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Evaluating the Importance of Radio Frequency Identification (RFID) in Warehouse Operations for Army Supply Readiness

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Abstract

Modern military logistics rely on technology to optimise warehouse operations and sustain operations during both peacetime and wartime. However, the problem with the existing army WMS is that it cannot afford to meet the current operational requirement causing inefficient warehouse operations. While existing research highlights the benefits of RFID technology in supply chain management, its impact on army warehouse operations and supply readiness remains unexplored. This study aims to evaluate the importance of RFID technology in army supply readiness warehouse operations, with the ultimate goal of improving the current WMS-RFID integration. The study utilises basic qualitative research by examining quality journals and articles. This research analyses data from 21 related articles, identifying recurring themes of RFID potential. The analysis revealed that the implementation of RFID technology in warehouse operations has the potential for improvement, with a perceived score: receiving (26%), shipping (21%), picking (20%), put-away (16%), record keeping (12%), and packaging (5%). The result reveals that there are 4 performance metrics for measurement: cycle time reduction, improved process quality, reduced cost, and increased productivity. These metrics translate to enhanced warehouse operations activities to achieve army supply readiness. Notably, quality improvement has the greatest impact, followed by cost reduction, cycle time, and productivity. Ultimately, we anticipate that complete automation of the CODIMS-RFID system in army depots will boost army depot performance by facilitating real-time asset tracking, eradicating errors, and simplifying processes, ultimately boosting army supply readiness.

Keywords: RFID, Warehouse Operations, Military, Readiness

Introduction

In military context, readiness is always the first priority for any operation, and it projects the army's will and capability to fight, acting as a deterrent against any opponent (Hale, 2016). It is about the availability of stocks, including supplies, spares, or materials required by a military organisation to support operating units during peacetime or wartime activities (Wong et al., 2018; Mustapa et al., 2020). In terms of military architecture, the high availability of stocks will provide the capability required to maintain their designated mission in order to remain at the frontline (Wong et al., 2018). Therefore, stocks must be sufficient to provide for the unexpected as well as to satisfy normal consumption rates, and production lines must operate for as long as necessary to sustain the flow of material from factory to battlefield (Karim et al., 2017). Any shortage poses significant risks of substantial losses, surrender, withdrawal, or an increase in intensity against the forces. Maintaining a balance between having enough stock supply to meet demand without overstocking is crucial to prevent shortages or excess inventory. Therefore, warehouses or depots are designed as buffers to control supply and demand variations (Frazelle, 2016). These storage facilities are meant to keep, hold, handle, and distribute goods, raw materials, or items for a certain period (Kress, 2016; Dissanayake et al., 2020; Ambrosio et al., 2022).

However, the exhausting tasks in warehouses have put pressure on organisations to implement automation technology to enhance the traceability of incoming and outgoing products, thereby achieving high responsiveness in customer fulfilment (Garavito-Bejarano et al., 2023; Ghafar and Mohamad, 2023). Due to the high investment of cost for the adoption of technology, most organisations consider partial automation as an alternative. Thus, the absence of integration between the warehouse's physical stock and the warehouse's WMS has caused inefficient order workflow (Abhishek and Pratap, 2020). When WMS is unable to trace item movement across the supply chain, a high frequency of data errors may occur in item records, subsequently leading to poor stock visibility. It is because operators manually input data into WMS, which can increase the chances of human error. Without proper automation equipment such as RFID, barcode scanners, and pick-to-light, it may cause inaccurate recording of items during pre-receipt and increase order queuing times during data transfer into WMS (Setayesh et al., 2022; Ghafar and Mohamad, 2023). Information accuracy is critical in decision-making for an organisation to fulfil orders. Processing inaccurate data on product availability can lead to the establishment of inaccurate information for the customer, thereby causing a delay in delivery or an order not being fulfilled.

