

IMPACT OF WAREHOUSE DESIGN AND OPERATIONS USING AR ON FOOD SUPPLY CHAIN

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ABSTRACT

Thousands of studies might have been done over the augmented reality (AR) in various sector such as education, medical and retail and the limited information on the logistics and supply chain where the implementation of AR could be found. Logistics is one of the sectors that could be utilise the AR to maximum due to the nature of the supply chain process that require fast paced technologies to meet the demand and supply. This sector is vital in daily operations over every single process for the goods to meet the end user's needs. Hence focusing on a smaller aspect of logistics and supply chain, one of the most crucial processes is inventory management that occur inside of a warehouse. Warehouse is not only able to handle the inventory but there are many types of processes that take place inside. To be able to achieve the goal of supply chain in efficiency the warehouse itself must be well prepared to carry out the whole process efficiently with the help of AR. Inside of a warehouse the entire production is exposed to many risks and from this management should be able to be foreseen the warehouse design and operations so that business does not need to change or find solution to expand in the future to meet rigorous demands. This research will go deeper on the warehouse design and operations through the AR world on the overall supply chain. The findings will enable everyone to understand the impact of it on the current proves that take place inside of warehouse and achieve the efficiency needed in supply chain.

Key words: Warehouse Design, Warehouse Operations, Augmented Reality, Supply Chain Management, Food Supply Chain, Warehouse Efficiency.

INTRODUCTION

Generally, the word supply chain is critical in logistics where the process of moving goods from one place to another and until the end user must be done efficiently. In the modern days, supply chain is more crucial due to the demand from e-commerce getting out of hand. The modern supply chain exists in order to improve the living standards of the users. Where the current supply chain enables the users to access the essential products at a lower rate compared to the physical stores rate. Knowing these facts, the consumers become more aggressive in reducing the logistics cost. Hence effective supply chain management in the process needs to be more proactive day by day. Supply chain management is important in daily life since it carries the basic necessities for people, creating good infrastructure for the consumers and the fact that supply chain plays a role in job creation is no doubt. Business must consider many aspects of the supply chain since the bad and ineffective supply chain could put the whole process in risk. The role of supply chain is enabling the growth of the economy by creating an exchange of goods between business and consumers. The Supply Chain Management (SCM), has its own impact on the economy due to the entities involved which include the materials processors,

manufacturers or producers, vendors, warehouses, transportation and companies, distribution centres, and retailers.

Looking back to the year of 2020, the pandemic disrupted the current supply chain in many ways. For instance, the price of goods and services are insanely high due to the shut down or slowed down of many factories that produce low-cost hubs around Southeast Asia due to the financial problems (Reuters, 2021). The disruption created thousands of issues and challenges to the supply chain. But the most important is the effect of the pandemic in the food supply chain. The price for the basic needs rose abruptly and mismatch the demand that led to many reports on the health issues. Based on data researched by The Economics Daily: U.S. Bureau of Labor Statistics, 2021, the prices for raw meat, fish, and eggs went up to 10.5% by the end of September 2021. It is not only affecting these sectors on the other hand the prices also increase for cereals and other bakery products related, fruits and vegetables too. Food is the main source of energy and the condition of the food plays a major role in daily production. The food supply chain defined by (Bourlakis, & Weightman, 2008) is a controlled process in a combination of knowledge, technology, biology and more. The one of contributors in SCM is the warehouse, hence the whole process of moving goods and the complexity of the supply chain will be directed to the efficiency of the warehouse (Kiefer, & Novack, 1999). In the logistics and supply chain the inventory management is crucial to avoid extra cost in the process hence the importance of warehouse (Banabakova, Latyshev, Georgiev, & Stoyanov, 2018; Jaehrling, 2018). Business will consider the inventory management and warehouse cost into account even before the process takes place and SCM are not widely considered after the business hit globalisation (Ali et al., 2008). After the year of 1990, the growth of logistics makes the current problems become more complicated and aggressive due to the multiple distribution channels (Gundlach et al., 2006). Issues on the logistics is adaptable, but the solutions need to be more aggressive as the warehouse issues is vital for the world supply chain (Coyle et al., 2003).

The warehouse efficiency has become the key point and centre of competency and used as a strategic weapon by organisations to improve their current situations (Tompkins, 1998). Being one of the important key players in the logistics and supply chain process warehouse could be affected by incomprehensible challenges. Beforehand, warehouse might only just part of the process, but today it has been considered as one of the solid industry of itself (Gundlach et al., 2006). In the present environment the business operational activities are related to the warehouse efficiency where supply chain ideas and competitiveness could give a big influence over it (Harmon, 1993). The massive difficulties in the efficiency of warehouse operations has become more complex and require more experts to embrace these issues. Manzini (2012), stated that the businesses are currently facing warehouse issues and the adverse effect of supply chain activities that give a big impact on the business performance. Because a particular standard of performance is required to thrive in the competition (Nadeem et al., 2018), logistic companies must tackle warehousing challenges in order to improve performance. However, these problems could be addressed through the warehouse attributes and there are various studies on these challenges (Baker, 2007; Mason et al., 2003), unfortunately the warehousing attributes are not well represented in the current studies making it hard to be explored. To address various supply chain warehousing issues, it is vital to research warehousing features (Jermsittiparsert et al., 2019). The assembling business is longing for the warehouse hence it clearly shows the role of it in improving the warehouse capabilities throughout the operation (Lambert et al., 1998). The importance of a warehouse is depending on the abilities of the operations and special connection between the end user and producer of goods where a good warehouse operation

could fulfil client desire in shorter time, increase in reliability and provide the accurate goods (Jermstittiparsert et al., 2019). Thus, this shows that the warehouse operations will impact the supply chain warehouse efficiency. These were agreed by many researchers where businesses must invest to improve the warehouse efficiency to create frequent stock turnovers and allocating orders from assembly to final delivery (Stock, 2001).

