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Trends and Research Landscape of Smart Warehouse in Malaysia A Bibliometric Analysis

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ABSTRACT

The uses a quantitative bibliometric technique to map the intellectual structure, publishing trends, and topic development of smart warehouse research internationally. 1766 publications published between 1971 and October 2025 were retrieved from the Scopus database using an optimum keyword search using the phrase "Smart warehouse" in an undefined field. A high of 249 yearly publications was reached in 2024, indicating a fast increase of the discipline. China rank first in publishing volume with 360 papers, whereas Papua New Guinea rank first in average article citations with and 60.00. Some important places to find these kinds of articles published are Lecture Notes in Computer Science and Lecture Notes in Networks and Systems. Anon, J.C. R. has written fourteen papers, making them the most prolific individual author. Smart Warehouse (94 occurrences) was the most frequent terms according to the co-occurrence analysis. From data warehouses and conventional warehouses (before the 2000s) to RFID and data mining (during the 2000s and early 2010s) thematically evolving into the present emphasis on AI, Big Data, and the Internet of Things (IoT) is evident. Issues with Big Data integration and trust, RFID technical understanding, inadequate IoT-based warehouse architecture, the need for increased employee skills, and a lack of strategic top management commitment are fundamental and persistent research themes worldwide, as validated by the study, which also indicates critical implementation challenges already identified in practice. To help lawmakers and future academics fill in the gaps by understanding and fast digital transition of smart warehouse, this study mapped the intellectual framework.

1. Introduction

Companies in now days, are making many different of products such as clothes, electronics product, soft drinks product, and many more product. This all products are created for sale at market

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to the customers and get profit from the sales. This profit is playing an important role for the growth of in a company. Because of that the products of a company need always enough in market for selling to customer and also to get loyalty customers for the company. Logistics is also a type of business that involves providing logistics service to the business or customers. For example, the logistics service provided is transportation, integrated through a network of having facilities, and warehouses. For example, Coca Cola company is having more than two hundred of warehouse at around of this world to keep they goods such as in Malaysia, India, Ireland, United Kingdom and many countries. This warehouse is built for keep the goods and to storage the raw materials that use by a company for creating they products or goods. A warehouse is a place that deals with many warehousing activities that involve value adding, receiving, put away, picking, and shipping. Thus, inventory is also a part of warehousing that is used for places to keep the goods such as raw materials, work in process, and finished products. On the other hand, the inventory is used to keep the goods and to achieve good customer service and the warehouse management able to know how to manage the buffers inventory and stocks of goods to reduce the inventory cost. For example, updating customers about the goods in the warehouse on space of inventory and the cost, which "was also undertaken by Hamdy et al.,[7]". More than that, there is a need to change the warehousing to smart warehouses to meet their customers because the technology has optimized the warehouse operations to meet the customers' requirements. For example, updating software systems about the goods movement or details that can view by supply and manufacturing more transparency, reduce warehouse cost, and decision making that impact the industry 4.0 such as unit's orders. Not only that, this smart warehouse is involved with the use of internet of things (IOT) that can work with computers. Where it is suitable for use of wireless channels with multiple access in long range. For example, radio frequency identification (RFID) is a scanning that works wireless and scans with the tag of goods to provide the fresh record, which "was also undertaken by Vatumalae et al.,[24]".

Smart warehouse is involved of warehouse management system is known as WMS that is used in big warehouses to optimize the warehouse operations, which "was also undertaken by Hamdy et al.,[7]". Where this system is involved with using software systems and this warehouse management system is an important thing in warehouse to business performance that include off, their customer, supplier, and manufacturing. Thus, this warehouse management system was used in Malaysia by many logistics companies such as Fast Logistics using DHL parcel system or Logistaas, which "was also undertaken by Logistaas,[12]", to monitor the goods status. This research is important for warehouse to reducing the warehouse cost, which "was also undertaken by Hamdy et al.,[7]". Where the warehouse is involved with many activities such as value adding, receiving, put away, picking, and shipping, which "was also undertaken by Richards et al.,[15]". Thus, the inventory also holds a place on increasing the cost of warehouse on management the spaces. Hence, the use warehouse management system can reduce the cost of fundamentally, which "was also undertaken by Hamdy et al.,[7]", in areas of activities in warehousing. For example, using of software can reduce the cost of hiring more labor because the systems can manage the warehouse activities that work with internet of things such auto tracking or auto calculate weight of shipment. Furthermore, the importance of smart warehouse is to improve logistics and storage systems. Where the software system that is involved in warehouse operations will monitor the activities and reduce the error which "was also undertaken by past study, [7,15]". Thus, the software will be able to provide the right information at the right time to work more quickly. For example, the supplier and manufacturing can view transparency about the stock in the warehouse on ordering new units of goods at the right time. Hence, the software system can be a medium to communicate on knowing the goods status with more transparency. On the other hand, the importance of the smart warehouse is to solve problems for supply chain management, which "was also undertaken by Christopher et al.,[6]". Where much

information can get more transparency through a software system to reduce the waste of goods. Thus, can provide right units of goods that the bullwhip effect will at balance level reduce the waste cost. For example, the supplier can order at right units of goods to balance the space for the goods such as transportation space and storage space, which "was also undertaken by Hamdy et al.,[7]". Hence, the supply chain management can optimize their operations more efficiently with a software system on monitoring the activities. On other sides of that, this study is important for warehouse companies in Malaysia to practices fit into smart warehousing. Where the companies need to look into internal problems to change their warehouse operation in using smart technology. Which there are two variables that important for practices to fit digitization into their core business activities such as inventory and warehouse operation that involved of value adding, receiving, put away, picking, and shipping, which "was also undertaken by past study, [15,22]".

The variable to warehouse companies in Malaysia fit to smart warehouse is employee skill. Where the skills are important for the employees in doing their jobs. The high skills of employees will enable them to do many activities at a time and this will increase their salary, which "was also undertaken by Azil,[3]". On the other hand, skill is important for the production department to create quality products. For example, the skill of multitasking is needed to motor and complete the task on time. Thus, the use of technology in an industry will increase their employees' skills. Where the employees are able to work tighter with the technology on doing, they work and unlock the new skills. For example, the employees are able to unlock the skill of using mobile tracking during scanning the goods using smart devices. Hence, having the employees with high skill that can work together with smart technology can increase the quality of products and activities. Where the employees are able to provide a better quality of work because their skills are working with technology to complete the task of work. For example, using the skill of multitasking can enable the employees to do the work faster by using smart devices such as smart shelves that will update the SKUs of goods on the shelf in a software system, which "was also undertaken by Hamdy et al.,[7]", and this will enable the employees to replace the stock of goods on time.

The other variable to warehouse companies in Malaysia need fit to smart warehouse is top management in decision making because core competencies are grown more. Technologies are created lot of business for many industrial, which "was also undertaken by Harian Metro,[8]". Where known as core business that doing smiler activities or production of goods and services. For example, Faber-Castell and Stabilo made pen and pencils. Thus, the new trade agreement includes Kerjasama Ekonomi Komprehensif Serantau or regional comprehensive economic cooperation (RCEP), which "was also undertaken by Azil,[3]", is one of the world's largest FTA where can covering about 30 percent of global GDP. Where the use of logistics and warehouse will increase for handling the goods. For example, need warehouse for stock the goods at minimization cost. Hence, the decision making from top management is need to growth of business. For example, the use of Kiva systems or known as Amazon Robotics will save the space, which "was also undertaken by Amazon,[1],". Where this Kiva systems will be able to carry and hold the goods at upright and this will reduce the space of inventory. Hence, smart things need to use in warehouse to not only done the activities but also for reduce cost of inventory, which "was also undertaken by Hamdy et al.,[7]". Where the use of smart gadgets can reduce the space of inventory on stock keeping the goods. For example, the robotics system such Kiva systems able hold many goods with used the minimum of inventory space and this will make the supplier's and manufacturing on save the cost of space and minimum the storage charges.

The companies need to fit with current digitations world. Where the of digitization is an importance tools of running the warehouse operation to optimates the performance. Which the gaps of knowledge in imputing smart technology that can affect warehousing operations. The, smart

warehouse has involved of using technology for their operations with working together human. However, there need knows on the challenges of imputing the smart technology into operations as digital warehousing. For examples, embedding big data, internet of things, radio frequency identification (RFID), skill of workers, skill of workers and commitment from top management. Hence, a study is required to investigate the challenges of implementation smart warehouse. The problem statement of this research is knowledge gaps for embedding big data that might face while moving forward in warehouse automation. Big data is a type of information system that able to have a lot of information in data such using thru software system that works together with information system. Where the embedding big data is different to impending in smart warehouse because there are gaps of lack knowledge. Which, the use of software is needed to support with the information system to collection and store the data, management and people shipping information's, which "was also undertaken by Li et al.,[19]". For example, the technology of systems such as the Logistaas software is able to monitor the information and works with AI in the system. Thus, there is research was doing research on investigate challenges and barriers for embedding big data solutions in smart warehouse from trust of using outscoring software that managing all companies' shipments details, which "was also undertaken by Li et al.,[19]". Hence, the used big data or Logistaas software used a medium to communicate on knowing the goods status with more transparency with other departments such as the warehouse, sales, marketing, and billing department on making the decision.

Not that only, the problem statement of this research is knowledge gaps for radio frequency identification (RFID) that might face while moving forward in warehouse automation. Where this smart warehouse is working with radio frequency identification (RFID) is a technology that is used to monitor the goods status. For example, scanning the goods IDs that have details of the goods for long or short ranges and will auto update in warehouse management systems such as software. Thus, the lack of findings from software and equipment understands, lack of standards using radio frequency identification (RFID), and how to make into transparency with supplier and warehouse inventory. Hence, warehouse design is important to make the movement of goods faster. Thus, using the internet of things and good warehouse design can optimize the warehouse operations because the internet of things can work in many areas at the warehouse, which "was also undertaken by Osyk et al.,[4]". For example, the RIFD can scan the goods at long ranger aisles and open space areas and provide the fresh record. Besides that, the problem statement of this research is practice gap for internet of things internet of things that might face while moving forward in warehouse automation. Where the warehouse structure is playing a role to having optimates of smart warehouse performants. Which type of layout and with the internet of things, this sort of arrangement can optimize efficiency. Described IoT as "the set of connections of physical devices such as home appliances, vehicles and other items implanted with software, electronics, actuators, sensors and connectivity to enable communication for the transfer of data." IoT allows objects to be operated and controlled remotely through connectivity, which "was also undertaken by Affina et al.,[10]". Thus, the smart warehouse's various designs reviewed above ascertain, which "was also undertaken by Affina et al.,[10]", consider warehouse operations as a vast issue to research, as various warehouse models provide various tasks and activities. Warehouses in each industry or organization have a purpose, layout, size, use, management system, process flow, and adding-value activities that are specific to the sort of business they serve. Hence, an IoT-based smart warehouse infrastructure should be designed customary according to the critical characteristics and aspects of the respective warehouse operations and business process.

More than that, the problem statement of this research is practice gap for skill of workers that might face while moving forward in warehouse automation. Where is warehouse companies in Malaysia need fit to smart warehouse based of employee skill. Where our Malaysia companies that

deal with logistics and warehouse activities need to look to their employee skill to fit their employee with used of technology in the warehouse activities. In that warehouse companies need to hire or placed the right employee based to their skill of the job task. The skills are important for the employees in doing their jobs. For example, the use of technologies such as machines will cannot utilization used if the employee are not responsiveness, flexibility, reliability, and quality. Hence, human aspects are needed to have skills to implementing these technologies, which "was also undertaken by Cirillo r et al.,[23]", to make a smart warehouse operation. In addition, the problem statement of this research is practice gap for commitment from top management that might face while moving forward in warehouse automation. Where the commitment from top management is used in smart warehouse to making decision. Where the digitization industry will work thru an online system because it's reduced the time and speed. On that, there is gap on commitment from top management need to make the right decision to growth of business and operation. Where the commitment from top management can visible the use of labor and capital to reduce the risk of business. At the same time, the commitment from top management can optimize their business to better performance. For example, making decision based from the integrity of the team, top-down planning, and while allocating other necessary resources, which "was also undertaken by Kumar et al.,[14]". Nonetheless, no clear study on the function of smart technologies in the link between smart warehouses appears to exist. Previous research has focused on the advantages of utilizing the internet of things and smart technology to enhance warehouse operations through the use of smart technologies and the internet of things. However, in the available research, this knowledge and practice gap has not been thoroughly examined. As a result of this void, a study is needed to look at the obstacles of implementing smart warehouses and fill in the gaps in knowledge about the role variable in the link between smart technologies and smart warehouses. As a result, this research might be crucial for Malaysia. Where the challenges that the warehouse may face while adopting automation will be studied, and strategies to mitigate these challenges will be provided, as the potential for smart warehouse implementation in the local environment has yet to be fully realized, and there are significant opportunities for smart warehouse growth and optimizing warehouse performance.

Logistical is a sector that entails providing logistics business support services or clients. Transportation, for example, is a logistics service that is interconnected through a supply chain and warehouses. A warehouse is a location where numerous warehousing activities like as value - added, receiving, putting away, picking, and shipping take place, which "was also undertaken by Richards et al.,[15]". As a consequence, inventory is a type of warehousing which is used to store commodities like raw materials, work in progress, and finished goods. Inventory, on the other hand, is used to save products as well as provide good customer service, and warehouse management able to manage buffer inventory and stock of goods in order to decrease inventory costs. For instance, informing consumers on the commodities in the warehouse, inventory space, and pricing. Smart things are involved with using of smart technology to optimize the operation or to better the performance of business or activities. Where technology will work with internet of things to connect with smart devices. By working internet of things with smart things will able a business to optimize the operation to better performance because the smart technology will monitor the activities or task, which "was also undertaken by Richards et al.,[15]". For example, the software can auto update the QR code number of parcel into software system during the scanning process of inbound activity, which "was also undertaken by Hamdy et al.,[7]". Smart warehouse is involved of using smart things as operations digitization warehousing. Where the smart warehouse needs of used internet of things to deal with the shipment. For example, the use of mobile scanners that works with internet of things can scan multi shipments and update the details of shipment in the software systems, which "was also

undertaken by Sari et al.,[17]". Hence, the mobile scanner can reduce the time of key in with the manually way and optimize the warehouse operations. Furthermore, because technology has improved warehouse operations to suit customer requirements, there is a need to shift warehousing to smart warehouses to fulfil their customers' needs. For instance, updating software systems on products movement or facts that can be viewed by supply and manufacturing, which "was also undertaken by Helo et al.,[9]", to increase transparency, minimize warehousing costs, and make decisions that affect industry 4.0, such as unit orders.