The Malaysian army (MA) currently utilises WMS to monitor and control their logistics supplies, such as food supplies, spare parts, apparel, and equipment. The management employed several logistic modules system including Computerised Ordnance Inventory Management System (CODIMS) to expedite warehouse operations, but significant inefficiency in warehouse operations has been perceived, resulting in delayed deliveries (Samad et al., 2019; Mustapa et al., 2020). The root cause of inefficient warehouse operations stems from the ineffective use of WMS, primarily due to inefficient flow of product and information, causes unavailability and delay in distribution of goods. The problem with the current WMS is due to manual data entry of product, a shortage of operators during receiving, insufficient storage space in depots, and system breakdown (Zainal, 2006). However, the major concern is the manual inputting of data, which can result in human errors in data entry such as incorrect items or quantities, and increase the waiting time for product to be

processed. Seifermann et al. (2014) highlighted that the relevance of warehouse automation is derived from the potential for human errors during manual processing. The human error is the result of repetitive nature which is physically demanding and exhausting activities (De Lombaert et al., 2022).

Due to that, the army depot has been under significant pressure to improve its WMS with a reliable automation technology. Therefore, the aim of this investigation is to evaluate the importance of RFID applications in the context of army supply readiness warehouse operations. The lack of knowledge on the importance of RFID application towards MA readiness demands a more detailed study. The study further contributed to the measurement of automation technology application in warehouse operations by presenting the benefits as an indicator concerning automation technology reliability.

Literature Review

Warehouse Operations

In the supply chain, a warehouse works as a buffer that lets organisations quickly respond to changes in the competitive market caused by unexpected shifts in demand (Çelik et al., 2022; Calzavara et al., 2019). They play a crucial role in ensuring the successfull distribution of products and have become a core business function for most organizations. The function depends on the type of warehouse, including commercial and non-commercial. The commercial warehouse provides storage services for business, but the non-commercial warehouse provide support for the public and sectors (i.e., a warehouse for disaster management), as well as the Armed Forces (Richards, 2018). Specifically, the Armed Forces type of inventories held in their depots are inventories that comprise of supplies that are not a part of the product itself (e.g., oils and lubricants, machinery and plant spares, tools and fixtures, etc.) but are necessary for maintenance, repairs, and operations, and finished goods inventories ready for military use (Richards, 2018). These inventories are distributed to the military personnel to maintain their capability to operate in the field. **Figure 2** illustrates the level of supply system within the distribution network flow.

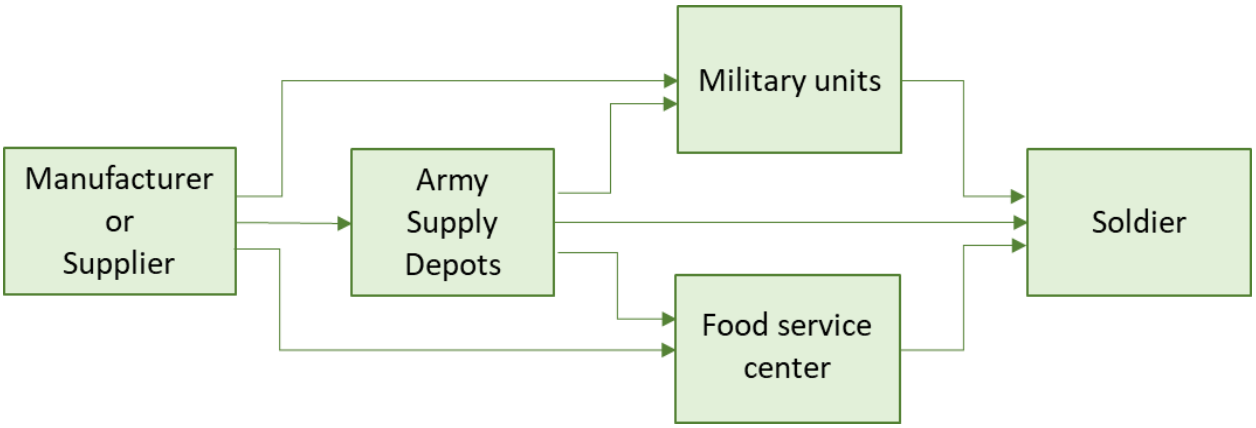

Figure 1: General Structure of Distribution in Army Supply Depots (Karim et al., 2017).