Furthermore, determining the warehouse operation capacities for the future expansion and development, stockpiling and data exchange is challenging and crucial for business (Adam, 2012). All these activities could affect the warehouse efficiency since the supply must meet all the demands to ensure no shortage in the supply chain. Warehouse efficiency is relying on the smoothness of the process (Talamo and Sabatino, 2018), in further the cost is relatively related to warehouse efficiency since a more effective the process the lower the cost and more quantity can be produced (Lambert et al., 1998). There is also a further discussion on this topic, where the warehouse operations that exercise with high efficiency will create a high potential in influencing customers to be loyal and serve as a competitive advantage for business. A unique and well-equipped warehouse eventually related to warehouse features. The more efficient warehouse features and layout the business could compete with other business with a new competitive advantage. A previous study also showed that the connection of warehouse layout and operations impact on the supply chain generally. Study by Jermstittiparsert et al., (2019), focusing on the management information system (MIS) between the warehouse efficiency showed a positive effect on the supply chain and increased the whole production.

The efficiency is driven by warehouse layout where the procedure to plan the layout is like putting the puzzle together and being characterised by profiling, benchmarking, streamlining, computerisation, and automation of warehouse operations (Frazelle & Frazelle, 2002). The efficiency of supply chain related to the warehouse design since a well-designed layout will contribute to a reduction of production cycles, reduce the bottlenecks problem, shorter lead time, and eventually reduce the material handling times (Bartholdi III & Hackman, 2008). Considering the layout for the whole operations would at least boost the performance which could have a good impact on profitability. Since the operations zone is the most busy and important inside the warehouse, it must be treated as a central point to create a bigger impact on the production. The strategy for warehousing layout management surely affects the whole system's efficiency, as warehousing layout management is vital to the organisation's business success (Bartholdi & Hackman, 2008). Bartholdi & Hackman, (2008) stated that selecting the optimal warehousing plan for productivity is not a simple task since many aspects influence warehousing activity achievement, such as dock area, rack kinds, rack access, and others. While other studies found that the warehouse layout supposed to be standardised to fight the limitation on expenditure impose by the administration and flexibility in the layout to create a wider and variety of supply to meet the demands in their inventory (Faber et al., 2002). Hence, the result showed the warehouse layout is one of the critical factors to create an efficient warehouse in the supply chain.

Similarly, Mohsen and Hassan (2002) emphasised that designing the layout of a warehouse framework is a tricky job for a broad range of reasons. These are major and significant structure choices that comprise a collection of challenging problems inside the warehouse. There are various operations being carried out such as picking, docking, value addition services and other physical operations that must meet the lead time along with the right material at the right cost to avoid risk that could affect the entire process. Processes inside the warehouse reflecting the a thorough designed layout the able to handle all processes and

support every operational change without the need for visit changes that would enhance the plan (Mohsen & Hassan, 2002). Legitimately shows the importance of warehouse layout and design to help the business plan their whole process and achieve efficiency from the warehouse design itself. While on the other hand the operation relationship with efficiency is the next feature that further plays an important role in the supply chain warehousing efficiency as it is frequently discovered that successful operations boost system efficiency (Potočan, 2006). Besides, businesses must start to assess and evaluate the customer satisfaction according to the right procedure to enable them to increase the warehouse efficiency (Frazelle & Frazelle, 2002). Dealing with a lengthy process is troublesome but it is a must in order to be able to identify the advantages that required by the business to improve and examine the process that need extra attention to avoid technical issues that could lead to bottlenecks, and the equipment problems (Frazelle & Frazelle, 2002). It is critical since warehouse operations have a direct impact on the business overall viability and quality. Furthermore, the vast change of demands require the supply chain to improve performance has prompted warehouse management to focus on integrating their efforts (Corinna Cagliano, DeMarco, Rafele, and Volpe, 2011). From this the warehouse operational performance is closely related to the warehouse efficiency.