The advantage of having smart warehouses is to optimize the warehouse operation. Where in warehouse there deals with many warehouse activities to move the shipments. For example, of warehouse activities are receiving, put away, picking, value add, and shipping, which "was also undertaken by Richards et al.,[15]". These warehouse activities process is involved in different department such as inbound and out bound to handle the shipments. Thus, the warehouse is to shift into smart warehouse to optimize their warehouse operation that can utilization their operation to deal the shipments faster by involved of smart things such smart devices and software system, which "was also undertaken by Helo et al.,[9]". Hence, the warehouse can management the warehouse operation better to reduce the delays of shipments. The advantage of having smart warehouses is to keep the inventory at optimal level. Where in warehouse there is inventory that used for stocking the goods or raw materials. Where inventory is the place to stock the goods of raw materials, work in process, and finished products. Thus, the inventory is used to keep the goods but to achieve good customer service and the warehouse management can know how to manage on order safety stocks of goods at the right time to reduce the inventory cost. For example, the goods levels at inventory can be monitored thru an ERP system and software system. Hence, the internet of things places a role on warehouses to inventory operations more efficiently such as monitor the safety goods level, which "was also undertaken by Helo et al.,[9]". The advantage of having smart warehouses is faster picking and shipping. Where the in now days there are having omni channel and e-commerce that need to used logistics to deliver the shipments. Thus, this logistics are involved of using warehousing to value adding and transportation process that need to go thru the warehouse activities such as receiving and shipping. Hence, the used of smart things will make the process of moved the shipments can faster, which "was also undertaken by Sari et al.,[17]", such as creating AWB shipping and transportation thru software system.

The advantage of having smart warehouses is customer service can improvement. Customers are important for business because they are the people that buy the products and get profit from them. Where the products that sell at market able to meet the customers. For example, information, quality and price able to meet the customers to buy their products. Thus, Technology is the new world of digitization for all the peoples in the modern era. The use of technology is increasing day to day because having a lot of advantages for human life. For example, save time and faster to do a task or activity. Hence, the warehouse able to change their business to meet their customers in this era because customers' decision making of buying the products is affecting their business. Where most of the people in this modern era had knowledge on using of technology to make, they life easier. If the using of offline systems will not meet the customers of millennials such as warehouse does not use online platform for selling the product’s and this will not reach to the millennials customers. The advantage of having smart warehouses is fit to industrial 4.0, which "was also undertaken by Harian Metro,[8]". The market of export for Malaysia will increases from the trade agreement of Kerjasama Ekonomi Komprehensif Serantau or regional comprehensive economic cooperation (RCEP), which "was also undertaken by Azil,[3]", has the effect of promoting Malaysian commerce by expanding market access and minimizing trade tariffs. Malaysia will be able to create more products and have larger units of commodities to sell to other nations as a result of this. Where inventory is demanded

to stock the warehouse with merchandise. For example, Maggi works at the warehouse because has a lot of clients who would like to buy the goods and doesn't want to run out. Hence, the warehouse management system will be employed in the smart warehouse to ensure that warehouse activities are run efficiently. Where the smart warehouse will employ the Internet of Things (IOT) to do tasks faster and with less mistake. For example, the smart shelf will update auto to the system on the stock of goods at the shelf.

The disadvantage of having smart warehouses is dependent with internet, which "was also undertaken by Berita Harian,[5]". Where their smart warehouse is works with internet of things to operation the warehouse activities. On that, the internet need in good range to used it if not the warehouse needs to face with lack of internet connection that delay the shipments process. Thus, the lack of internet connection will bring big loss to the business. For example, the lack of internet connection will make the fast-moving consumer goods of shipments not moved at right time cause the management to pay refunds to the suppliers on the goods against stock outs and expired dates. The disadvantage of having smart warehouses is maintenance cost high. Where the smart warehouse is operating based too smart things and machine to optimize the warehouse operation performances. On that, the smart warehouse is dependent based to the smart things and machine if the smart things and machine bring problem the warehouse cannot performances well that created problem in warehouse operation. Thus, the needed of funds to maintenance the smart things and machine to void from having problem in warehouse operation. Hence, the involved of funds to maintenance is a part of doing with digitalization operation. The disadvantage of having smart warehouses is skill of works is needed. Where to use the smart things in smart warehouse there is needed of skill to handle the smart things and operation. It’s not only enough to having knowledge on the smart things but able to use the smart thing with right skill. Thus, skill is important for the production department to create quality products. For example, the skill of multitasking is needed to motor and complete the task on time. The use of technology in an industry will increase their employees’ skills. Where the employees are able to work tighter with the technology on doing, they work and unlock the new skills. For example, the employees are able to unlock the skill of using mobile tracking during scanning the goods using smart devices. Hence, having the employees with high skill that can work together with smart technology can increase the quality of products and activities.

The disadvantage of having smart warehouses is needed of knowledge to understands the functions smart things. Where the company that moving the warehouse or business into digitalization need have a look on understands the functions smart things to optimism the operation. Thus, the lack of knowledge in using the smart technology will cause to reduce in movement of shipments. For example, the lack of understand on functions of radio frequency identification (RFID) will cause to not optimism the operation process that can bring the business loss their customers. Hence, the company able to sure that all of their employee is fully understand the use of smart things or technology. The disadvantage of having smart warehouses is needed to have good software to work with supply chain. Where the trade-off decisions can make more transparency through a software system to reduce the waste of goods. Thus, the supplier and manufacturing need to have forecasting to order the goods at the right time at right units to reduce the inventory cost. These details of good units are getting form software data inform if the software was not able to works goods or cannot be trust that cause to delay on finding the information, which "was also undertaken by Helo et al.,[9]". For example, the supplier can order the right units of raw materials and stock at the warehouse with the right space of inventory to reduce the cost of storage and space. Hence, the supply chain management can optimize their operations more efficiently with a software system on monitoring the activities with their warehouse department, which "was also undertaken by Hamdy et al.,[7]".

The smart warehouses having important because the government is shifting to digital industrials, smart warehouses can adapt to digitization operations. Based on the Wawasan Kemakmuran Bersama 2030 (WKB 2030) under RMK-12, with the topic of "Restoring economic growth, resolving socio-economic concerns, balancing regional development, and boosting competitiveness." Where the government is concentrating its efforts on the development of digital businesses, which "was also undertaken by Harian Metro,[8]". As a result, the increased use of technology in daily life is transforming employment into a digital business. As a result, the expansion of digital and the usage of technology has an influence on the logistics industry's transition to smart business, such as smart warehouses. For example, in a warehouse, SMART shelves may be used to update the supply of SKUs and therefore minimize inventory space. Furthermore, the technology employed in the smart warehouse includes internet connections or the internet of things (IOT) to maintain excellent functioning, such as auto updating systems. To upgrade existing 4G networks, the supply of digital infrastructure would require RM28 billion in governmental and private sector investments, which "was also undertaken by Harian Metro,[8]". However, in order to fulfil client requests, labor or activities able be completed faster these days, necessitating the employment of strong internet networks in smart warehouses. "An additional RM15 billion would be spent by the private sector to speed up the deployment of 5G nationally, which "was also undertaken by Harian Metro,[8]", while submitting a motion on the 12th Malaysia Plan (RMK-12) in the House of Representatives, which "was also undertaken by Harian Metro,[8]". Having a robust internet network, such as 5G, may assist smart warehouses that operate with internet of things connections (IOT). It can be utilized to employ new technology that requires a high-speed internet connection. For example, if want to update the status of your items via mobile tracking, there need to have a 4G or 5G internet connection, which "was also undertaken by Harian Metro,[8]". Besides that, the smart warehouses having important because they need to increase the skills of employees for high pay by 2025, which "was also undertaken by Azil,[3]". Employees require skills in order to do their tasks. Employees with excellent talents will be able to perform many tasks at once, resulting in a higher remuneration. On the other hand, in order to produce high-quality items, the manufacturing department need talent. Multitasking, for example, is required to drive and complete the assignment on time. As a result, the employment of technology in a sector will improve the abilities of its personnel. Employees who are able to work more closely with technology on what they do work and unlock new talents. Employees, for example, can enable the ability to use mobile tracking while scanning products using smart devices. As a result, having highly skilled personnel who can collaborate with smart technology may improve the quality of goods and operations. Employees are able to give a higher level of work because their talents allow them to execute tasks using technology. Multitasking, for example, can help employees to complete tasks faster by utilizing smart devices such as smart shelves that update the SKUs of items on the shelf in a software system, allowing staff to replenish stock of goods on time.

More than that, the smart warehouses having important because of the increase of production. Production is the process of making items and then selling them at a profit. Where the items are manufactured, and some are hoarded in a warehouse to be sold at market against stocks out. Maggi, Fraser and Neave, Limited (F&N) jus, pens, and a variety of other products are examples. As a result, the Kerjasama Ekonomi Komprehensif Serantau (KERS) trade pact, also known as the Regional Comprehensive Economic Cooperation (RCEP), which "was also undertaken by Azil,[3]", has the potential to facilitate Malaysian commerce by expanding market access and lowering trade barriers. Malaysia will be able to create more items and have greater units of commodities to sell to other nations as a result of this. Where inventory is required to stock the warehouse with merchandise. For example, Maggi works at the warehouse because she has a lot of clients who want to buy her goods, and she doesn't want to run out. As a result, the warehouse management system will be employed

in the smart warehouse to ensure that warehouse activities are run efficiently. Where the smart warehouse will employ the Internet of Things (IOT) to do tasks faster and with less mistake. The smart shelf, for example, will automatically update the system with the supply of products on the shelf.

Not only that, but the smart warehouses also having important because they make customers happy. Customers are critical to a company's success since they are the ones who buy the items and benefit from them. Customers can be able to meet the things that sell on the market. Customers, for example, require knowledge, quality, and pricing in order to purchase their items. Ismail Sabri stated in the Pelan Jalinan Digital Negara (JENDELA) that the project will deliver 100% 4G coverage in bigger 5G areas, as well as 5G coverage and fixed line internet to nine million premises by 2025, which "was also undertaken by Azil,[3]". By 2025, nine million premises will be using the 5G network to update the details of items to their consumers faster, which "was also undertaken by Azil,[3]". For example, utilizing a software system to update details such as package details via the Public Parcel or Logistics system (Logistaas). Hence, to minimize stock outs, smart warehouses are required to supply the appropriate information at the right time from their suppliers and manufacturers. Where smart devices are required to update product inventory in a software system to suppliers and manufacturers for their capacity to make and deliver the correct unit of stock at warehouse, which "was also undertaken by Sari et al.,[17]". For example, delivering the proper information and forecasts at the right time to suppliers and production so that they can offer the right unit of goods since using more inventory space would cost more in terms of storage fees. They will be able to meet their suppliers and production to offer the proper number of items at the warehouse and update information to clients faster by using the 5G network in the smart warehouse. Lastly, the smart warehouses having important because core competencies are grown more. Many industries have benefited from technological advancements. Whereas main business is recognized for conducting smiler activities or production. Pens and pencils were created by Faber-Castell and Stabilo, for example. As a result, the new trade deal includes Kerjasama Ekonomi Komprehensif Serantau (RCEP), which "was also undertaken by Azil,[3]", which is one of the world's largest free trade agreements, encompassing around 30% of global GDP. When it comes to managing commodities, the usage of logistics and warehouses will grow. For example, a warehouse is required to store items at the lowest possible cost. The utilization of Kiva systems, often known as Amazon Robotics, for example, will save space, which "was also undertaken by Amazon,[1],". Whereas Kiva systems will be able to transport and hold products vertically, hence reducing inventory space, which "was also undertaken by Amazon,[1],". As a result, smart objects can be used in warehouses to not only complete tasks but also to cut inventory costs. Where the usage of smart devices may minimize inventory space on stock holding items. For example, robotics systems like as Kiva systems can keep numerous items while using the least amount of inventory space, which "was also undertaken by Amazon,[1],", allowing suppliers and manufacturers to save money on space and storage fees.

The challenges of implementation smart warehouse are trust in business. Where all business there is involved of trust on believe to use other companies' goods and services. Thus, in warehouse also same on trust with other companies to deal the shipments. For example, the warehouse companies need to think on using the outscoring software that involved their customers shipment details, which "was also undertaken by Li et al.,[19]". Hence, the warehouse company need to find the right software company that able to deal with big data information of the companies. The challenges of implementation smart warehouse are internet, which "was also undertaken by Berita Harian,[5]". Where the smart things in warehouse are operation based to internet of things. Thus, it needed for using new technology that need speed connection of internet network. For example, the used to update goods status by using mobile tracking that need to use 4G OR 5G internet network for having faster update, which "was also undertaken by Harian Metro,[8]". Hence, the government

can investments funds to builds the internet infrastructure that can works with digitalization activities, which "was also undertaken by Harian Metro,[8]".

The challenges of implementation smart warehouse are knowledge of understanding radio frequency identification (RFID) use, which "was also undertaken by Osyk et al.,[4]". Where the warehouse companies need to understand the functions of radio frequency identification (RFID) to optimize the warehouse operation activities. Thus, the radio frequency identification (RFID) is needed will cannot working with the internet of things on mentoring the goods at warehouses if the employee and management not able to understand the function of radio frequency identification (RFID). For example, the function of radio frequency identification (RFID) is to scan the carton label number or tags will update the data of shipment in the system, which "was also undertaken by Osyk et al.,[4]". Hence, the Radio Frequency Identification is able to be used at long range because they work in wireless sensor networks. The challenges of implementation smart warehouse are skill of works is needed to using smart things, which "was also undertaken by Cirillo r et al.,[23]". Where that warehouse management needed to hire the right employee that able to fit in smart warehouse. Thus, the skill of employee works is needed to optimize the use of smart things to have good warehouse operation. For example, the employee able to use scanning devices and software functions to reduce the error of works. Hence, there need of skill in working to optimize the warehouse operation activities. The challenges of implementation smart warehouse are commitment from top management is needed. The management efforts required, which "was also undertaken by Kumar et al.,[14]". All the goods need to have the effort to move the goods. Where the management needs to put his or her efforts monitoring the goods from stock out. For example, update all amounts of goods based to the expired date or ABC analysis. Thus, the management can balance his or her efforts on monitoring the goods from stock outs and expired dates. Hence, the lack of monitoring the goods will cause the management to pay refunds to the suppliers on the goods against stock outs and expired dates.