The most challenging task faced by warehouses is managing the ongoing activities of their operations (Kembro et al., 2018). Operations play a crucial role in the performance of supply chain warehouses, as effective operations enhance system performance (Halawa et al. 2020). The four most common warehouse operations activities include receiving, putting away, or storing, order picking, and shipping (Istiqomah et al., 2019; Slavkovic et al., 2022).

Measuring Warehouse Performance

Efficient and effective warehouse operations are critical for any organisation's success. Information regarding products, resources, and processes that is accurate and timely is essential for executing a plan and control structure that accelerates warehouse operations to their maximum efficiency and effectiveness (Vishnu, 2016). Efficient logistics, including warehouses, allow manufacturers to minimise delays that can be avoided, thereby causing the output per unit of time to be increased and reduced cost (Blancas et al., 2014). Thus, enhancing WMS capability with automation equipment will increase efficiency and effectiveness as well as enhance warehouse operations (Chow et al., 2006; Li, 2008; Vishnu, 2016). Warehouse can be measured by observing certain performance indicators. According to researchers, there are four distinct categories by which organisations evaluate logistics performance metrics: quality, cost, cycle time, and productivity (Kumar, 2013; Staudt, 2015; Vellian, 2020). Kumar (2013) identified logistics performance evaluation as follows: logistics quality (e.g., items damage and inventory accuracy), logistics cost (e.g., expenses and return on assets), logistics cycle time (e.g., in-transit time and order entry time), and logistics productivity (e.g., orders shipped per hour and transport container utilization). Therefore, these 4 metrics are useful to measure the performance of WMS-RFID implementation by assessing their operational capability, efficiency, and effectiveness.

Technology Utilisation in Warehouse Operations

To promote efficiency and effectiveness, technological advancements have simplified warehouse data processing. An organisation requires a warehouse management system (WMS) to plan and organize warehouse activities act as a database information system. However, none of the WMS has been able to completely eradicate human error-caused, such as miscounting (Helm et al., 2023). This is because the technology system heavily relies on manual input of operation information into the system or the bar-code system, which inherently exposes the data to human error (Poon et al., 2009). Hong-ying (2009) stated that inputting product information either by hand or in writing would result in many data errors and reduce the process's reliability. Due to that, some organisations have to hire more labours to carry out inspection jobs to prevent errors that lead to an increase in labour costs, a reduction in directive processing speed, and eventually a drop in organisational benefit (Hong-ying, 2009). In recent decade, there has been a significant evolution in RF technologies with the ability to track and trace supplies either through transportation or within factories and warehouses (Schrauf and Berttram, 2016). Information is made more accessible to warehouse through technologies such as RFID etc. which provide timely information on incoming goods, quantities, weight etc (Christiansen, 2015). This technological advancements have increased productivity, led to higher accuracy in warehouse operations (Richards, 2018). A study by Teixeira et al. (2020) found that integrating WMS-RFID in a cargo warehouse has significantly optimised receiving processes of checking, identifying batch, and expiration products that are time-consuming. Another study by Chen et al., (2013) found that introducing RFID technology integrate with lean principle has reduce operation time by 87% as a result of process reengineering. Thus, integrating RFID technology with WMS surely enhances product flow and enables forces to sustain themselves during peacetime or war time.