Problem Statement

An antiquated, paper-based system is now used for warehouse management. The changeover to fully supported by technology in warehouse system seems impossible and high cost because this technology is currently in place. The AR has restrictions on the food supply chain and supply chain itself for other goods. Due to the complexity of warehouses, warehouse design requires a very rigorous and well-organized approach. When designing a warehouse system, there are many storage methods and handling equipment alternatives, but contemporary warehouses are not adequately built to effectively leverage the AR functions. Making sure that all of the processes that take place in a warehouse run as smoothly and effectively as possible is the aim of warehouse management. As a multi-criteria problem with connected functions and parameters, warehouse design is extremely difficult. Implementing an automated processes could be seems as lower risk to error, the whole process still prone to errors and difficulties. A simple mistake or errors during the process eventually will affect the overall productivity and the speed of the entire process will reduce the efficiency. Most frequently, these errors aren't identified until the process has begun or even after it has ended. At that time, it's usually too late to undo the error and occasionally even too late to mitigate the damage that has been done. However, if we are aware of the numerous issues that might occur in the warehouse operation, we can prepare for them and avoid damage altogether. Using effective simulation-based AR visualisation, warehouse management teams may swiftly select the optimal storage strategy, such as block stacking, deep lane storage, an automatic storage and retrieval system, the right handling equipment, and the layout of the warehouse (configuration). With these capabilities, warehouses may automate vital engineering design processes, saving money and time on physical product development. By utilising AR, we substantiate the influence of warehouse design and operating simulation. Thus, the objectives of this research are to analyse the existing literature on AR implementation impact in design and operation of the warehouse in the food supply chain, to study the extent to which AR technology can be used in warehouse management and the positive effects that can be obtained, and to determine the potential to speed up the procedure of AR in warehouse management.

LITERATURE REVIEW

Augmented Reality (AR)

Growing of new technologies in many industries has improved human-computer interaction. When virtual objects and signals are instantaneously superimposed on the physical world, augmented reality (AR) improves how the user perceives both technology and the outside world (Furht, 2011). Currently, people seem to consider the AR is only the head-mounted display (HMD), hence Azuma et al., (2001) stated in Azuma et al., (2001). The current development of AR is not only restricted to HMD or limited sense of sight (Furht, 2011). AR also could be sensory substitution for the human and some of it are applications that are commonly called mediated or diminished reality (Herling, & Broll, 2010). Azuma et al., (2001) added that the AR application able to remove objects from the real environment from the physical world entails covering it with digital data that blends in with the surrounding area to give the user the impression that the object is absent. AR could project the information through hardware where the virtual object's information can assist the user in doing out daily chores. Besides, the AR has also been utilised in entertainment, medical, and other fields widely. The study on AR has gained popularity, mixing virtual and the real world have different proportions that attract the interest among the business key players since AR could cut the production cost. The AR breakthrough in the business field created thousands of benefits in terms of profit and return for stakeholders since the virtual equipment could not provide the same level of AR technology.

Implementation of augmented reality immensely in certain sectors such as the medical, engineering, education and industrial training. However those sectors only operate inside of the building for the indoor activities and are not widely used as a whole. Advancing from the research phase, AR has stepped up the games to mass application in the real industry working as connector between technology and reality, where it enables humans to gain new ability in understanding and experiencing the non-living elements around them (Zlatanova, 2002). For example the use of the sensor, track and register, 3D- modelling help in produced virtual information for humans embedded in the reality as the result of text, music, video and more (Zlatanova, 2002). The benefits from utilising the AR technologies are powerful and it helps in collection of data in real-time, provision of 2D and 3D images to reduce risks, and enhance user experience and efficiency by continuously improving user experiences. The globalisation that the world is facing has a big impact on the supply chain that requires advanced technology such as AR to aid the high demands in the future. The AR in the supply chain could be more efficient since AR is mainly to increase the user's view and will provide more information during the whole operation. Szajna and Kostrzewski's (2022) research emphasise the importance of AR and AI tools in ecologically friendly workplaces. According to Shelton and Hedley (2004), the marriage of cognitive or thinking technologies with AR has made images more engaging, which could provide greater and more thorough knowledge of the subject in this period.

The initial idea of AR came from Morton Heilig a cinematographer in 1950, he believes that the spectators will fully immerse into the action on screen if only all the five senses are utilised. After that there are many other digital computing and augmented reality systems using the HDM that are introduced to the public. The benefits from AR started to be the talk of every researcher hence the rapid growth year by year despite the limited technology back then. Each year new AR systems and applications are introduced, and the revolution of mobile AR is getting more advanced these days. The camera could be the most crucial hardware in AR where it

captures the actual object or scene and turns it into 3D virtual objects. The computer vision techniques used for augmented reality picture registration are primarily connected to video tracking. This stage is the first stage of reconstructing a real-world using the features captured. Somehow there are advantages and disadvantages of it since tracking could be hard and require different techniques for indoor and outdoor environments. Furthermore, a new approach for the visual tracking has been studied similarly the function of the human brain that is able to handle complex images and advances in visual tracking.

AR Devices

The aim of AR itself is to improve the overview of user's surroundings by overlooking the information that enhanced by the virtual computer-generated information hence the major instruments in AR are displays, input devices, tracking, and computers (Furht, 2011).