Logistics information technology is knowing as logistics information system that works for industrial or business that involved in digitalization activities. In logistics there used of internet of things that works with information system that bring to information technology to better the business performances, which "was also undertaken by Hamdy et al.,[7]". For example, the technology of systems such as the Logistaas system is able to monitor the information and works with AI in the system. Hence, the used Logistaas system or software system that works with dig data used a medium to communicate on knowing the goods status with more transparency with other departments such as the warehouse, sales, marketing, and billing department on making the decision. Figure (1) is Logistics is a business that providing services to the customers that deals with customers goods such as customers and companies. Logistics has served other logistics companies and companies that need logistics service such as Shopee and Top glove such as B2B shipments. The customers are customers for the company such as B2C or C2C shipments. Where customers buy and use the logistics service such as freight forwarding, storage and terminal, shipping agency, and warehousing from the company. Besides that, logistics having goals on minizine the cost, which "was also undertaken by Hamdy et al.,[7]", and satisfaction the customers such as prodding the shipments at right time. Hence, the logistics having functions of work with other department such as warehouse and Halal logistics to deal the shipments, which "was also undertaken by Ab Talib et al.,[21]. The logistics are having functions of work on order processing. Where the logistics are needed to do order processing to do the customer requirement. Thus, the logistics will get the information about the customer requirement to meet they order, which "was also undertaken by Auramo et al.,[2]". Hence, the fast information flow is needing such as using email and Whatapps for past the information to other department such supply chain. For example, getting the order of customers and find what are

the requirement needed to full fill the order such units of goods. Besides that, the logistics are having functions of work on inventory. Where Inventory is the place to keep the goods such as raw materials, work in process, and finished products. Thus, the inventory is used for keeping the goods but to achieve the good customer service, the logistics able to manage the inventory and stocks of goods, which "was also undertaken by Auramo et al.,[2]", to reduce the inventory cost to the goods. For example, using update to customers about the goods in warehouse on space of inventory and the cost. More than that, transportation is a part in logistics work. Where the transportation is used to move the goods for a place to another place. Thus, the cost of the transportation is needed to meet the customers requirement to avoid from high cost and need to speed on sending or moving the goods, which "was also undertaken by Auramo et al.,[2]". For example, the logistics need to look at the cost of using transportation and the time to move or sending the goods to the end of customers. Not that only, warehousing is a part in logistics work. Where the use of warehousing is to handle the goods such as on packing and handling materials. For example, warehouse is used to handle the goods on packing goods, which "was also undertaken by Hamdy et al.,[7]". Other than that, integrated through a network of having facilities. Where all the works in of handled the goods are need a placed and also facilities. For example, there are need warehousing to handled goods activities such stock or packing, which "was also undertaken by Hamdy et al.,[7]". Lastly, the logistics activities such as order processing, inventory, transportation, warehousing, and facilities are needing used warehouse for handled the value adding activities such packing into small SKU units. Hence, there need of using smart warehouse to better the shipments moved.

Fig. 1. The operational area of logistics

Figure (1), in logistics the fundamental sourcing activities like as policy and strategy formulation and execution, research, vendor evaluation, contract negotiation, and the purchasing procedure necessary to acquire and receive items are all covered by procurement. Hence, this plays a role on reduce the cost by having right unit of number stock to reduce the use of larger space of inventory, which "was also undertaken by Hamdy et al.,[7]". Procurement is the process of locating and agreeing on terms with an external source in order to obtain products, services, or works, usually through a tendering or competitive bidding procedure, which "was also undertaken by Skipworth et al.,[20]".

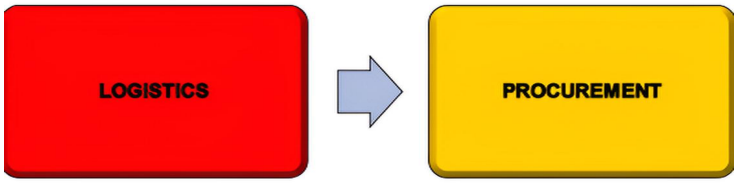

Fig. 2. The operational areas of logistics to procurement

Figure (2), procurement is the process of locating and agreeing on terms with an external source in order to obtain products, services, or works, usually through a tendering or competitive bidding procedure, which "was also undertaken by Skipworth et al.,[20]". Table (1) is divides purchasing into

three levels: strategic, tactical/managerial, and operational, with each level having its own set of tasks and considerations. This information may be gleaned from the table. The strategic level is long-term, whereas the operational level is concerned with the day-to-day operations of a buying department. Purchasing and procurement are two procedures that occur throughout an organization's acquisition of products and services. Their methods and approaches, however, are significantly different. Purchasing is a term that refers to the processes used to acquire equipment, goods, and services, which "was also undertaken by Roberta et al.,[13]". People resolve their conflicts via negotiation. It is a method of reaching a compromise or agreement while avoiding conflict and disagreement. Negotiation is the process through which you and your provider with competing requirements come to a mutually beneficial arrangement, which "was also undertaken by Roberta et al.,[13]". It's all about getting people to move around each other. The negotiation process' goal is to assure the delivery of five rights: the appropriate product or service at the right price, at the right time, in the right place, and in the right number. You'll have to weigh these rights; for example, a faster product delivery might mean a greater price. In the negotiation there are 4 steps to purchasing the goods. below is the example of negotiation steps in used ABC company to purchase the goods. In a negotiation before any negotiation makes it need to be gone with preparing step. In this step, the ABC are do some preparation for they deal. And this deal is use for making a negotiation with the supplier. In this step the ABC company is gather all the information about the supplier such as price for raw materials. By using the information, the ABC company can do a negotiation with the supplier. ABC company can use the information to give an advantage for the company. For example, ABC was do negotiation with Huizhou Blueway Electronics to get electronics material such battery for ABC electronics products. This at Huizhou City, Guangdong at China. Opening a negotiation is creating a people or company that work with other company. In ABC the suppliers will work and give the supplier materials that need for ABC. For example, ABC are outsourcing for manufacturing outsourcing from Foxconn company. Foxconn company is manufacture for ABC's Galaxy phone line. This opening is giving both side advantage on selling the product of ABC. For example, ABC are getting quality product from the manufacturing of Foxconn company and the Foxconn is getting advantage on getting climate. Which is Foxconn company being manufacture more than 100 ABC Galaxy phone line. After the two steps are done with a supplier. Next is going to third step which is conducting a negotiation. In this step the ABC company able to understand about they supplier offer or deal. For this step the ABC company able to do a discuss all the negotiable with the supplier. For this step the ABC company can identified what are the advantages that ABC company get from the supplier. This step is going to give a big impact to the negotiation steps for an ABC company. This is because this is step ABC company can get know what here the supplier will give to, they such giving discount on raw materials. Last step of negotiation is preparing a closing a negotiation. For this step the ABC need to prepare closing the deal with the supplier. In this step the supplier and ABC company needs to accept the terms and conditions that they made with them. If they accept the terms and conditions, then the ABC company and the supplier is done with the negotiation. The procurement is not only need for warehouse to purchasing the goods at right negotiation price but need procurement for keep the goods at optimal level of inventory from out of stock. Hence, there need to use the software system on provide the real time unit numbers for ordering new goods with procurement department.

Table 1
Shows the purchasing roles on various.

STRATEGIC LEVEL	TACTICAL/ MANAGERIAL LEVEL	OPERATIONAL LEVEL
Purchasing research	Buying methods	Expediting
Long range planning	Negotiations	Recodes and system maintenance
Predicting availability	Budgeting	Invoice clearance
Policy determination etc.	Contracting	Requisition handling
	Cost reduction techniques etc.	Inquiries/ quotations
		Price determinations etc.

Figure (3), supply chain management is all actions related to sourcing and procurement, conversion, and logistics management can be planned and managed. Coordination with channel partners, such as suppliers, middlemen, third-party service providers, and customers, is also included, which "was also undertaken by Hamdy et al.,[7]". Where supply and demand management, sourcing raw materials and parts, production and assembly, warehousing and inventory tracking, order entry and order management, distribution across all channels, and delivery to the client are all tasks that need to be completed, which "was also undertaken by Christopher et al.,[6]". For example, design and administration of cross- organizational, value-added processes that address the genuine demands of the end consumer.

Fig. 3. The operational areas of logistics to supply chain management

Figure (4), the origin of supply chain management was being during 1950 with United State manufacturers' primary cost-cutting and productivity- improvement initiatives were mass manufacturing techniques. During 1960, to coordinate inventory management and increase internal communication, new computer technology led to the creation of Materials Requirements Planning (MRP) and Manufacturing Resource Planning (MRPII). During 1980, due to intense worldwide rivalry, American industries have adopted supply chain management with just in time and business process reengineering practices. From 2000s and current to enhance purchasing and supply management, industrial purchasers will depend increasingly on third-party service providers (3PLs/ 4PLs). Wholesalers and retailers will place a greater emphasis on transportation and logistics, which will be referred to as rapid response, service response logistics, and integrated logistics by wholesalers and retailers, which "was also undertaken by Christopher et al.,[6]". Hence, the use of internet of things is need in warehouse to works with supply chain activities such as update real time data by using software system from out of stock and waste units' stock, which "was also undertaken by Hamdy et al.,[7]".

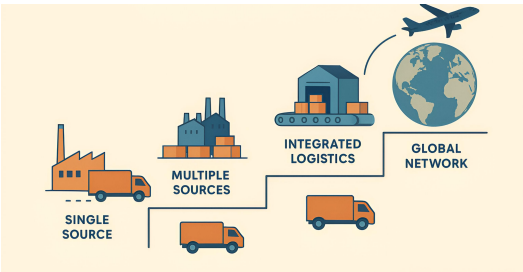

Fig. 4. The evolution of supply chain management

Figure (5), the word "information systems" refers to the systems, people, and procedures that are used to produce, store, alter, distribute, and disseminate data. Information systems is a field that combines business and computer science. Hence, this information system is need to in warehouse to update the real time data to supply chain management on provide the right unit of stock, which "was also undertaken by Hamdy et al.,[7]". An information system (IS) is a system or process that delivers the data needed to efficiently manage an organization. People, machines, procedures, and technology are all part of an information system, which "was also undertaken by Helo et al.,[9]". For bridging the gap between business and the ever-growing area of computers, an information system is essential. People and procedures are also involved in the design of a system; thus, it requires much more than technology. Information technology has greatly enhanced people's quality of life. Modern medicine has benefited the most from improved information systems based on cutting-edge technology. Information system is having goals to support the logistics department activities. For logistics efficiency and effectiveness, logistics information systems are critical. A logistics information system in an organization aims to do the following: It integrates logistical operational functions into a process that aims for customer satisfaction at the lowest total cost, which "was also undertaken by Hamdy et al.,[7]". The logistics of order fulfilment may be better planned and controlled with the help of an information system. It helps the company become more competitive by allowing it to make better tactical and strategic decisions that benefit both the company and its customers. Assists in providing consumers with product availability, order status, and delivery timetables in order to improve customer service. It enables needs planning, which decreases inventory and human resource requirements, which "was also undertaken by Helo et al.,[9]". It connects to marketing, financial, and production data systems and delivers data to senior management to aid in the formulation of strategic choices for the whole company. Forecasting is no longer necessary because of the usage of information technology in information systems, which "was also undertaken by Helo et al.,[9]". This has also aided in the implementation of "pull" systems such as just-in-time, which has helped the company become more competitive.

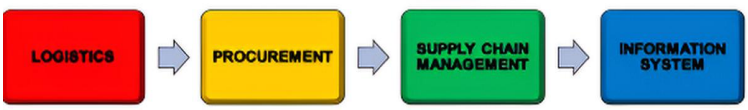

Fig. 5. The operational areas of logistics to information systems

Figure (6), moving freight from one site to another is referred to as logistics. A logistician will be happy handling 5 or fewer cargo. However, it gets more difficult when we have more than 100 distinct

types of merchandise to convey to more than 100 different destinations, using various means of transportation and time periods. In this case, information technology is critical, as competing in such a setting manually would be nothing short of a miracle. Information technology is included in the IS umbrella; however it is concerned with the technology used in the systems, which "was also undertaken by Helo et al.,[9]". The study, design, implementation, support, or administration of computer-based information systems is referred to as information technology. Hence, the layout of warehouse is needed to fit with internet of things to work with internet, which "was also undertaken by Salomonsson,[16]". Information systems are a subset of information technology. It is described as the research, development, and implementation of computer- based information systems. It is responsible for the technological aspects of any information system, including hardware, servers, operating systems, and software. Information technology is all about managing technology and putting it to good use in the workplace. Information technology frequently regulates the collecting, processing, storage, and transmission of data created by computer and telecommunications disciplines. Information systems have long been used by humans as a decision-making tool in some form or another. However, as information technology advanced, information systems became more complex, and their use spread to many aspects of society. Information technology has aided in the transformation of vast amounts of data into meaningful and valuable data. Hence, this information systems are need to logistics industries to optimally their operation business that involved of smart warehousing, which "was also undertaken by Hamdy et al.,[7]".

Fig. 6. The operational areas of logistics to information systems

Figure (7), warehouse automation comes from digitization warehousing that involved of smart things in the warehouse operation activities such software to optimize the warehouse operation and full fill the customer needs at right time, which "was also undertaken by Hamdy et al.,[7]". For example, the internet of things places a role on warehouses to inventory operations more efficiently such as monitor the safety goods level, which "was also undertaken by Hamdy et al.,[7]". A warehouse is a place that deals with many warehousing activities that involve value adding, receiving, put away, picking, and shipping. In logistics the needs of warehousing are important to stock the goods, which "was also undertaken by Richards et al.,[15]". On those shipments also are need to a place to keep before going thru the transportation process.

On that, the operational areas of logistics to information systems are need a place to handle the shipment of goods before handover to transportation. Where the shipping and value adding activities that need place such as warehouse to handle the goods. Which in the warehouse are having warehouse activities such as value adding, receiving, put away, picking, and shipping. Hence, the need the operational areas of warehouse to smart things for handled the goods activities to record all the move of goods and can track by other department like procurement and supply chain management that can provide a transparent recorded activity.

Fig. 7. The operational area of warehouse

Figure (8), a warehouse is a place that deals with many warehousing activities that involve value adding, receiving, put away, picking, and shipping, which "was also undertaken by Richards et al.,[15]". Thus, inventory is also a part of warehousing that is used for places to keep the goods such as raw materials, work in process, and finished products, which "was also undertaken by Hamdy et al.,[7]". On the other hand, the inventory is used to keep the goods and to achieve good customer service and the warehouse management able to manage the buffers inventory and stocks of goods to reduce the inventory cost. For example, updating customers about the goods in the warehouse on space of inventory and the cost, which "was also undertaken by Hamdy et al.,[7]".

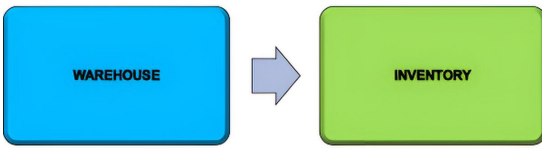

Fig. 8. The operational areas of warehouse to inventory

Figure (9), the world is changing to digitization industrials that works with smart things. Where the smart things are involved of using technology in their operations activities to better their business performance and fit with industrials 4.0. Smart things are using new technology and deceives in operation activities to optimize the business performance, which "was also undertaken by Hamdy et al.,[7]". Where the smart things are works based with internet of things that having connection with internet. On that the layout is needed to fit with internet of things to not loss connection, which "was also undertaken by Salomonsson,[16]". Hence, in warehouse there need of using smart warehouse to move he warehouse functions in warehouse automation to utilization their operations activities, which "was also undertaken by Richards et al.,[15]". For example, update trucking number of parcels from faster by using radio frequency identification (RFID) scanning, which "was also undertaken by Li et al.,[18]".

Fig. 9. The operational areas of warehouse to smart things

Figure (10), warehouse automation is involved of works with WMS is warehouse management system that do not need to all organization because warehouse management system or WMS is use in big warehouse to management the warehouse, which "was also undertaken by Hamdy et al.,[7]". For example, using computer to put the data of the goods. This warehouse management system or

WMS is use with software system because of that the small warehouse does not need this system, which "was also undertaken by Hamdy et al.,[7]". The use of software system for the big warehouse company to management the warehouse better and collet the data faster, which "was also undertaken by Li et al.,[19]". For example, in coco-cola company they are using guide vehicles system to carry the goods and using computer system to put and keep the data of the goods.