Radio Frequency Identification

Today, radio waves have facilitated the transfer of data and function as wireless communication technologies, which can have a high influence on various industries ranging from retail to manufacturing, healthcare, logistics, and defense (Ustundag, 2013; Costin et al., 2015). RFID tag has the capability to trace and track item across supply chain (Christoper, 2023). It is a wireless automatic identification and data capture technology consisted of three parts: an identification tag, a reader, and a computer (Oh et al., 2012). The function starts with reading a tag using two-way RFID handheld terminals or RFID readers and antennas placed on shelves (Ustundag, 2013). They stated that the tags can be active (battery-powered), passive (battery-assisted), or semi-passive (no battery). Attaching an object to this tag provides readable data for object identification and tracking. The RFID reader then reads RFID tags to gather and transmit information wirelessly, without necessarily being in the tag's direct line of sight. Additionally, the memory capacities of the tags are discrete, varying from a small license plate to thousands of records. The fundamental characteristics of using the RFID application in warehouse operations are automated reading, multiple readings of the tags, robust reading, record keeping and retrieval, and real-time tracking of the items (Chen et al., 2011).

RFID Benefits in Warehouse Operations

Researchers emphasised how RFID can significantly improve warehouse operations by streamlining processes, minimising waste, and enhancing efficiency. Investigation of the literature review found that the benefits of RFID are subdivided into two categories, which are based on the implementation of RFID in the real world and the conceptual use of RFID. Based on 21 articles examined, there are 25 benefits of RFID applications perceived in warehouse operations listed in **Table 1**.

Table 1
Literature of RFID benefits Warehouse Operation

RFID Implementation Benefits	**Articles Published**
Reduce labour cost	Chen et al., (2011a); Chow et al., (2006); Li (2008)
Accuracy item tracking	Chow et al., (2006); Li (2008); Morris and Glover (2007)
Increase inventory accuracy	Vishnu, (2016); Oh et al., (2012); Delaunay et al.(2007)
Accuracy of information	Li (2008); Poon et al., (2009); Yan et al., (2008)
Reduce inventory shrinkage	Oh et al., (2012); Doerr et al. (2006); Delaunay et al.(2007)
Timely information	Doerr et al. (2006); Sarac and Absi (2010); Brintup et al. (2010)
Increase throughput productivity	Li (2008); Ngai et al., (2007); Attaran (2012)
Reduce material handling	Morris and Glover (2007); Poon et al., (2009)
Improve product quality	Attaran (2012); Osyk et al., (2012); Lim et al., (2013)
Reduce loss of sale	Osyk et al., (2012)
Reduce inventory cost	Sarac and Absi (2010)
Reduce picking time	Vishnu, (2016); Chow et al., (2006)
Reduce inspection time	Chow et al., (2006); Sabbaghi and Vaidyanathan (2008)
Reduce receiving time	Chen et al., (2011a); Chen et al., (2011b)
Reduce packing time	Chen et al., (2011b); Zeimpekis et al., (2010)

Reduce shipment time	Chen et al., (2011a)
Accurate shipment	Chow et al., (2006); Oh et al., (2012)
Increase labour productivity	Chen et al., (2011a); Osyk (2016); Ngai et al., (2007)
Reduce put away time	Sabbaghi and Vaidyanathan (2008)
Accuracy in checking	Oh et al., (2012)
Accuracy in put away/picking	Osyk (2016)
Space utilization cost	Osyk (2016); Lim et al., (2013); Wang et al., (2010)

The Army's Supply Readiness

It is essential to maintain a balance between the availability of supplies and the requirements of the army in order to enable army units to sustain themselves at the front line through the effective use of WMS. The integration of WMS with RFID provides additional advantages by streamlining the flow of information and products, which in turn facilitates warehouse operations in ensuring that orders are delivered in full and on time. Ensuring the timely full delivery of an order, it is necessary to maintain an adequate stock level and ensure the accuracy of the receiving, inspecting, and recording processes. The availability of stock like food and water ensures that their members maintain optimal physical and mental health, as well as operational readiness (Marta and Malgorzata, 2020). Without automation technology support, the entire operations process will be affected due to insufficient of product information in real-time and exact location (Ghafar and Mohamad, 2023. Thus, the integration of RFID is expected to enhance the availability of supplies in the facilities by optimising warehouse operations and eliminating non-value-added activities, which enhances the state of readiness.