- Displays are divided into three; head mounted (HMD), handheld and spatial displays. HMDs can feature display optics that are either monocular or binocular and can be either video-see-through or optical see-through. In comparison to optical see-through systems, video see-through systems are more demanding because the augmented view is already produced by the computer and gives the user far more control over the outcome. This device projected displays for the users in s-phones, PDAs, and Tablet PCs are examples of portable screens that are now being used for augmented reality systems. With spatial augmented reality (SAR) allows users to view graphic data directly on physical things without having to wear or carry a display.
- Input devices such as controllers are undoubtedly the most popular type of input device. Since they cannot be controlled using hand movements, they are a fixed addition to the majority of VR glasses. The form of application for which the system is being designed and/or the display selected have a significant impact on the input devices used (Team Marketing, 2020).
- Tracking is mainly the cameras or other optical sensors that have different levels of accuracy and greatly depend on the system deployed.
- The computers used for AR systems must have a strong CPU and lots of RAM are needed.

AR in Supply Chain

The rapid expansion of augmented reality is getting more attention from various researchers. In supply chain AR technologies are aiding the process and offer organisations a comprehensive support through the full product life cycle. The process that includes the AR in the early concept planning over the products and maintenance. The implementation of AR techniques enables quicker and more effective design at the early stage as the product design itself (Elia et al., 2016). AR technologies gather all data and information that generate advanced data that enable visualisation for further research and help the development teams to carry out various dynamic prototypes that could manipulate the end result or products. For instance, the most well-known AR technologies are the glasses that allow operators to visualise the information that reduce the error and provide better quality control (Pierdicca et al., 2017). The implementation of AR has improved the business revenue since the technology mitigates a number of production issues. AR in production shows and guides the operators to complete tasks in their actual working environment and significantly improve their abilities and knowledge (Knauer-Arnold, 2020). The idea of producing and implementing AR in the process is not simply a matter of adding new features and technologies. AR is a bigger transformation for the supply chain. Representing a major shift in current pace of production gives a fresh approach that results in new methods of value creation and delivery that simplify products, coordinate processes

better, and improve customer experiences. For example, back in 1999 and 2003, a project called ARKIVA that aimed to help the German automotive and aerospace sectors using the AR system in R&D, production, and other service related operations (Rejeb et al., 2021). Another similar project in Italy is introducing Industry 4.0 to improve their nation's industry with the help of AR technologies where in the future the use of AR enables to create value added in the industry.

Recent studies show that AR is mainly in the manufacturing that supports the process to run smoothly and effectively through the maintenance services, creating a sustainable system and flexibility throughout the process. Most of the technologies that are used are AR glasses, simulations, display devices, sensors, QR codes and other that usually in the education or medical field are advanced in. These technologies are typically coupled to complete a task, so more than one AR application may be employed in a single activity. While in manufacturing AR could be divided into three stages that includes production, assembling and maintenance. Numerous academics have emphasised the need for aid with and instruction in AR-assisted assembly where before an actual production process, simulation can be conducted. These benefits in reducing errors that usually occur in assembly lines and planning processes where AR gives real-time information and tracking displays to the operators to avoid bigger issues in the production. This procedure will be carried out virtually with an instructor providing instruction. Technologies provide system that give a better access of virtual components on the essential data so workers can exactly know their working space (Esengün & İnce 2018). This will make optimum use of the labour resources and improve productivity.

AR technologies are increasing revenue and the application or system is offering practical solutions to a number of problems faced by the business. Business is focusing on the product quality and quantity to meet the market demands hence utilising AR to shorten manufacturing and delivery lead times, reduce resource usage, waste, and errors. These strategies in manufacturing reduce the overall cost and improve the flexibility in production. Investing in AR creates a bigger advantage for business in the long term since it enables new equipment and set of skills for operators to engage in an interactive experience along with computer-generated information and materials. The AR provide more reliable information on the plant maintenance activities and the resources are utilised effectively that help to improve sustainability in focusing on the manufacturing (Hauschild et al. 2005). Providing an assistance through the maintenance work ease the workers throughout the process and improve their visual interactions on the production equipment. From previous research the AR has demonstrates the ability to improve the effectiveness of remote maintenance methods in complex and challenging environmental settings (Elia et al., 2016).

AR in Food Supply Chain

Focusing on the food supply chain could be more complex hence the limitation of study and research are not as much as the AR in supply chain. The business is comfortable with the traditional ways of managing the food chains due to cost and the risks of errors. The available technologies has increase the demand from food producer that have interest in reducing the human labour and change into the AR technologies. Somehow the research in this area seems to be less despite the benefit they will gain in the future.

The technology in the food supply chain itself is relying on to give real time information to ensure no disruptions to the supply. Shortages in the production could be overcome due to the current technologies that could help to calculate and predict the demand and supply better. Food security is the main agenda in this industry, where maintaining the quality of food and quantity at

an affordable price is awfully hard. Finding effective ways to safeguard food security throughout the food supply chain is one of the top objectives related to the sustainability of food security, which is a global concern. Producing a big amount of food is not a way to ensure a good food supply chain. Besides, sustainability should not jeopardise the capacity of future generations to meet their own demand currently. Businesses are alert that an increase in product quality is anticipated to emphasise the influence a product has on the economy, the environment, and society, all of which are linked to its lifecycle. As a result, the idea of sustainability has taken centre stage in a variety of sectors' supply chain products and services.