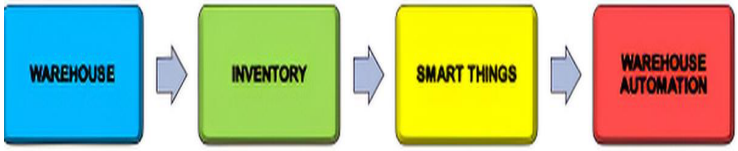

Fig. 10. The operational areas of warehouse to smart things

The warehouse's operational areas are equipped with smart devices that handle and record the movement of items. This allows other departments, such as supply chain management and procurement, to track the movement of goods and offer a transparent record of the activity. However, in order to increase a company's competitiveness in the market, the PEST study looks at significant external elements that have an impact on its operations, such warehouse operations.

Figure (11), PEST Analysis is involved with political, economic, social, and technological that is a management technique that allows a company to examine important external elements that affect its operations such warehouse operations in order to improve its market competitiveness. The warehouse companies have challenges and issues on the risk management of external environments in environmental risk. The environmental risk is a risk that comes from out of the company control. The warehouse company was having environmental risk based on the PEST analysis. The first PEST analysis is from the political of the Malaysian government, such as only allowing few of employees in private companies to work during this MCO. This will give an impact on warehouse on their daily activities. Thus, Malaysia needs to better performance of the growth of national income to increase the value of ringgit. On that Malaysia need to focus on export activities to having international market. For example, the trader agreement of RECP, which "was also undertaken by Azil,[3]", can increase the export activities that can increase the GDP of country. On that, the increase of exporting activities will make the production increase the product and goods for export. In this their need of manufacturing and supply chain management to providing the raw materials to again from stop production due of lack raw materials. Hence, the warehouse is need to manage the goods at their inventory from again out of stock such as using software system on provide real time stock units to Supply chain management and procurement on ordering new stock units, which "was also undertaken by Hamdy et al.,[7]".

Fig. 11. The PEST analysis of political

Figure (12), the second PEST analysis is from the economics of using SST tax for the import of goods. The goods that are imported from other countries need to pay customs duty for use in Malaysia by the customers. Every good that have SST tax will have a different SST tax value, and the

high value of duty tax will make customers not happy to pay tax for the goods and the warehouse companies can lose their import sales because of customers not being able to pay high duty for the goods. For example, the import of chemical goods is more than electric goods. To solve this problem, the warehouse companies need to know customer satisfaction such as check the SST tax for the imported goods and explain to the customers about the duty for the goods before doing the declaration. Hence, the top management needed to have link with customer department to knows the new SST values on making decision and that can help economic growth, which "was also undertaken by Yusliza et al.,[25]".

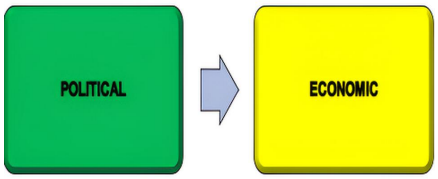

Fig. 12. The PEST analysis of economic

Figure (13), the third PEST analysis is from the social on hiring women's labor force in a company. In logistics, most activities will involve manpower to handle the logistics works such as carry cargo. But nowadays, women's labor is able to do the logistics work such as operations activities. Hence, the warehouse companies need to hire a balance of gender labor in their company. For example, women labor can handle customer service and the documents process of a company. Hence, the commitment for top management is needed to make the right moved to growth of business and social with economic, which "was also undertaken by Yusliza et al.,[25]". Other than that, the social also need to fit with using smart things to having skill in deal with digitalization works such as updating data in software systems, which "was also undertaken by Inkulu et al.,[11]".

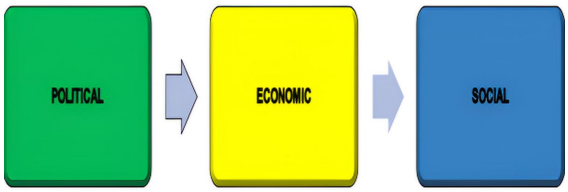

Fig. 13. The PEST analysis of social

Figure (14), the fourth PEST analysis is from the technology that is used in custom. Every good that has custom duty will need to pay the duty to get their goods. The duty of goods can be paid using a custom online system and receiving the receipt online and this system saves time. But sometimes the custom online system will go down and it will cause the warehouse companies to be unable to pay the duty. To overcome this custom duty payment problem, warehouse companies need to pay duty offline, which is that the warehouse companies will send their employee to pay the duty at the customs office and it takes more time than using an online system. Hence, the planning of top management is needed to overcome the problem when business involved with smart things to fit with industry 4.0, which "was also undertaken by Yusliza et al.,[25]".

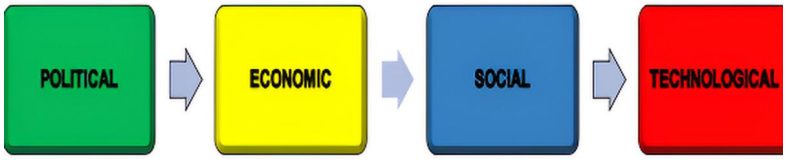

Fig. 14. The PEST analysis of technological

The lack of awareness and strategic planning, in turn, leads to the emergence of additional organizational-wide impediments, such as a lack of top-level commitment and a failure to recognize big data analytical demands in smart factories. People-related challenges, such as user reluctance and a lack of faith in big data analytical outcomes. In addition, there are technological and data hurdles, such as inadequate big data management and rising cyber-security risks. Thus, there also to find the trust of company using the outscoring software on managing their company details of shipment. User resistance to changes triggered by big data analytics and smart automation, as well as a lack of faith in the outcomes of big data analytics. When company managers pay more attention to big data, it's necessary to think about whether the analytical findings given by big data solutions can be trusted. Indeed, some scholars, which "was also undertaken by Li et al.,[19]", suggest that big data may compromise too many interests in a corporation, leading to a situation where various individuals may discover supporting evidence for whatever viewpoint they support. In light of this debate, practitioners may have reservations about "whether big data analytical outputs may make decision-making processes more efficient or, on the contrary, lead to increased confusion and possibility for error.

Thus, there also to know about the range of internet that works at warehouse for warehouse operation activities such as scan shipment parcel tracking number or QR code. Each industry or organization's warehouse has its own purpose, layout, size, use, management system, process flow, and value-adding activities that are specific to the company type it serves. This is one of the reasons why an IoT-based smart warehouse infrastructure should be tailored to the unique characteristics and components of each warehouse operation and business process. This research was done to look at the relationship between radio frequency identification (RFID) and the challenges of implementation smart warehouse in Shah Alam, Selangor warehouse. Where to find how good the using of radio frequency identification (RFID) has helped in improving the warehouse operation. Thus, there also to find is their lack of understanding the use of radio frequency identification (RFID) has affected the company to implementation it in the warehouse. Hence, when it comes to radio frequency identification (RFID) adoption, there are several concerns and obstacles to consider. Costs of software and equipment, a lack of standards, a lack of collaboration across multiple levels in the supply chain necessary to preserve information openness, technical issues, and privacy concerns are just a few of them, which "was also undertaken by Osyk et al.,[4]".

The adoption of automation is expected to have an impact on warehouse workers on the shop floor. With the advent of automation, job tasks, the physical architecture of the warehouse, style of communication, and the amount of information to process, among other things, may change. Individual abilities, knowledge, background, motivation, weakness, and relationship to other colleagues, among other things, are examined in the people factor. Operators, supervisors, mechanics, and passers-by are all possible candidates, which "was also undertaken by Cirillo r et al.,[23]". People's performance is determined by their assigned job in the system. In the United States, almost half of all automated linked sophisticated technology is deemed to be less effective in terms of dependability, quality, adaptability, and responsiveness. The fundamental reason for this is the lack of attention paid to human factors when these technologies are implemented, which "was

also undertaken by Cirillo r et al.,[23]". Skills are important predictors of digital enabling technology adoption, presumably because they are required for extracting productivity advantages from new assets. The policy lesson is that industrial policies that encourage digitization able to contain substantial components of upskilling and training, as well as suitable policies for the supply of new skills through the institutional construction of digital competencies. The commitment from top management is changing the business to smart warehouse. Thus, there also to investigate the commitment from top management is needed to growth of company that involved of decision making, lead, and planning. Hence, the way work is formally and informally structured is referred to as organizational factors. As a result, this element includes job descriptions, duties, and power, as well as hierarchical roles, rules, company objectives, and plans. This element also includes organizational culture, which "was also undertaken by Kumar et al.,[14]". To make innovative initiatives effective, project decisions should be based on a variety of organizational features. This covers things like organizational structure and top-level management mindset. The attitude of top management toward these projects is a critical factor in their success. The perception of a lack of support can be just as damaging to the implementation of a project as an actual lack of support. Furthermore, senior management should be willing to incur short-term risks in exchange for long-term gains. Top management support should be evident in assuring team integrity, top-down planning, and assigning other essential resources, which "was also undertaken by Kumar et al.,[14]".

As a result of the lack of knowledge and strategic planning, additional organizational-wide hurdles such as a lack of top-level commitment and a failure to understand big data analytical demands in smart factories develop. User skepticism and a lack of confidence in big data analytical conclusions are people-related issues. There are other technological and data barriers to overcome, such as insufficient big data management and increased cyber-security issues. The companies who use outscoring software to manage their shipping information have confidence in it. User resistance to changes prompted by big data analytics and smart automation, as well as a lack of trust in big data analytics' consequences. When executives' pay greater attention to big data, they can consider if the analytical results provided by big data solutions can be trusted. Indeed, some researchers, which "was also undertaken by Li et al.,[19]", argue that big data may compromise too many "interests" in a company, resulting in a situation where multiple persons may find supporting evidence for whatever position they favor. In light of this discussion, practitioners may be unsure "whether big data analytical outputs will improve decision-making processes or, on the contrary, will raise uncertainty and the risk of inaccuracy."

The internet range that is available in warehouses for warehouse operations such as scanning shipment parcel tracking numbers or QR codes. The purpose, layout, size, usage, management system, process flow, and value-adding activities of each industry or organization's warehouse are all unique to the firm type it serves. This is one of the reasons why an IoT-based smart warehouse infrastructure should be customized to each warehouse operations and business process's specific characteristics and components, which "was also undertaken by Affina et al.,[10]". Hence, the practice of right warehouse layout is a challenge of implementation smart warehouse in Shah Alam, Selangor. The company's failure to adopt radio frequency identification (RFID) in their warehouse is due to a lack of knowledge of its utilization. As a result, there are various challenges and hurdles to consider when it comes to radio frequency identification (RFID) adoption. Software and equipment costs, a lack of standards, a lack of collaboration across several levels in the supply chain, technical challenges, and privacy concerns are just a few of them, which "was also undertaken by Osyk et al.,[4]".

Employees were hired based on their ability to use technology. The deployment of automation is projected to affect warehouse and shop floor labor. Job activities, warehouse physical design,

communication style, and the volume of data to handle, among other factors, may alter as a result of automation. The people component looks at aspects like individual talents, knowledge, background, motivation, weaknesses, and relationships with other co-workers, among other things. Candidates include operators, supervisors, mechanics, and passersby, which "was also undertaken by Cirillo r et al.,[23]". The allocated task in the system determines people's performance. Nearly half of all automated linked advanced technology in the United States is judged ineffective in terms of dependability, quality, flexibility, and responsiveness. The main reason for this is because when these technologies are adopted, they are not given enough consideration for human issues, which "was also undertaken by Kumar et al.,[14]". Because skills are essential for obtaining productivity benefits from new assets, they are crucial predictors of digital enabling technology adoption. The policy takeaway is that industrial policies that promote digitization able to include significant components of upskilling and training, as well as appropriate policies for the supply of new skills through the institutionalization of digital capabilities.

Additional organizational-wide challenges emerge as a result of the lack of knowledge and strategic planning, such as a lack of top-level commitment and a failure to grasp big data analytical demands in smart factories. People-related difficulties include user skepticism and a lack of trust in big data analytical results. Other technological and data hurdles to overcome include poor big data management and rising cyber-security concerns. Companies who handle their shipment information with outscoring software have faith in it. User aversion to changes brought on by big data analytics and smart automation, as well as a lack of faith in the outcomes of big data analytics. When executives' pay more attention to big data, they can examine if the analytical findings supplied by big data solutions are reliable. Indeed, some academics, which "was also undertaken by Li et al.,[19]" suggest that huge data may jeopardize too many "interests" in a corporation, leading in a situation in which numerous people might uncover evidence to support their preferred viewpoint. Practitioners may be unsure "whether big data analytical outputs will assist decision- making processes or, on the contrary, will raise ambiguity and the risk of inaccuracy" in light of this issue. As a result, a lack of expertise and confidence in the software system will be a barrier to smart warehouse deployment in Malaysia.

In warehouses, the internet range is provided for warehouse activities such as scanning shipping parcel tracking numbers or QR codes. The warehouse's purpose, layout, size, utilization, management system, process flow, and value-adding activities are all unique to the industry or company it serves. This is one of the reasons why an IoT-based smart warehouse infrastructure should be tailored to the unique characteristics and components of each warehouse operation and business process, which "was also undertaken by Affina et al.,[10]". As a result, a hurdle in implementing smart warehouse in Malaysia is finding the correct warehouse plan. The company's failure to use radio frequency identification (RFID) in their warehouse is due to a lack of understanding of the technology's capabilities. As a result, when it comes to radio frequency identification (RFID) adoption, there are several problems and roadblocks to consider. Costs of software and equipment, a lack of standards, a lack of collaboration across several levels of the supply chain, technical difficulties, and privacy issues are just a few of them, which "was also undertaken by Osyk et al.,[4]". As a result, a lack of radio frequency identification (RFID) understanding is one of the problems of implementing smart warehouse in Malaysia.

Employees were hired based on their technological aptitude. The impact of automation on warehouse and shop floor labor is expected. Automation may change job activities, warehouse physical architecture, communication style, and the volume of data to manage, among other things. Individual abilities, expertise, background, motivation, shortcomings, and connections with other employees are all considered in the people component. Operators, supervisors, mechanics, and

passers-by are among the candidates, which "was also undertaken by Cirillo r et al.,[23]". People's performance is determined by the system's assigned task. As a result, having employees based on expertise to position in the proper department to suit with smart things is an implementation issue. warehouse in Malaysia that is smart. In terms of dependability, quality, adaptability, and responsiveness, about half of all automated connected sophisticated technology in the United States is deemed useless. The fundamental reason for this is that when these technologies are deployed, they do not take human considerations into account, which "was also undertaken by Kumar et al.,[14]". Skills are important determinants of digital enabling technology adoption since they are required for gaining productivity advantages from new assets. The policy conclusion is that industrial policies promoting digitization able to contain important components of upskilling and training, as well as policies for the supply of new skills through the institutionalization of digital capabilities. As a result, senior management's role in planning and decision- making poses implementation issues. warehouse in Malaysia that is smart.

