3. Pick by voice 4. Barcode scanning 5. Pick by light 6. Others

Section B: Implementation of vision picking technology in 3PL warehouse in Malaysia

Instruction: This section will collect data from your perspective on the Implementation of vision-picking technology. Please read each question below and provide your answer by choosing the appropriate number on the 5-point Likert scale provided below

(1) Strongly Disagree

(2) Disagree

(3) Neutral

(4) Agree

(5) Strongly Agree

The questions below are related to the Implementation of vision-picking technology in the 3PL warehouse in Malaysia.

No	Statement	1	2	3	4	5
IVP 1	I am aware of vision-picking technology in the market.					
IVP 2	Usage of vision-picking technology in Malaysia is very low.					
IVP 3	I intend to learn how to use vision-picking technology in the warehouse.					
IVP 4	I consider vision picking tobe my first choice for order-picking methods in the Warehouse.					
IVP 5	I would recommend vision-picking technology to be used in my company warehouse.					

Section C: Warehouse performance after implementation of vision picking technology

Instruction: This section will collect data from your perspective on Warehouse performances after implementing vision-picking technology. Please read each question below and provide your answer by choosing the appropriate number on the 5-point Likert scale provided below:

(1) Strongly Disagree

(2) Disagree

(3) Neutral

(4) Agree

(5) Strongly Agree

Part 1: Efficiency (EFY)

The questions below are related to the **Efficiency** of warehouse performance by implementing vision pick technology.

No	Statement	1	2	3	4	5
EFY 1	Using vision-picking technology increases pick rates.					
EFY 2	Using vision-picking technology minimizes travel time.					
EFY 3	Using vision pick technology never lets pickers arrive empty location.					
EFY 4	Multiple orders can be picked at the same time by having vision-picking technology.					
EFY 5	Vision-picking technology improves accuracy.					

Part 2: Productivity (PDY)

The questions below are related to the **Productivity** of warehouse performance by implementing vision picking technology.

No	Statement	1	2	3	4	5
PDY 1	Using vision picking technology orders are picked on time for a vehicle departure.					
PDY 2	Vision picking technology is very effective for 3PL orders where 100s of orders are in a single line.					
PDY 3	Real-time stock updates lead to fast and accurate replenishment by implementing vision-picking technology.					
PDY 4	Fewer processes of picking orders where time can be saved by using vision picking technology.					
PDY5	Vision-picking technology boosts productivity more compared to other picking methods.					

Part 3: Cost Reduce (CR)

The questions below are related to the cost reduction of warehouse performance by implementing vision-picking technology.

No	Statement	1	2	3	4	5
CR 1	The cost of repacking and re-delivery can be avoided by implementing vision-picking technology.					
CR 2	Using vision pick technology to reduce labor costs in handling and checking items on their return.					
CR 3	The cost of recovering the item can be reduced by implementing vision-picking technology.					
CR 4	The cost of picking replacement items can be avoided by having vision-picking technology.					
CR 5	Overall, vision-picking technology can lead to cost savings by reducing wrong item delivery.					