Therefore, AR in the food supply chain itself could simplify food management. Relying on the demands pressured the food supply chain sector and especially the business that supply raw materials. The pressure on the backend where supplies and inventories are troublesome for business with limited staff. Hence to overcome this through overseeing the AR technologies can deal with the increment in supply of food. Apart the foodservice sector is facing the same issues hence implementation of the AR could open to a new opportunity. The entire of food supply is a complex process and getting more complex and meticulous due to the products being perishable and requiring extra attention. The mistakes or any errors throughout the whole process could cost the business. By implementing AR technologies give the food industry such as just-in-time data processed over the inventory they are holding (Rejeb et al., 2021, Beck et al., 2016). Food operators can optimise food warehousing and logistics due to AR's visualisation capabilities, which go beyond human constraints. In one of research by Phupattanasilp and Tong (2019) point out the high visualisation using AR such as farmers, able to improve their data in reducing the threats in production. AR itself is not mainly used to lower operation cost and increase revenue or risk that businesses are facing but it goes beyond in creating resource utilization to meet the increasing demands.

Besides, efficiency is the number one priority in the food supply chain industry. As discussed in many studies AR itself is growing to improve the current productivity with extra efficiency. AR technologies are no longer in doubt for providing real time data, boost labour efficiency, and simply current complex operations. The technologies that overlaying the reality with virtual images in the manufacturing plant enhance overall level of efficiency and efficacy. Previous studies show that, with the help of AR workers are able to carry out a variety of tasks and see their problems in different views with information provided through the devices embedded with AR technologies and systems. The inefficiency before using the AR is mainly related to slow real-time information provided to workers hence the errors happened. Processes like the current file consultation work in process, availability of data collected and sharing, and immediate help are just a few that can be made easier by using AR devices simply and without using hands.

The digitalization of logistics and food supply chains has made better situational awareness more crucial than ever. Implementing AR improves control over food processes and encourages more productive production methods by allowing for a more interactive representation of the interplay between dynamic sensory input and intricate food constituent structures. AR could simplify data collection and analysis, enhance understanding of the workplace, and provide a wealth of location- and context-based information. Direct access to and comprehension of location-based information, such as order pickup, indoor navigation, and warehousing management, makes food supply chain management more effective (Caria, M., Todde, G., & Pazzona, A. (2019). For example, a study was conducted on a system that uses drones to help farmers in soil sampling data collection with AR by Huuskonen and Oksanen

(2018). They stated that in broadacre farming, the majority of field work is done by human-powered machines, thus with the AR able to create more efficient ways to collect data and reduce the amount of efforts to gather soil samples. From these the key players could see that by enabling operators to move around physical areas quickly, reduce idle time, and optimise routings, augmented reality technology can be useful to the food sector. Food inventory management needs to be done correctly, product identification needs to be done automatically, and operational inefficiencies need to be fixed.

METHODOLOGY

This section discusses the technique used to find articles on impact of warehouse design and operations using AR. We applied a systematic literature review technique, which incorporates resources.

Research Design

To substantiate the impact of warehouse design and operation using AR, a systematic literature review were used based on the guidelines developed by Tranfield, Denyer, and Smart (2003). A key scientific activity that tries to accurately reflect the body of knowledge in a certain research subject is a systematic literature review (Mulrow, 1994). Using systematic literature review the data collected and assessed is a rigorous, thorough, and repeatable approach for locating, assessing, and summarising the research projects that have already been undertaken by academics, researchers, and practitioners. Systematic literature review is more reliable and has high relevancy based on previous studies. A series of methods were followed to assure the relevancy over recovered studies, the accuracy of the quality evaluation, the lack of prejudice in the research, and the analysis from researched before on this topic. The guidelines used in this study are designed to create a new knowledge base from the current literature on AR enablers in the food supply chain and evaluating the research study thoroughly. Along the way, extra attention is made to make sure that all relevant publications are included and that prior research findings may be applied to the current study.

Database Selection

The review relied on four main journal databases – Scopus, ScienceDirect, Emerald Insight, and Taylor and Francis. With sophisticated tools to manage, analyse, and visualise research, Scopus is one of the largest abstract and citation databases of peer-reviewed literature and reliable web sources. The Scopus interface is easy to use and has a more extensive worldwide coverage. Scopus covers almost 36,377 titles from roughly 11,678 publishers (22,794 active titles and 13,583 inactive titles), of which 34,346 are peer-reviewed journals in high-level topic areas. The second database examined in the review is ScienceDirect. The Dutch publisher Elsevier's extensive bibliographic library of scientific and medical publications is accessible through this website. It houses nearly 18 million pieces of information from this publisher's 30,000 e-books, 4,000 academic journals, and more. Four major categories—Physical Sciences and Engineering, Life Sciences, Health Sciences, and Social Sciences and Humanities—are used to organise the journals. With a portfolio of over 300 journals, over 2,500 books, and over 1,500 teaching examples, Emerald Insight is a global publisher that offers high quality, peer-reviewed research. Taylor and Francis was the most recently used

database. More than 2,700 top-notch, multidisciplinary publications in the humanities and social sciences, sciences and technology, engineering, medicine, and healthcare are accessible through it.

Identification of Keywords

Identification is the initial step in the systematic review process. The procedure involved identifying keywords for use in information searches. Several pertinent information sources were consulted, including keyword suggestions from databases, keyword synonyms from earlier publications, and keyword variations for the term rural library. 159 documents were obtained from the databases as a consequence of this process.