Despite the recent increase in interest in smart warehouses, the present body of research is still fragmented and has a narrow focus. The majority of research focuses on bibliometric metrics like keyword analysis, co-citations, and publishing patterns, but it ignores the more profound qualitative facets of smart warehouses. Due to the underrepresentation of cross-cultural viewpoints, little is known about how smart warehousing practices vary depending on the educational setting. Furthermore, there has not been enough discussion of the impact of cutting-edge technology like big data and blockchain. Many studies continue to focus on the past, ignoring implications for warehouse growth that are focused on the future. These discrepancies highlight the necessity for a more comprehensive and proactive investigation of smart warehouses in connection to digital performance in warehouses. This study is important for full fill knowledge gaps that can implementation smart warehouse in Malaysia and worldwide. Where there this having knowledge gaps on embedding big data and radio frequency identification (RFID) that might face while moving forward in warehouse automation. In the embedding big data is involved of using outscoring software to handle the company shipment details such as managing the company customer information in a software from other company. In additional, trust is playing a role for the company to using outscoring software because providing their customer shipping details by using outscoring software that might can happen to sell the information to other companies. Other than that, the lack of understand of using radio frequency identification (RFID) that might face while moving forward in warehouse automation. Thus, this understand of using embedding big data and radio frequency identification (RFID) can benefit for industrials that can better their operations to performance better such as auto update details the right info at the right time to the right people.

This study is important for reduce the practice gaps that can implementation smart warehouse in Malaysia and worldwide. Where there this having practice gaps on internet of things, skill of works, and commitment from top management that might face while moving forward in warehouse automation. The internet of things will cannot utilization for the use if the layout of warehouse is not fit the range of using the internet that cannot connection with other device for warehouse activities such as scanning. In additional, the skill of works is needed to fit with current area job that involved of using digitization to better their company or business performance. For example, the use of technologies such as machines will cannot utilization used if the employee are not responsiveness, flexibility, reliability, and quality. Hence, human aspects are needed to have skills to implementing these technologies, which "was also undertaken by Cirillo r et al.,[23]", to make a smart warehouse operation. More than that, the commitment from top management is needed to make the right decision to growth of business and operation that involved with visible and think the use of labor and capital to reduce the risk of business. For example, making decision based from the integrity of the

team, top-down planning, and while allocating other necessary resources, which "was also undertaken by Kumar et al.,[14]". Thus, the used and implementation of practice the internet of things, skill of works, and commitment from top management is need to the warehouse can utilization the operation that fit to industrial 4.0. Hence the social can have benefit because direction for industrial development is creating high value jobs because they need to increase the skills of employees for high pay by 2025. The skills are important for the employees in doing their jobs. The high skills of employees will enable them to do many activities at a time and this will increase their salary. On the other hand, skill is important for the production department to create quality products. For example, the skill of multitasking is needed to motor and complete the task on time. Thus, the use of technology in an industry will increase their employees to high skills. Where the employees are able to work tighter with the technology on doing, they work and unlock the new skills. For example, the employees are able to unlock the skill of using mobile tracking during scanning the goods using smart devices. Hence, having the employees with high skill that can work together with smart technology can increase the quality of products and activities. Where the employees are able to provide a better quality of work because their skills are working with technology to complete the task of work. For example, using the skill of multitasking can enable the employees to do the work faster by using smart devices such as smart shelves that will update the SKUs of goods on the shelf in a software system and this will enable the employees to replace the stock of goods on time.

This study is important for smart warehouses that playing a role for inventory on managing the department activities. Where the use of Internet of Things (IOT) with smart devices in the warehouse is given benefit on increasing the speed of activities and reducing the error. For example, the movement of goods can be monitored thru Radio Frequency Identification and SMART shelfs will update the status of goods into the software. Thus, the growth of digital and use of technology increases are given an impact from logistics industries on changing to smart business such as smart warehouses. Where the use of technology in an industrial such as logistics industries are needed to meet the business and customers because the use of technology is used by many peoples on their business to do, their work. For example, by having the DHL parcel system or Logistaas systems (Logistaas), the goods status can view more transparency by all internal and external parts that work with the warehouse and do the work faster, which "was also undertaken by Richards et al.,[15]" and reduce over-lot goods in the inventory. Hence, the growth of technology not only gives benefits for business activities but also from the growth of the economy and peoples. Where the use of technology in all industries is changing the world to a digital world and smart business that gives benefits for the economy and people of the country, which "was also undertaken by Harian Metro,[8]". For example, the government is moving to digital industries, which "was also undertaken by Harian Metro,[8]", increasing the skills of employees for high pay, which "was also undertaken by Azil,[3]", increasing production, ensuring customers are happy, and getting new business at international level. This study is important for warehouse in Malaysia to adopt smart warehouse because government moving to digital industrials. Based on the Wawasan Kemakmuran Bersama 2030 (WKB 2030)," under RMK-12 with the theme of 'Restoring economic growth, addressing socio-economic challenges, balancing development between regions as well as enhancing competitiveness, which "was also undertaken by Harian Metro,[8]". Where the government is focused on growth of digital business. Thus, the increases of using with technology in daily are changing the works of activities into digital business. Hence, the growth of digital and used of technology increases are given impact from logistics industrial's on changing to smart business, which "was also undertaken by Harian Metro,[8]", such as smart warehouse. For example, the use of SMART shelf in warehouse to update the stock of SKU's on reduce the space of inventory. Furthermore, the technology that used in the smart warehouse are connection with internet or know internet of things (IOT) to having good

commotion such as auto update systems. Thus, the provision of digital infrastructure involves RM28 billions of public and private sector investments worth RM28 billion to improve existing 4G networks, which "was also undertaken by Harian Metro,[8]". But in now days, the work or activities need to done faster to fulfil customer's orders because of that the smart warehouse is needed to have good internet networks on used for internet of things. Hence, in order to faster the implementation of 5G nationwide, another RM15 billion will be invested by the private sector, from presenting a motion on the 12th Malaysia Plan (RMK-12) in the House of Representatives, which "was also undertaken by Harian Metro,[8]". By, having a good network of internet such as 5G can be able to support the smart warehouse that operation with connection of internet of things (IOT). It can used for using new technology that need speed connection of internet network. For example, the used to update goods status by using mobile tracking that need to use 4G or 5G internet network for having faster update.

This study is significant because it offers one of the comprehensive bibliometric mappings of smart warehouse, consolidating scattered literature into a structured overview. By analyzing 1766 publications from the Scopus database, it identifies leading authors, influential journals, and key thematic evolutions in the field. The findings provide practical insights for educators and policymakers on how smart warehouse can be designed to improve warehouse outcomes such as digital warehouse performance, big data, and internet of things. Importantly, this study fosters interdisciplinary collaboration across big data, industry 4.0, and information systems. As such, it serves as a valuable foundation for future research and practice in the digital transformation of warehouse. The endeavor will use bibliometric analysis to address a number of topics. Search academic databases and research repositories to determine the total number of publications on the topic of Smart warehouse. Analyze the publication trend over time, breaking down the number of research papers published year on year. Identify and list the names of influential academic journals that frequently publish papers on Smart warehouse. Find reports or analyses on the geographical distribution of Smart warehouse research to determine which countries are the most prolific in publishing on this topic. Identify the most relevant and most influential authors in the field of Smart warehouse, based on their publication volume and citation count. Find the titles of highly cited research papers, differentiating between papers with high global citation counts and those with high local citation counts. Find the title of the research paper that has been cited or referred to the maximum number of times. Analyze existing literature reviews and meta-analyses to determine the current and evolving thematic structure of Smart warehouse research. This study used bibliometric analysis of the Scopus database to describe the patterns of publications on smart warehouse in order to support the earlier findings. This study looked at a range of publications in terms of accessibility, language, topic matter, and source title in addition to the most often cited works, publishing patterns, and authors' keywords. The rest of the paper will be organized in the following steps. The methodology for bibliometric analysis will be presented in part (2) and result in part (4) and followed by results and conclusion in parts (4) and respectively.

2. Methodology

The bibliometric toolbox will be used to do the bibliometric analysis. The primary technique and the enrichment technique are the two methods included in the toolbox. Performance analysis (A) and science mapping (B) are the two key components of the approach. Although the primary approaches may be used for a wide range of investigations, this research study will concentrate on a few of them. Two pieces of software, R and VOSViewer, helped with the bibliometric. A quantitative study of a vast collection of data is called bibliometric analysis, and the results are presented as themes, networks, research elements, and descriptive analysis. The evolution and thematic

organization of a certain field may be studied with the use of this bibliometric analysis, which "was also undertaken by *Badenes-Rocha et al.,*[27]". Additionally, this study is free of subjective prejudice. This paper's analysis of the bibliographic data "was also undertaken by *Nasir et al.,* [29]." Science mapping and performance analysis were used to derive the trends and research direction. A technique for analyzing the contributions of research participants, including authors, counties, publishers, publications, and institutions in the subject region, is performance analysis. The purpose of science mapping is to create connections among the components of research. As "also undertaken by earlier studies [26-27,29]," combining scientific mapping and enrichment approaches gives us the conceptual framework of a study area and the fundamental topics of the issue, establishing a connection between different research parts.

2.1. Bibliometric search

A bibliometric analysis database is gathered from the Scopus database. The Scopus database, which "was also undertaken by *Jakhar et al.,*[28]," is regarded as the most scientific and methodical database for bibliometric analysis. Scopus has been recognized as the best database for bibliometric analysis in addition to the aforementioned claim, which "was also done prior research [27], [29]". Therefore, it can be claimed that Scopus is the most extensive database that includes a wide range of information on articles and that papers must meet strict criteria in order to be included in this database.

Several keywords are recognized for the optimal search, including “Warehouse”, “Smart warehouse”, and “Industry 4.0”. The optimal keyword was “Smart warehouse”. This article will analyze smart warehouse. A search was performed on the Scopus database using the phrase smart warehouse, resulting in the retrieval of 1766 papers. It finds prominent authors, significant journals, and significant topic developments in the discipline by examining 1766 publications from the Scopus database. The results give educators and policymakers useful information on how smart warehouses may be developed to enhance warehouse outcomes including big data, digital warehouse performance, and the internet of things. Crucially, this study promotes multidisciplinary cooperation in the fields of information systems, industry 4.0, and big data. As a result, it provides a useful basis for further study and application in the field of warehouse digital transformation. The project will cover several themes using bibliometric analysis. Look through scholarly databases and research archives to find out how many papers there are on the subject of smart warehouses overall. Dissect the number of research articles published annually to examine the publishing pattern over time. List the titles of reputable scholarly publications that regularly publish articles about smart warehouses. To find out which nations publish the most on this subject, look for studies or analysis on the regional distribution of smart warehouse research. Based on their number of publications and citations, determine which writers are the most significant and pertinent in the subject of smart warehouses. Look for the names of research publications that have had a lot of citations, making a distinction between those that have a lot of local and worldwide citations. Locate the research paper's title that has received the most citations or references. Examine previous literature reviews and meta-analyses to ascertain the present and developing theme framework of research on smart warehouses. To confirm the previous findings, this study described the trends of publications on smart warehouses using bibliometric analysis of the Scopus database. In addition to the most often referenced works, publishing trends, and authors' keywords, this study examined a variety of publications in terms of accessibility, language, topic matter, and source title.

2.2. Filtration

The language publications were not chosen for to having other language publications. The selected papers were then those that were printed in journals. 1766 publications were ultimately chosen for study. Since further filtration may lower the number of articles and may affect the bibliometric analysis, no sorting criteria other than these two were used.

2.3. Duplicate elimination

A duplicate elimination procedure was executed using both automatic detection on the Scopus platform and human verification of author names and publication titles. This process guaranteed the removal of superfluous records and the maintenance of data integrity. Implementing these filtering approaches, a total of 1766 unique and valid records were retained for bibliometric analysis. No exclusion criteria, including publication year, source title, or topic category, were applied, ensuring comprehensive coverage of the scientific landscape pertaining to smart warehouses. This comprehensive screening method enhanced the reliability and representativeness of the dataset utilized for subsequent performance and science mapping assessments.

3. Results

3.1. Total publication and number of active years of publication

One performance analysis approach is the total publication. The overall number of publications on the study topic is taken into account. The 1766 gathered findings from the articles released each year are included in the yearly scientific production. The papers were arranged in groups based on the year they were published in the journals. It is possible to conclude from Figure (15) that smart warehouse research is growing annually. There was just one publication in 1971; nevertheless, by 2012, there were 16 publications overall, and in 2023 and 2024, there were 209 and 249, respectively. 186 papers are counted until October 2025. The phrase "active years of publishing" refers to the number of years that research has been done in the field to examine the phenomena. Groundbreaking research is still being conducted, and the active year began in 1971. Given the pattern shown in Figures (15) and (16), there are still comparatively fewer studies conducted annually; as a result, there is need for further study on this subject.

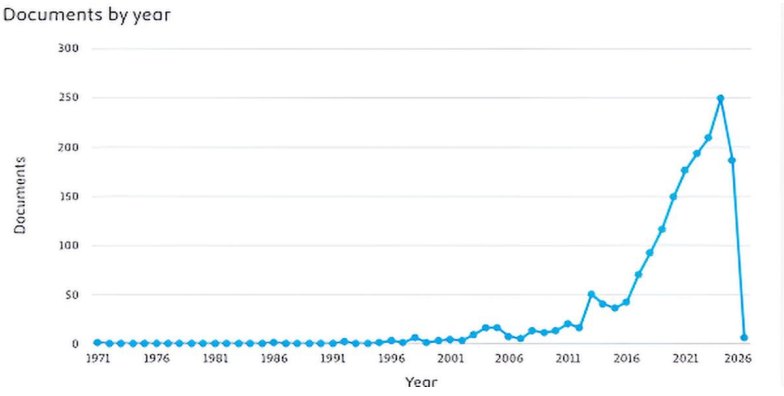

Fig. 15. Shows year-to-year publications from 1971 to 2026

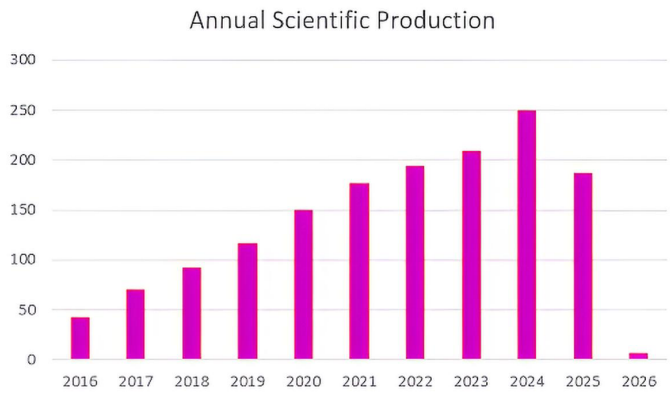

Fig. 16. Shows year-to-year publications from 2016 to 2026

3.2. Most promising journals

The journals that publish the most articles on a certain subject are considered promising. R software was used to identify promising journals based on Bradford's law. Table (2), which lists the top 10 promising journals in the subject of smart warehouse, shows the most promising journals. With a total of 48 articles in the topic of smart warehouse, the Lecture Notes in Computer Science Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics has an advantage over other journals. With a total of 33 articles in the field of smart warehouse, the Lecture Notes in Networks and Systems, has an advantage over other journals. With a total of 28 publications in the subject of smart warehouse, the ACM International Conference Proceeding Series, and Lecture Notes in Electrical Engineering have an advantage over other journals. Bradford's law was chosen for examination in publications that showed promise. A graph displaying the source name and the quantity of papers published by a journal achieved the result. This can be seen in Table (1), the graph was later shaped into a table. By identifying the most pertinent journals that are leading the way in publishing content about smart warehouse, Bradford's law analysis will help researchers swiftly find and choose a few journals that will support their study of smart warehouse and future research. A journal's potential to impact future scholars in a certain topic increase with the number of papers it publishes in that field.