Selection of Relevant Articles

The selection of the article procedure continued with the analysis of the abstracts of the remaining articles after the multiple copies in those searches were eliminated. This selection procedure was carried out independently, focusing on chosen publications that included study questions and findings that were only directly related to the goals of this research.

Collection of Data

The data extraction was eventually successful. We conducted a critical assessment of the literature in order to accomplish the research goal. The investigation has focused on the warehouse's effect over the last five years. Finally, a systematic strategy was used to summarise the research findings from the publications under examination. This methodical methodology heavily relies on the researchers' subjective assessment of the papers they are looking at. According to Tranfield et al. (2003), the researchers should be given a certain amount of subjective latitude to assess and interpret various studies in order to produce definitions and abstracts that are comparable. At the conclusion of this phase, the collection of articles was reduced to 9 papers that addressed the goal.

FINDINGS

In recent years, there has been a surge in e-commerce due to the increasing number of consumers and business owners who have switched their activities online. This has been a major contributor to this growth. Because of this, there has been a rise in the amount of commercial activity that takes place on various internet platforms. The efficiency with which warehouses are managed will have a direct effect on the length of time it takes for things to be moved and, as a consequence of this, the length of time it takes for customers to get their hands on products. It is quite essential to have this component of the equation that represents the supply chain in order to make sure that items can be carried rapidly and efficiently all over the world. Due to the increase in orders with a high demand and the shorter time frames within which they must be delivered, any mistakes or delays that occur in the warehouse may result in dissatisfied consumers, which in turn hurts the company's brand image as well as its income. As a direct result of this, the findings were divided into four categories warehouse design and operation using AR in the five years (2017-2021). These includes the layout of the available space within warehouse, control over stock and supplies, order selecting, and The use of augmented reality (AR) has the potential to speed up the procedure by a large margin.

The Layout of The Available Space Within The Warehouse

It is necessary to organise the actions that take place in the storage facility in such a manner that they are as productive as can be expected under the given conditions and in light of the options available. This is as a result of the fact that the efficiency of these processes is one of the most important aspects that determines an organisation's overall performance. The management of the warehouse needs to come up with a plan that takes into account all of the significant factors that could be involved in the warehouse's day-to-day operations in order to ensure that everything functions in an orderly manner. Warehouses nowadays are useful for a variety of purposes, in addition to serving as a location for the disposal of outdated products, which is the traditional function of a warehouse. When compared to those supplied by a contemporary warehouse, which gives a much great variety of alternatives, the choices that are presented by a current distribution centre are extremely restricted.

To be more specific, the warehouses of today serve as a centre for the performance of more challenging activities such as product subassembly (Mourtzis et al., 2019). These services are typically outsourced to other locations. These services are conducted so that both time and money can be saved as a result. Checking the product, putting it together, making any necessary repairs, packing it, and sending it to the customer are all steps that are included in this operation (da Cunha Reis et al., 2017). This would imply that in addition to their typical operations, warehouses also supply their customers with value-added services that they can take advantage of. It is necessary for these services to have continuous monitoring as well as exact service delivery, and the warehouses are the only ones who can give any of these things. It is of the utmost requirement to build a thorough plan for the warehouse that outlines how each duty may be carried out in a trustworthy manner. This strategy must be established as soon as possible. The formulation of this approach needs to take place as soon as the opportunity presents itself. In order for the plan to be successful, it is necessary to address issues such as the most efficient use of space, the redesign of the warehouse to take into account the potential of unforeseen events, and the safe storage of high-selling or seasonal commodities (da Cunha Reis et al., 2017).

These are only some of the problems that need to be solved. AR is able to be the major aid to warehouse managers as well as the people who work in the warehouse when it comes to the process of generally setting the layout of the warehouse. This is something that can be accomplished via the usage of AR. Since it is able to build a digital and interactive 3D layout of the warehouse, augmented reality (AR) makes it possible to try out a variety of different alterations to the configuration that is currently in place at the facility. These alterations can be made because AR can construct a digital and interactive 3D layout of the warehouse. These modifications are possible thanks to the fact that AR is capable of building a digital and interactive 3D blueprint of the warehouse. Putting on a pair of augmented reality glasses and looking through them is all that is required for the necessary authority to obtain specific information on the configuration of the storage facility, including the adjustments that are being suggested.

Control over The Stocks And Supplies

Since it is one of the most important jobs that must be completed at a warehouse, inventory management is also one of the most difficult duties that must be conducted there (Mourtzis et al., 2019). In spite of the fact that it is one of the most mind-numbing tasks involved in the management of inventory, it is also one of the most important operations and it

is necessary to conduct a check on the inventory. In the past, workers were required to physically hurry around the warehouse in order to perform manual checks to determine whether or not the goods needed to be refilled, were ready to be shipped, or were in the appropriate condition. These checks were performed to determine whether or not the goods were in the appropriate condition. To assess whether or not the goods were in the appropriate condition, several inspections were carried out.