Table 2
Shows the name of the journal along with the number of a paper published

No.	Name of journals	No. of published
1.	Lecture Notes in Computer Science Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics	48
2.	Lecture Notes in Networks and Systems	33
3.	ACM International Conference Proceeding Series	28
4.	Lecture Notes in Electrical Engineering	28
5.	Advances in Intelligent Systems and Computing	27
6.	Communications in Computer and Information Science	27
7.	IEEE Access	25
8.	Procedia Computer Science	22
9.	Proceedings of SPIE the International Society for Optical Engineering	22
10.	Lecture Notes in Mechanical Engineering	20

3.3. Dominant countries

In the field of research, the nations with the highest number of published papers and citations are regarded as dominating nations. The database is examined using R software for the analytical task. The results are interpreted using the scientific production and citations of the countries in order to identify the leading nations in the field of smart warehouse. Both the quantity of papers and the number of citations is used to determine which nations are dominant. The top ten nations are chosen to be examined from both angles. Finding the top nation by looking at figures (17) and (18) shows that, while Papua New Guinea has the greatest average article citations (60.00), the China leads all other nations in terms of documents (360). With just 31.40 papers, the Iran ranks second in terms of average document citations. Even though China nation had more published documents, China behind several others in terms of citations, including Iran, Australia, North Macedonia, and others. India is in a similar situation. Compared to its Papua New Guinea equivalent, this country earned more citations with less papers. Information from figures (17) and (18) was transformed into a tabular format in Table (3) to facilitate the interpretation of the analysis. Thus, it can be said that China and the India are at the forefront of smart warehouse research. In terms of average article citations, the Papua New Guinea, the Iran, Australia, North Macedonia are notable nations.

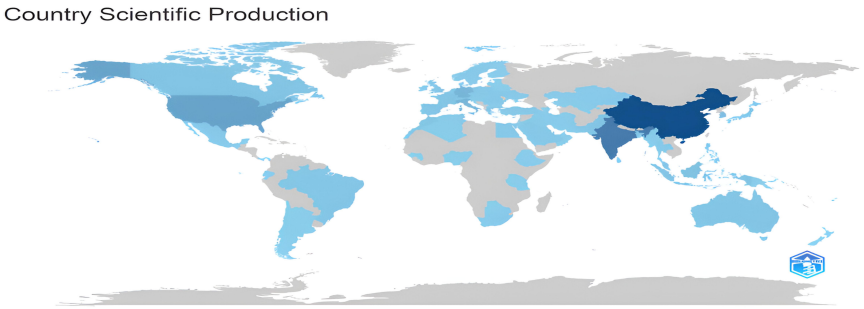

Fig. 17. Shows a world map depicting the number of documents published by each country

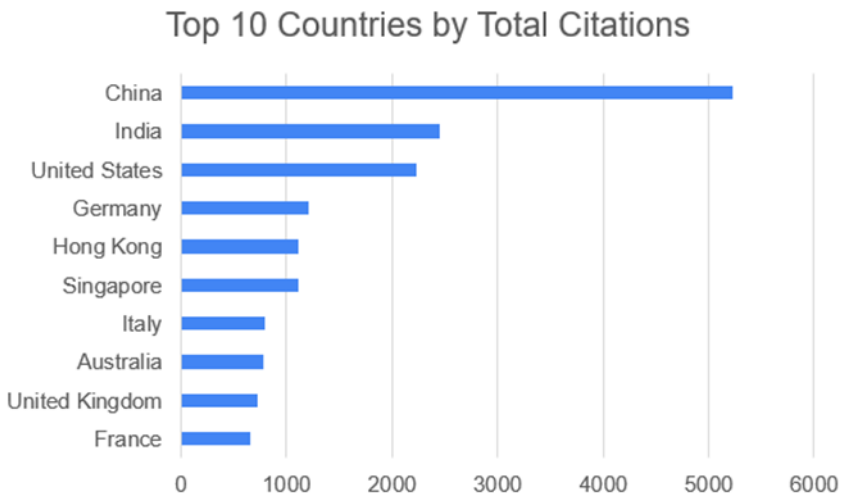

Fig. 18. Shows the number of citations received by each country's documents

Table 3
Countries' names, the number of documents published and the number of citations received

Rank	Country	Documents	Rank	Country	Average Article Citations
1	China	360	1	Papua New Guinea	60.00
2	India	264	2	Iran	31.40
3	United States	165	3	Australia	29.43
4	Germany	78	4	North Macedonia	29.00
5	Italy	72	5	Spain	23.47
6	South Korea	53	6	Hong Kong	21.72
7	United Kingdom	49	7	Cyprus	20.50
8	Canada	44	8	Ireland	19.83
9	Taiwan	43	9	Slovakia	18.8
10	France	43	10	Pakistan	18.80

3.4. Most relevant authors

The quantity of papers each author publishes determines which writers are the most pertinent. R software therefore calculated it by counting the number of smart warehouse-related publications they had written. According to the data, an author's significance increases with the number of papers they have written. The ten most pertinent writers are displayed in Figure (19). It is evident that Anon, J.C R have 14 papers. The top ten writers cited can help readers understand their work and what more needs to be done. Kim, Jong-Ho and Le, Huan Ngoc both contributed significantly with 9, each of the respectively.

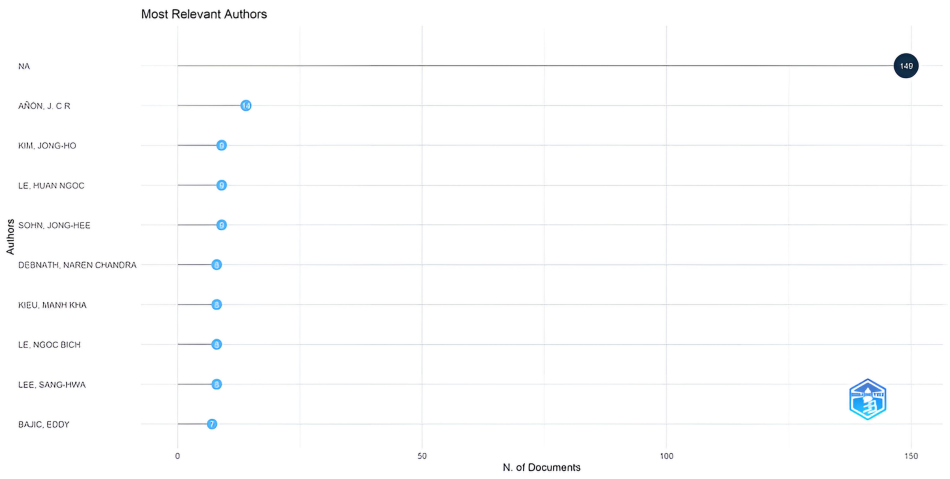

Fig. 19. Shows the authors' names and the number of papers published by them

3.5 Influential authors

The most influential authors are the ones who have received the highest number of documents in their field. It is solely based on the citations. Therefore, influential authors were determined by the total document count an author receives. Authors with the highest total document in their account will be the most influential, and authors with fewer citations will be less influential. Authors such as Wang Tian with 821 document, Ma Xin with 819 document, and Cheng Hui with 812 total documents are clearly leading the chart. The rest of the authors are shown in figure (20) with 812 total documents each author.

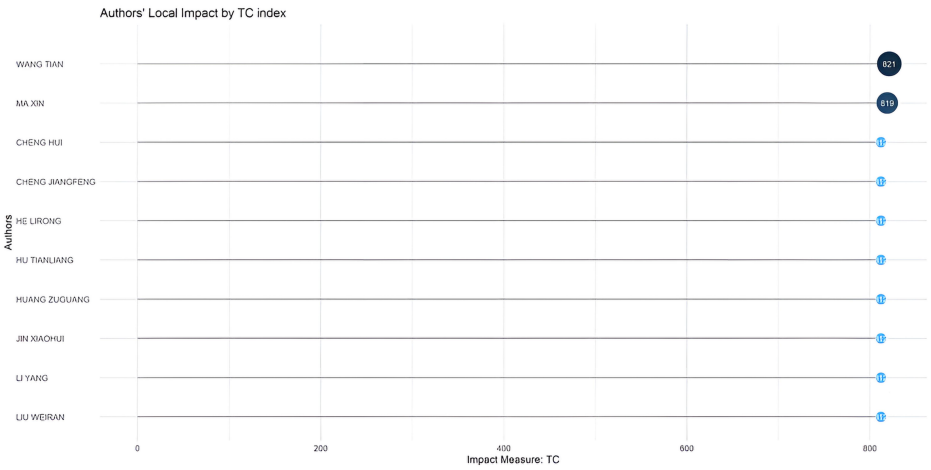

Fig. 20. Shows authors' names and numbers of total document

3.6. Citation analysis

Citation analysis is a scientific mapping approach. When a publication is referenced by another publication, it links the publication. This "was also done by *Jakhar et al.,* [28]". Two criteria are used for citation analysis: (1) global citation and (2) local citation. The quantity of citations an article obtains from readers may be used to gauge its impact in citation analysis.

3.6.1. Most global cited documents

The publications with the most citations without any filtering, such as topic domain, are referred to as the most internationally cited texts. This research "was also done by *Jakhar et al.,* [28]". To put it another way, global citations are those that a publication receives regardless of whether it has been cited inside or outside of its topic domain. The ten most frequently cited papers worldwide might also be seen as having a significant impact on other writers' decision to include citations in their works. Both articles that discuss smart warehouse and those that do not discuss it make reference to these materials. Figure (21) displays the ten most influential papers, and table (4) analyses them. The top ten most internationally cited publications that were examined from Figure (21) are included in Table (4) along with their article names, authors, and citation counts.

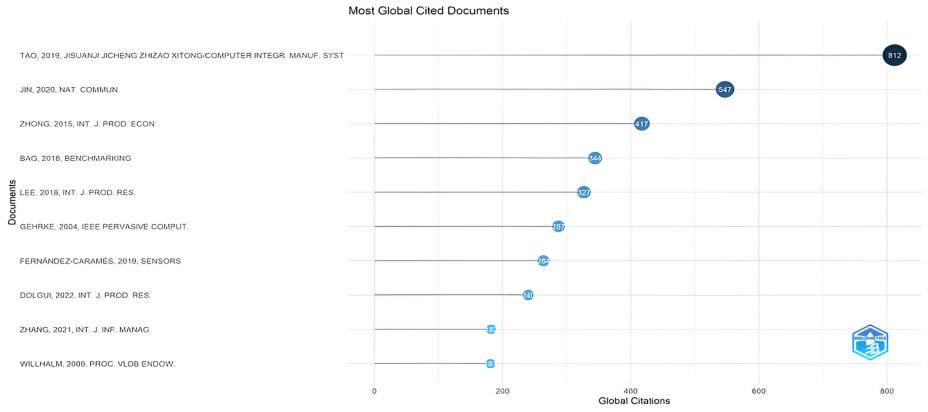

Fig. 21. Shows the most influential papers in terms of global citation

Table 4
Article name, authors' name, and citations of the top 10 globally cited documents

No.	Article Title	Authors	Global citation
1	Five-dimensional model of digital twin and its applications in ten fields	Tao, 2019, Jisuanji Jicheng Zhizao Xitong/Computer Integr. Manuf. Syst. C.	812
2	Triboelectric nanogenerator sensors for soft robotics aiming at digital twin applications	Jin, 2020, Nat. Commun.	547
3	A big data approach for logistics trajectory discovery from RFID-enabled production data	Zhong, 2015, Int. J. Prod. Econ.	417
4	Industry 4.0 and supply chain sustainability: framework and future research directions	Bag, 2018, Benchmarking	344
5	Design and application of Internet of things-based warehouse management system for smart logistics	Lee, 2018, Int. J. Prod. Res.	327
6	Query processing in sensor networks	Gehrke, 2004, Ieee Pervasive Comput.	287
7	Towards an Autonomous Industry 4.0 Warehouse: A UAV and Blockchain-Based System for Inventory and Traceability Applications in Big Data-Driven Supply Chain Management	Fernández-Caramés, 2019, Sensors	264
8	5G in digital supply chain and operations management: fostering flexibility, end-to-end connectivity and real-time visibility through internet-of-everything	Dolgui, 2022, Int. J. Prod. Res.	240
9	Artificial intelligence in E-commerce fulfillment: A case study of resource orchestration at Alibaba's Smart Warehouse	Zhang, 2021, Int. J. Inf. Manag.	182
10	SIMD-scan: ultra fast in-memory table scan using on-chip vector processing units	Willhalm, 2009, Proc. Vldb Endow.	181

3.6.2. Most local cited documents

Publications that are mentioned inside the topic domain are known as local cited documents; for example, an article that "was also undertaken by *Jakhar et al.,*[28]" obtains citations from another article in the same subject area. To put it another way, local citations are those that are specific to the field in which the materials are found. As an illustration, a paper about smart warehouse is referenced in another work about smart warehouse. As a result, the majority of locally cited papers examine works that are often referenced or mentioned in the field. One can rely on the papers displayed in figure (21) to gain understanding about the topic matter. These materials are particularly pertinent to the subject of smart warehouse and can be considered trustworthy sources for obtaining first papers. It should be highlighted that, for the clear reasons stated in their definition, local citations are always lower than global citations. The analysis of Figure (21) is completed in Table (5).

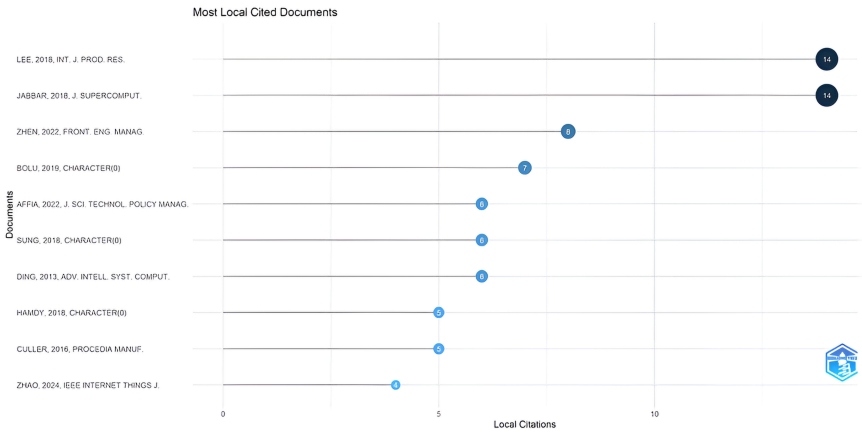

Fig. 21. Shows documents receiving a total number of local citations

Table 5
Shows the article name, authors' name, and citations of the top 10 locally cited documents

No.	Article Title	Authors	Local citation
1	Design and application of Internet of things-based warehouse management system for smart logistics	Lee, 2018, Int. J. Prod. Res.	14
2	A REST-based industrial web of things' framework for smart warehousing	Jabbar, 2018, J. Supercomput.	14
3	A literature review of smart warehouse operations management	Zhen, 2022, Front. Eng. Manag.	8
4	Path planning for multiple mobile robots in smart warehouse	Bolu, 2019, Character	7
5	An internet of things-based smart warehouse infrastructure: design and application	Affia, 2022, J. Sci. Technol. Policy Manag.	6
6	Smart warehouse management based on IoT architecture	Sung, 2018, Character	6
7	Study of smart warehouse management system based on the IOT	Ding, 2013, Adv. Intell. Syst. Comput.	6
8	A facile microwave-assisted synthesis of PbMoO4 nanoparticles and their key characteristics analysis: a good contender for photocatalytic applications	Hamdy, 2018, Character	5
9	A prototype smart materials warehouse application implemented using custom mobile robots and open source vision technology developed using emgucv	Culler, 2016, Procedia Manuf.	5
10	Order picking optimization in smart warehouses with human–robot collaboration	Zhao, 2024, Ieee Internet Things J.	4

3.7. Co-citation analysis

One method of scientific mapping is co-citation analysis. When two references are mentioned together in a third work, it is assumed that they are related in some way or share a similar content structure. Co-citation analysis, which "was also undertaken by *Jakhar et al.,*[28]," is used to expose the conceptual framework of a particular field of research. Based on the clusters created, this approach also assists us in identifying the most important publications. Each cluster has a theme and is based on a certain foundation. After grouping the documents into clusters, the co-citation analysis identifies the publications that are most related to each subject. Researchers can learn more about the article based on their interests thanks to this analysis. Additionally, future scholars might gather

literature on a specific topic by consulting the related publications. The VOSViewer program employs a co-citation approach for the analysis. Only publications that have at least six citations in published articles are chosen. Just 84 out of 4409 reach the citation limit. Figure (22) was examined by assigning weight to the links.

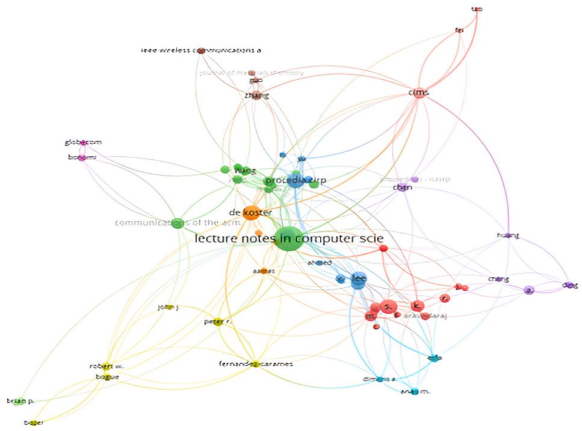

Fig. 22. Shows a map of co-citation analysis based on the authors' name

Table (6) is 11 clusters are created in total. By giving the connections more weight, you may show how many additional papers are related to the papers in the reference list. A paper is better suitable for study if it has a greater number of connections.

Table 6
Shows the interpretation of the co-citation map.

Color of cluster	Author name	Citation
Red	Aravindaraj	9
Green	Liu	15
Bule	Ahmed	6
Gold	Bogue	8
Purple	Chen	14
Sky bule	Effa	9
Orange	Amas	6
Brown	Guo	6
Pink	Bonomi	8
Maroon	Cims	18
Light green	Gerkey	6

This bar chart, titled "Document by author," in Figure (23) illustrates the number of documents published by a selection of authors. The y-axis represents the number of documents, while the x-axis lists the authors. The graph unequivocally shows that Wang, Y. is the most prolific author, having published the most documents (20 in total). A group of authors with almost equal publications follows Wang, Y. Zhang, Y., and Liu, J., each of whom has 13 articles. Zhang, X., Chen, J., Zhao, Z., Liu, X., Wang, Z., and Liu, Y. make up the following group, and they all have the same number of documents—12. With 11 publications, Wang, J. is the author with the fewest number in the top 10. With most authors grouped between 11 and 13 documents, the productivity of the top authors as a whole reveals a clear difference between the top author and the others.

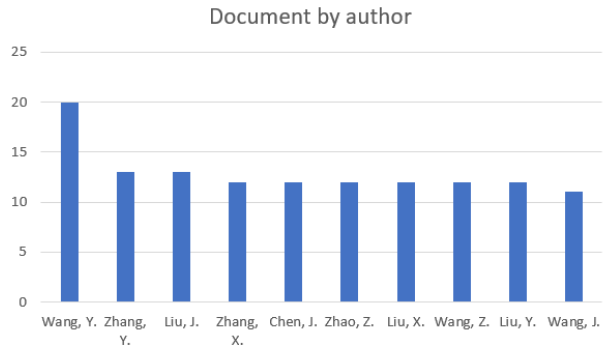

Fig. 23. Shows of highest document from authors' name

This Table 7. shows the author pair of the collaborations," lists the top 10 author pairs based on the number of collaborations they've had. The table has three columns: No. (ranking), Author Pair, and Collaborations (the number of joint publications). With nine collaborations between them, Kim and Sohn are the most frequent partners. Two couples with eight partnerships each Kim, J. H. and Lee, S. H., and Lee, S. H. and Sohn, J. H. follow this. There is a significant grouping of highly collaborative pairs just below the top three, as evidenced by the equal number of collaborations for the remaining seven author pairs, which include different combinations like Kieu, M.K. and Le, N.B.; Le, N.B. and Le, N.H.; Kieu, M.K. and Le, N.H.; Nguyen, V. A. T. and Nguyen, X. H.; Nguyen, X. H. and Ninh, T. T. D.; Kim, J. H. and Kwon, Y. S.; and Nguyen, D. C. and Nguyen, X. H.

Table 7
Author and co-authors and their collaborations

No.	Author Pair	Collaborations
1.	Kim, J. H. and Sohn, J. H.	9
2.	Kim, J. H. and Lee, S.-H.	8
3.	Lee, S. H. and Sohn, J. H.	8
4.	Kieu, M.K. and Le, N.B.	7
5.	Le, N.B. and Le, N.H.	7
6.	Kieu, M.K. and Le, N.H.	7
7.	Nguyen, V. A. T. and Nguyen, X. H.	7
8.	Nguyen, X. H. and Ninh, T. T. D.	7
9.	Kim, J. H. and Kwon, Y.-S.	7
10.	Nguyen, D. C. and Nguyen, X. H.	7

3.8. Co-occurrence analysis

A further science mapping method that uses "author keywords" is co-occurrence analysis. Considering the study aims to concentrate on the author's preferred method of conducting research, it contains terms that the author has utilized as keywords. Co-word analysis, which "was also undertaken by Jakhar et al.,[28]," creates themes or groups based on words that occur together. Because just those keywords are desired, just the ones that appear in at least six articles are utilized for the purpose of analysis.

keywords are frequently used by several writers to assess how a field of study is operating, and only powerful words may be examined. The point where the limit is reached by 112 characters. Ten groups were formed by co-occurrence analysis using Figure (24) and Table (8). A keyword's effect increases with the size of the circle; Industry 4.0 and Smart warehouse were mentioned 111 and 94 times, respectively. The keywords Data warehouse and Big data appeared 69 and 43 times,

respectively, and the Data mining appeared 31 times in a cluster (1) of red highlight words. The terms "Logistics" (42) and "Smart logistics" (29) are included in cluster (2) of green. Keywords like "Industry 4.0" (111) in a blue cluster (3), "Warehouse" (41), and "Internet of things (IOT)" (37), are highlighted. The gold-colour cluster (4) had terms like IOTt (81), Smart manufacturing (23 times), and Sustainability (21). Purple is cluster (5), and the terms are Blockchain (44), Supply chain (25), and Supply chain management (23). Sky bule is cluster (6), and the terms are Machine learning (57), Deep learning (26), and Computer vision (17). Orange is cluster (7), and the terms are RFID (49), Artificial intelligence (42), and Energy efficiency (11). Brown is cluster (8), and the terms are Smart warehouse (94), Digital twin (24), and Reinforcement learning (12). Pink is cluster (9), and the terms are Internet of things (75), Cloud computing (31), and Smart factory (21). Purple is Maroon (10), and the terms are E-commerce (12), and Clustering (7).

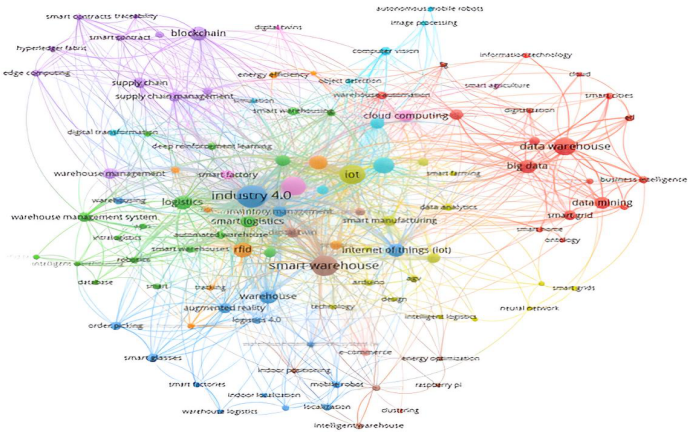

Fig. 24. Shows a map of the co-occurrence of keywords

Table 8
Various keywords formulated through co-occurrence analysis

Colour of cluster	Keywords	Link	Total link strength	Times appeared
Red	Data warehouse	25	72	69
	Big data	30	66	43
	Data mining	18	32	31
Green	Logistics	45	93	42
	Smart logistics	32	59	29
	Automation	42	62	27
Blue	Industry 4.0	72	228	111
	Warehouse	31	58	41
	Internet of things (IoT)	36	63	37
Gold	IOT	68	147	81
	Smart manufacturing	25	38	23
	Sustainability	18	26	21
Purple	Blockchain	33	95	44
	Supply chain	29	58	25
	Supply chain management	31	63	23
Sky bule	Machine learning	41	90	57
	Deep learning	28	49	26
	Computer vision	12	28	17

Orange	RFID	43	94	49
	Artificial intelligence	41	84	42
	Energy efficiency	3	5	11
Brown	Smart warehouse	64	156	94
	Digital twin	24	41	24
	Reinforcement learning	13	18	12
Pink	Internet of things	52	122	75
	Cloud computing	29	51	31
	Smart factory	25	35	21
Maroon	E-commerce	14	23	12
	Clustering	2	2	7

3.8.1. Thematic analysis

The co-occurrence analysis was used to create thematic clusters, as seen in Figure (25). This "was also studied by *Jakhar et al.,*[28]" Co-occurrence analysis is a science mapping approach concentrating around terms to develop clusters of different themes by categorizing keywords the fact that come together regularly. Every term was chosen in order to recognize the various themes that emerged. The reason is due to the simple reason that all keywords provide a more accurate image for theme creation, which considers the words used in the abstract, title, or keywords. Because the coverage of all keywords is greater than that of the author's keyword, phrases that featured in publications at least ten times were chosen for the thematic analysis. Phrases that appeared in documents more frequently were also considered. Although a keyword develops of greater significance in a specific area if it appears a minimum of 10 times in various papers, we need to assign it a weight of at least ten times before it appears in papers. Second, a hit-and-trial approach was used with varying weights; findings were easy to understand when the weight was ten times. A total of 315 words satisfied the minimum requirement, which assigned weight to keyword occurrences. Six clusters in all were created. Theme 1 talks about the Red Cluster concentrates on the physical layer and stands for robotics, the Internet of Things, and automation technologies, such as RFID, deep learning for control, and driverless cars, all of which are essential to real-time warehouse operations. Theme 2 aims to the green cluster stands for business intelligence and data management. This cluster highlights the strategic analysis necessary for sound decision-making and incorporates ideas like data warehouses, Big Data, data mining, and artificial intelligence. Theme 3 is all about the Blue Cluster connects these two by focusing on the idea of the "smart warehouse," which includes inventory control and warehouse management (WMS) technologies that coordinate the sophisticated physical assets. Theme 4 is all the Purple Cluster, which emphasizes cyber-physical systems and comprehensive supply chain management, places these technologies in the framework of Industry 4.0 and Supply Chain Integration. Theme 5 is all the Yellow Cluster emphasizes blockchain and decentralized technologies, emphasizing how smart contracts may improve security and trust. Theme 6 is all the recognizing the significance of ergonomics and human-robot collaboration in increasingly automated contexts, Light Blue Cluster Tackles Human Factors and Emerging Concepts. These six concepts collectively show how network integration, data intelligence, and physical automation are combining to shape logistics in the future. The same idea applies to analysis here as it does to cooccurrence; that is, a word is given more weight the larger the circle, which is visible.

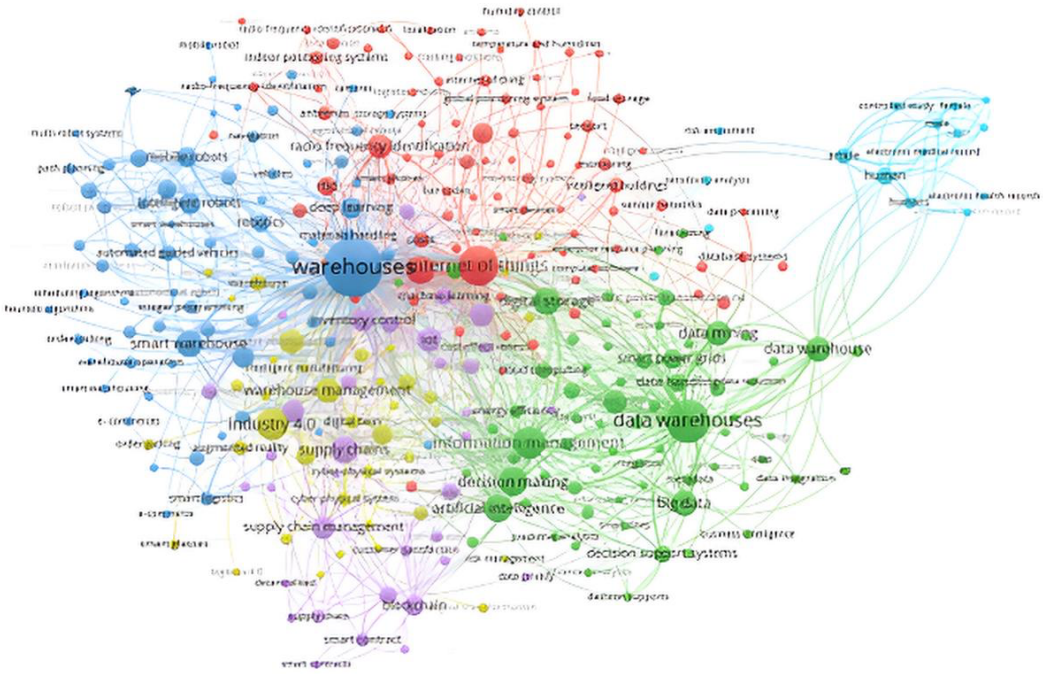

Fig. 25. Shows a map of co-occurrence analysis to form themes through all keywords

3.9. Thematic evolution

Thematic evolution is used to determine the direction of the trend, the diversification of the subject throughout time, and the paradigm change. Time is broken down into groups in theme progression in order to examine changes across time. Based on the Figure (26), analysis of publication trends and key research topics, the thematic evolution of smart warehouse has progressed through distinct phases. Early foundational work, primarily in the pre-2000s, was focused on legacy ideas like data warehouses and warehouses, as well as structural management. The research's initial foundation is the theme of warehouses, which first surfaced in the 1970s and 1990s, along with data warehouses and information management. Another early significant notion that reflects early attempts to mechanize processes is automation. As the field matured, transition and integration from 2 000s to Early 2010s, the research shifted its focus for "smart" systems is laid during this time by the significant emphasis on operational and data-driven improvements. Themes related to supply networks and warehouse management become more prevalent, suggesting a more comprehensive systems approach that extends beyond the warehouse floor. As the first significant wave of real-time tracking and data capture integration into logistics, radio frequency identification (RFID) emerges as a crucial technology term. Data mining emerges as a crucial term, highlighting the trend toward using the growing volume of stored data to inform decisions. Finally, the most recent and modern era of digital and intelligent systems in publications since mid-2010s Onwards, Industry 4.0 and AI-driven technologies, which are prevalent in the most recent era, are closely related to the idea of a "smart warehouse." Artificial intelligence (AI), big data, and the internet of things (IoT) have all seen rapid increases in popularity in recent years and are now the most researched subjects. These terms stand for the modern smart warehouse's drive for real-time networking, massive data processing, and cognitive decision-making. As a key element of a completely digitalized supply chain, the warehouse is housed within the macro-level frameworks of industry 4.0 and smart manufacturing. In general, the theme progression shifts from emphasizing early automation and structural management (warehouses, data warehouses) to operational efficiency and data collecting (RFID, data mining), and ultimately to fully developed intelligent and linked ecosystems (IoT, AI, Big Data).