Multiple inspections were carried out so that it could be determined whether or not the goods were in the appropriate condition. In the past, taking inventory was performed using procedures that required the use of paper and, more importantly, demanded a considerable amount of time to finish (Rejeb et al., 2021). In addition, in order for the occupations of the employees to provide the results that were desired, it was required to provide the employees with training, which was an extremely pricey investment. Only then could the jobs of the employees produce the results that were sought. In order to achieve the outcomes that were intended, this action was taken. In addition, since human are involved in the process, there is a greater possibility that errors will be made, as well as an increased likelihood that the stocktaking would be erroneous. This is because human have flaws and are prone to making mistakes. This is due to the fact that people are not perfect and are prone to committing errors. As a direct consequence of this, companies are unable to offer any form of guarantee that the completed product will be perfect and accurate on a consistent basis.

After realising that this particular company needs to be managed more efficiently, large logistics organisations have begun deploying barcode scanning systems for inventory control and management (Rejeb & et al., 2021). These systems are used to manage and control inventories. After getting to the conclusion that barcodes should be utilised, these companies got to this realisation as a result of their discovery. The utilisation of these technologies allows for the management as well as the control of the inventory to be completed successfully. The discovery of barcode scanners ushered in a period of innovation and change that fundamentally altered how stocks are inspected and managed. This paradigm shift brought about a new era of creation and revolution. Despite the fact that barcode scanners offered a variety of advantages, this event nonetheless took place. On the other hand, using AR, warehouse workers and managers would be able to manage inventories without actually having to touch any of the things in the warehouse. This would make AR an attractive alternative to traditional inventory management methods (Rejeb et al., 2021). If the workers have access to this information, it will be much simpler for them to determine which commodities go into which container and how those things should be loaded. If the workers do not have access to this information, it will be considerably more difficult for them to do these tasks. Due to this, the workers will be able to finish the process of loading and unloading the cargo without having to deal with any delays along the route.

Order Selecting

The process of picking the orders that have been placed is one of the most labour-intensive and important activities that must be accomplished in a warehouse. It is projected that the order picking process will be responsible for up to 55 percent of the overall costs connected with running the business (Mourtzis et al., 2019). Order picking is the process of receiving the specific item or items that a customer has ordered at the exact moment that they have requested it and in the exact amount that they have asked. This must be done in order to fulfil the order in its entirety. Customers have grown to anticipate in these days, which is powered by technology

that all goods and services would be supplied at a quicker pace. This is because customers have come to expect that technology will make their lives easier. Customers have been accustomed to getting things in a more expedited manner, which has led to the development of this expectation on their part. The reason why consumers have this anticipation is because they believe that technical progress will continue to advance in the future. Due to this, logistics companies are under constant pressure to rationalise and decrease the expenses linked with the process of order picking in order to maintain their capacity to generate revenue. This is necessary in order for these businesses to remain profitable. This is done with the goal of protecting their capacity to continue operating at a profit in the future, and it is done in this manner. Traditional order picking was a laborious and time-consuming process throughout its entirety, during which the personnel had to navigate the warehouse in order to locate things that were in accordance with the criteria of the customers. This meant that traditional order picking took a significant amount of space in the warehouse. This indicated that the conventional approach to order picking was not only ineffective but also inconvenient due to its reliance on manual labour.

Order picking is a process that needs a substantial amount of space within the warehouse because this labour-intensive manual process was not only expensive, but it also had a high rate of error, which led to an increase in the cost. There was a surge in the number of persons using barcode scanners during that time period. AR is capable of streamlining the multi-step process of determining which order to put objects in by lowering the number of steps that are engaged in the process. For instance, when an operator is informed about a scheduled pick-up, he or she will walk around the facility while wearing AR-based smart glasses in order to keep track of the location of the pick-up that is scheduled to take place. Keeping track of the location of the pick-up that is scheduled to take place. The worker will be able to remember when and where the pick-up is due to take place if she does it this way. Even if the worker turns the head in different directions, the smart glass might still be able to scan the barcodes of the items she sees in the shopping basket. The necessary information is presented to the worker in both visual and an auditory format so that they may reach the location of their choice. This is done in order to facilitate the operator's arrival at the location of their choice. When the selection is complete, the information that has to be saved for later use is promptly updated on the system. This happens as soon as the picking is finished. As soon as the picking is completed, this occurrence takes place. As a result of this, the precision of the information is consistently and reliably guaranteed. In one of the warehouses held by Deutsche Post DHL in the Netherlands, augmented reality has already been put to use for order picking purposes, and it has been met with a great deal of success in this endeavour. In the business of logistics, DHL is the most successful and well-known company in the world.

There has been a lot of discussion in the media over the course of the past few years discussing the potential ways in which contemporary technologies such as artificial intelligence (AI), big data, and the internet of things (IoT) may help to make warehouses more intelligent and innovative. Furthermore, research into the application of augmented reality in warehouse management has only just recently begun, despite the fact that this indicates that there is a significant amount of promise for the technology. Every essential warehouse-related operation, such as receiving items, classifying, sorting, storing, managing inventories, stocktaking, inventory replenishment, assembling, packing, and dispatching, which in the past was carried out by a labour-intensive manual process, are now automated, streamlined, and painless thanks to the introduction of cutting-edge technologies.

AR Hold Ability to Speed Up The Procedure By A Large Margin

As one of the product using AR, Agile Automated Storage And Retrieval System (aASRS), which was developed by AR Technologies Pte Ltd, that use as mutli-pick robot system will increase the productivity by higher margin inside a warehouse (Stoltz et al., 2017). The aASRS robot is able to travel freely between the warehouse racking and the workstations, and it can also integrate with the pre-existing WMS product identifier barcoding system in order to improve the operations' precision. The total adaptability of the aASRS robot is enhanced by the presence of both of these characteristics. As a system that combines the processing power of efficient Fleet Management and Scheduling with a Control and Algorithm Platform, Intelligent Device/Equipment Interface, and Big Data Analysis for the purpose of creating an ideal operating environment (Stoltz et al., 2017). This is done in order to realise the system's primary goal, which is to produce an ideal working environment.

In a wide range of commercial and industrial contexts, the use of the cutting-edge technology known as augmented reality is swiftly gaining pace and popularity. The application of AR is currently being investigated for use in a wide range of different contexts and settings. There are many different applications for this technology, some of which include the dissemination of information, the transmission of technical instructions during assembly activities, and the provision of remote maintenance assistance. This will continue until the technology on both hardware and the technical knowledge side, evolved sufficiently to be fully integrated into manufacturing. This integration can then be considered complete. This is true with regard to the information as well as the knowledge. It is possible that finishing this up will take some time. Its portability and applicability, in the sense that it can be utilised through a variety of host devices, have proven to be significant advantages, which has made it possible for it to be utilised in the production line in a manner that is not complicated.

Due to the fact that its mobility and applicability allow it to be utilised through a range of host devices, there has been an increase in overall production. It has been demonstrated to be useful for the giving of location instructions, which can be utilised in the navigation of maps in addition to the management of inventory and the retrieval of packages in big warehousing facilities. This kind of information can be utilised for the navigation of maps as well as the retrieval of packages in huge warehousing facilities. It has been shown to be useful for the purpose of supplying positioning directions, which is why it is being employed since it has been demonstrated. It is currently a simpler for managers to successfully supervise activities at vast locations that contain a range of merchandise such as the case of logistics warehouses.

CONCLUSION

As the backbone of food process, food supply chain are under pressure to compete in the more internationalised business environment, and they also have to deal with higher demands for better quality food. Despite the forecasted demands on food products might be accessible for particular commodities, maximising the efficiency of the for the process remains a difficulty. This is due to the type of goods carry are prone to damage and high risk to conduct. Complex layout and structure of the supply chain the could cause the quality of food drop. The whole process in food supply chain are impacted over the globalisation where shorter the life cycle exposing the process to vulnerability to risk. If companies want to remain competitive, they must use the most recent technological developments to streamline supply chain operations and get rid of inefficiencies. The influence of warehouse design and operations utilising augmented reality from 2017 to 2021 was the subject of this paper, despite the fact that there have been numerous

studies on warehouse management. Hence this study is prepared to understand the development of AR and the impact of warehouse design and operations on food supply chain using a detailed literature analysis. Through a systematic data collection with big data and text mining We made an effort to organise and analyse the body of recent academic research on the idea of AR from the perspective of the food supply chain. For this, 30 articles were researched and reviewed in-depth. Focusing on the studies was mostly on understanding the implementation of AR in current manufacturing process discussed based on selected publications and the research used to study this technology. Although theoretical and empirical research did not extend into the early years of the study phase, it was regularly seen that the developed AR prototypes were tested and validated using empirical approaches (2017-2021). Hence, the studies were by far the most frequently used method for claiming the advantages of AR in the food supply chain. The AR enablers that were identified throughout the research and grouped into these categories as a result contributed significantly towards better understanding of the growth of augmented reality concept, wider in theory, and the application of it in reality.

The study's findings indicate that AR is a relatively new technology that has recently attracted increased interest from academics. As a result of the growth of the AR is variety throughout the whole process involved inside the warehouse. Firstly through the layout of the warehouse that could be improved with the AR planning system. Besides, having control over the stocks and supplies in food supply chain with the sensors and barcode system ease the process and reduce the risk over perishable goods. Apart from that increase the most human power intensive process in order selecting inside a warehouse could be automated with the help of cutting-edge technologies. Lastly, the power to speed up every procedure that resulting in big number of production with AR has demonstrated the ability of this technology in the food supply chain to meets the blooming demands of food. It is clear that understanding about the adaptability of AR inside the warehouse for food supply chain is still lacking and hence a further research should be carried out to study and clarify how AR could increase company value in various sectors.

LIMITATIONS

This study has several restrictions. Although choosing multiple search databases is advantageous to ensure thorough literature coverage, studies apart from selected database could be more relevant to the topic studied but not taken into account. Extended research in the future can make use of additional well-known and include wider database into account, such as Google Scholar and Web of Science. As the findings of this research were restricted to the few chosen articles. They should therefore be expanded upon and validated using various methodological stances, such as expert interviews and extra empirical techniques. Another undiscovered field of research that can offer a fair image and fascinating insights into the essential solutions to further industrial deployments of AR is the study of AR difficulties in the food supply chain.

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