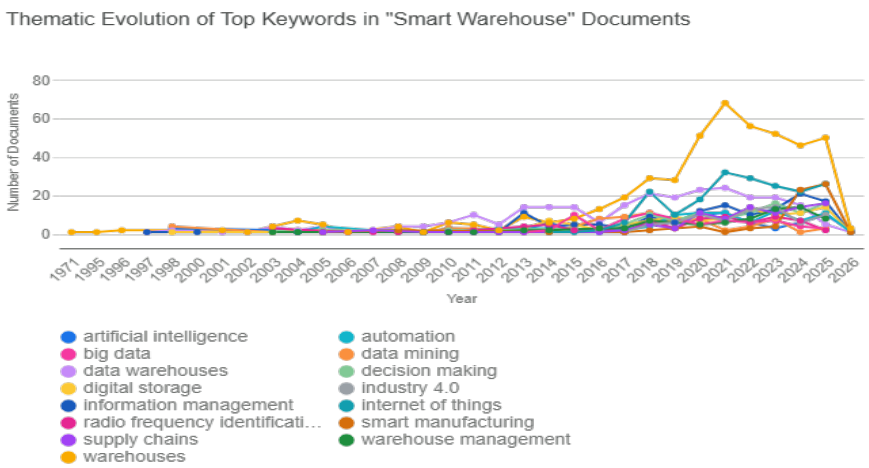

Fig. 26. Showcases thematic evolution

3.10. Discussion

Through offering a thorough bibliometric analysis of smart warehouse research, which methodically maps the field's intellectual structure, publishing patterns, and thematic evolution, the current study has significant advantages for both academia and practice. The bibliometric review's topic structure and keyword co-occurrence analysis reveal ideas that closely align with the recognized knowledge and practice gaps in the implementation of smart warehouses. A significant cluster associated with corporate intelligence and data management consists of big data, data warehouses, data mining, and artificial intelligence (AI). Prominent keywords include phrases like "Big data" (43 times) and "Data warehouse" (69 times). Big data integration and the trust issue with outsourcing software for handling private shipping information. The bibliometric dominance of "Big data" highlights its crucial function and indicates that one of the main and ongoing study areas for smart warehouses is closing the knowledge and trust gap for this technology. For the clear flow of products status information to departments like sales and marketing, the software must be trusted to make choices. One of the important terms in the keyword co-occurrence group associated with "Artificial intelligence" is RFID (49 times). As the first major wave of real-time monitoring and data capture integration into logistics, it is also recognized as a key technological phrase in the thematic progression. In the thematic analysis, the physical layer and automation technologies such as RFID and robots are the emphasis of the Red Cluster. The significance of RFID as a crucial automation technology is validated by the bibliometric study. Because of its crucial significance, a lack of knowledge about its capabilities and compatibility with the Internet of Things (IoT) would seriously hinder warehouse operations optimization and result in company loss. The terms "Industry 4.0" and "Smart manufacturing" are grouped with the terms "Internet of things" (IoT) (37 times) and "IOT" (81 times). The latest thematic progression places a strong emphasis on IoT, AI, and Big Data, which stand for the contemporary push for intelligent systems and real-time networking. The Blue Cluster coordinates the advanced physical assets and focuses on the "smart warehouse" idea. IoT is a key technology for smart warehouses, according to the bibliometric analysis. The right warehouse architecture is a problem to adopt as IoT-based infrastructure needs to be customized based on the unique features of warehouse operations in order to be as performant as possible. The theme analysis's Light Blue Cluster focuses on Human Factors and new ideas, acknowledging the importance of ergonomics and human-robot cooperation in automated settings. Employees that are implementing smart technologies must possess the abilities to operate efficiently with smart

machines and gadgets, including multitasking, reactivity, adaptability, and dependability. According to bibliometric research on human factors, technological implementation is not enough on its own; human utilization of technology is essential for achieving productivity gains and running a smart warehouse successfully. Making decisions is specifically mentioned as a major area of attention in the theme progression. It is emphasized that organizational elements, such as the dedication and mentality of upper management, are critical to the success of creative ventures. This is corroborated by the bibliometric study, which highlights the strategic and organizational elements of adopting smart warehouses, where a lack of commitment at the highest level of the organization is a barrier. Hence, the bibliometric analysis validates the emphasis of this study by confirming that the issues raised by Big Data, RFID, IoT, talent, and top management commitment are fundamental and developing research themes in the worldwide smart warehouse literature. All of the results suggest that a comprehensive digital transformation is required, one that includes not only the technology (Big Data, RFID, IoT), but also the vital organizational and human elements (talent and top management pledge).

4. Conclusions

To enable readers to better comprehend the field of smart warehouse, the paper's main objective was to perform a bibliometric study of the data gathered. The study's path, theme development and evolution, network analysis, and smart warehouse patterns were the main topics of the current study. Relevant data was gathered with the use of the bibliometric analysis about the Smart warehouse and to uncover the topic's various warehouse, smart warehouse, industry 4.0 and more. This bibliometric analysis on Smart warehouse highlights the progressive development of research in this field, with a steady increase in publications from 1971 to 2026, indicating its growing academic and industry relevance. According to the bibliometric study, the subject of smart warehouse research is expanding quickly, as shown by the notable rise in yearly publications, which peaked in 2024 at 249 papers. In terms of publication volume, China and India lead the research landscape geographically with 360 and 264 papers, respectively, but countries with the greatest average article citations include Iran and Papua New Guinea. Lecture Notes in Computer Science, including the subseries Lecture Notes in Artificial Intelligence, Lecture Notes in Bioinformatics, and Lecture Notes in Networks and Systems, are among the leading publications for scholars wishing to publish in this field. With 14 publications, Anon, J.C. R. is the most productive individual author. A number of fundamental topics that have developed over time establish the conceptual framework of the subject of study. The most common terms, as determined by co-occurrence analysis, are Industry 4.0 (111 times), Smart Warehouse (94 times), and IOT (81 times). From the pre-2000s foundational work on warehouses and data warehouses to the 2000s and early 2010s integration phase centered on RFID and data mining, thematic evolution demonstrates a progression. Concepts pertaining to Industry 4.0, Artificial Intelligence (AI), Big Data, and the Internet of Things (IoT) have taken center stage in the most recent era (from the mid-2010s forward), indicating a push for real-time, enormous data processing and cognitive decision-making systems. Citation analysis also identifies highly influential articles by separating locally cited works that are most relevant to the smart warehouse domain, like "Design and application of Internet of things-based warehouse management system for smart logistics" (14 local citations), from globally cited works that have an impact on many fields, like "Five-dimensional model of digital twin and its applications in ten fields" (812 citations).

The companies able to successfully implement smart warehouses in order to comply with Industry 4.0 and attain maximum operational efficiency; yet, this process is severely impeded by clear knowledge and practice gaps. The study specifically found practical issues arising from insufficient

IoT infrastructure and the reliance on robust network connectivity (4G/5G), as well as a crucial lack of knowledge about the efficient implementation of Big Data and RFID technologies. Important non-technical variables also play a key role in effective implementation, such as the need for staff to be upskilled in multitasking and technical skills to handle automation, as well as the requirement for top management to demonstrate a clear and strategic commitment to allocating capital and labour. Confirming the increasing academic significance and complexity of smart warehouse technology, the bibliometric analysis also found that the research field is maturing, moving thematically from early concepts like "Automation" to the current focus on AI, IoT, and Big Data. Key publications are coming from all over the world. For smart logistics to reach its full potential and improve economic performance, these knowledge, practice, and structural gaps need to be filled.

The bibliometric review's thematic structure and keyword co-occurrence analysis elucidate concepts that closely correspond with the identified knowledge and practice deficiencies in the execution of smart warehouses. A prominent cluster related to corporate intelligence and data management includes big data, data warehouses, data mining, and artificial intelligence (AI). Notable keywords encompass terms such as "Big data" (43 occurrences) and "Data warehouse" (69 occurrences). Integration of big data and the trust concerns associated with outsourcing software for managing confidential shipping information. The bibliometric preeminence of "Big Data" underscores its vital role and suggests that a primary and persistent research focus for intelligent warehouses is bridging the knowledge and trust gap associated with this technology. To ensure a seamless dissemination of product status information to departments such as sales and marketing, the software must be reliable in its decision-making. A significant term in the keyword co-occurrence group related to "Artificial Intelligence" is RFID, appearing 49 times. The initial significant wave of real-time monitoring and data capture integration in logistics is seen as a pivotal technological phase in thematic development. The theme analysis highlights the physical layer and automation technologies, including RFID and robotics, as the focal point of the Red Cluster. The bibliometric analysis confirms the importance of RFID as a vital automation tool. The absence of understanding regarding its capabilities and interoperability with the Internet of Things (IoT) would significantly impede the optimisation of warehouse operations and lead to corporate losses. The terms "Industry 4.0" and "Smart manufacturing" are associated with "Internet of Things" (IoT) (37 occurrences) and "IOT" (81 occurrences). The most recent thematic development highlights IoT, AI, and Big Data, representing the current drive towards intelligent systems and real-time connectivity. The Blue Cluster orchestrates modern physical assets and emphasises the concept of a "smart warehouse." The bibliometric study indicates that IoT is a vital technology for smart warehouses. Optimal warehouse architecture is a challenge, as IoT-based infrastructure must be tailored to the distinctive characteristics of warehouse operations to maximise performance. The Light Blue Cluster of the thematic analysis emphasises Human Factors and innovation, recognising the significance of ergonomics and human-robot collaboration in automated environments. Employees using smart technologies must possess the skills to function effectively with intelligent machines and devices, including multitasking, responsiveness, adaptability, and reliability. Bibliometric research on human factors indicates that technological deployment alone is insufficient; effective human engagement with technology is crucial for realising productivity enhancements and efficiently operating a smart warehouse. The act of decision-making is explicitly identified as a significant focus within the theme progression. Organisational factors, including the commitment and mindset of senior management, are essential for the success of creative initiatives. The bibliometric analysis substantiates that the strategic and organisational factors in adopting smart warehouses are impeded by insufficient commitment from top management. Consequently, the bibliometric analysis substantiates the focus of this study by affirming that the concerns associated with Big Data, RFID, IoT, talent, and top

management commitment are essential and evolving research themes in the global smart warehouse literature. The findings indicate that a thorough digital transformation is necessary, encompassing not just technology (Big Data, RFID, IoT) but also essential organisational and human factors (talent and executive commitment).

The results that have important ramifications for both scholars and practitioners, the bibliometric study of the smart warehouse domain offers a thorough and organized comprehension of its academic environment. By identifying the most popular publication sources, including Lecture Notes in Computer Science and Lecture Notes in Networks and Systems, the study was able to map the fundamental conceptual framework of the subject and point researchers in the direction of the most pertinent dissemination channels. Additionally, the study identifies the top countries in terms of citation impact (Papua New Guinea and Iran) and publication volume (China and India). A better understanding of the worldwide leadership in research is provided by this differentiation between volume and influence. A vital resource for both new and experienced scholars, identifying important and influential writers offers a critical starting point for monitoring foundational contributions and promoting academic networking. One of the main implications is that sophisticated scientific mapping reveals the intellectual underpinnings and thematic evolution of the field. From early ideas like automation and data warehouses to the present, prominent focus areas of Industry 4.0, artificial intelligence (AI), big data, and the internet of things (IoT), co-occurrence analysis vividly illustrates the development of the subject. In order to ensure relevance and effect, researchers may immediately match their work with basic knowledge and developing trends with the help of this useful thematic analysis. In addition, the citation analysis helps researchers compile a highly curated and trustworthy body of literature, thereby reshaping their research agendas for increased efficacy and efficiency by differentiating between local (papers specifically pertinent to the smart warehouse domain) and global citations such as documents with broader, cross-sector impact. Lastly, the results have significant strategic ramifications on a global and cooperative level. A deeper comprehension of the regional distribution of knowledge and quality is made possible by the obvious grasp of worldwide leadership in research production and influence. This understanding may then be used to improve institutional resource allocation and international partnership plans. The study helps scholars find possible collaborators and critical works more rapidly by laying the foundation for networking and literary synthesis through the identification of significant contributions. All things considered, the thorough information obtained from this study acts as a crucial intellectual road map, guaranteeing that upcoming researchers will be prepared to successfully digital warehouse the field of smart warehouse research and make significant contributions to its ongoing development in light of worldwide technological advancement.

The current study has limitations. This study's findings were not generalizable to other situations, mainly because it only looked at papers that were included in the Scopus database. Thus, employing larger databases, like Web of Science or Google Scholar, may yield fascinating insights for future research. This restriction reduces the range of insights and can leave out significant works in the field of smart warehouses that were not included in Scopus. Future studies might therefore broaden the bibliometric mapping by integrating many databases, enabling more comprehensive coverage, improved cross-validation of results, and more cross-disciplinary generalizability. Quantitative bibliometric variables including publishing trends, co-occurrence, co-citation, and topic progression were the main focus of this study. Deeper qualitative facets of customer experiences and management techniques are not captured by these approaches, despite the fact that they offer insightful information about structural patterns. To provide deeper theoretical and practical insights, future research might use a mixed-method approach that combines bibliometric mapping with content analysis or systematic literature reviews. The study also has limitations in insufficient

coverage of emerging technologies. The impact of developing technologies, such AI-driven customization, which are significant technical advancements, has not been adequately covered in the literature far. Examples of these technologies include academic progress connected to the topic. In order to predict new research directions and real-world difficulties in the smart warehouse ecosystem, future studies should broaden the scope of bibliometrics by integrating thematic evolution of smart warehouse, trend of digital warehouse study, and trend of clusters of keywords.

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