Research Method

The study employed basic qualitative research. The qualitative data of the study is based on the analysis of textual data from various sources, including journals and articles. The RFID criteria need to be developed to gain insight on the technology implementation, as they have not been applied in army depots. This basic qualitative research is interested in collecting documented data on how users of the RFID application describe their experience, how they have used RFID in warehouse operation, and what are the important benefits that relate the RFID application with the Army’s supply readiness, especially in warehouse operation. Numerous articles were examined using keywords such as RFID and Warehouse. The review process determines the selection process, size, and scope of the article. An overview of existing research is performed following the collection of articles from journals, articles, and internet databases like Scopus, IEEE, Emerald, and ScienceDirect. In this qualitative research, the sample selection is non-random, purposeful, and involves small sampling. Only 21 out of 215 journals and articles identified related to the topics were analysed. The sampling site is limited to topics that relate to the importance of RFID applications in warehouse operations. These journals and articles were analysed through the collection of, which involves identification of repeated sampling, and collections of data and patterns by dividing the data into their categories (Bougie, 2013). The data from articles is gathered and analysed using thematic analysis, which entails detecting, assessing, and documenting patterns or themes from the collected data (Braun and Clarke, 2006). The process includes the following steps:

- Familiarisation with the data through reading and re-reading the collected materials.
- Creating initial codes involves significant information related to the research objectives.

- Identifying themes by gathering codes together to create possible themes.
- Evaluating themes to ensure their logical consistency and unique characteristics.
- Defining and naming themes to represent the fundamental nature of each theme

Understanding the perspectives of both RFID users and researchers greatly contributed to the overall interpretation of the study. Therefore, the ultimate aim of the study is to reveal and interpret these criteria that impacted army supply readiness.

Results and Discussion

This study aims to capture the perceived benefits of using RFID in warehouse operations processes and were then evaluated the importance of RFID in warehouse operations. The articles were carefully reviewed to come up with a list of RFID benefits and warehouse operations core activities, derived from the previous work. Due to that, a matrix was formed to evaluate the benefits that frequently mentioned in the selected journals and articles as reported in the literature. After reviewing the selected articles, it is identified that there are a significant number of RFID benefits impacting warehouse operations acknowledged by researchers. Out of 21 articles reviewed, 22 major RFID benefits have been detected and listed in the matrix form.

Table 2 illustrates the widespread acceptance of RFID benefits across various warehouse operations, as reported in the literature. Based on the analysis, many articles acknowledge that the RFID application plays an important role as an enabler to the warehouse core activities. The result of analysis revealed that the receiving activities score stands at 26%, with shipments at 21%, picking at 20%, putting away at 16%, maintaining records and documents at 12%, and packaging at 5%. These results highlighted the widely perceived benefits with RFID applications, according to the article's publication. The results differentiate the ranking affecting the warehouse core activities. Therefore, by prioritising these core activities, organisations can make strategic decisions to maximise their organisation performance while considering the benefits of RFID technology and achieving their overall goals for efficiency and effectiveness.

Table 2
Warehouse operations Benefits Perceived from RFID Implementation

Warehouse operations benefit perceived from RFID implementation	No' of Published Articles					
	Receiving	Put Away	Picking	Packaging	Shipping	Document
Reduce labour cost	10	6	8	1	8	4
Accuracy item tracking	6	5	5	1	5	4
Increase inventory accuracy/visibility	6	4	4	1	4	2
Accuracy of information	7	6	6	1	7	4
Reduce inventory shrinkage	6	2	2	1	3	1
Timely information	5	1	2	1	3	2
Increase throughput productivity	3	1	2	0	3	1
Reduce material handling	2	3	4	1	2	2
Improve product quality	3	3	3	2	3	2
Reduce loss of sale	3	3	3	0	4	1
Reduce inventory cost	3	3	2	1	3	1
Reduce picking time	2	1	3	0	2	2
Reduce inspection time	2	1	2	0	2	1
Reduce receiving time	2	0	0	1	1	1
Reduce packing time	2	0	2	1	0	0
Reduce shipment time	1	1	1	0	1	1
Accurate shipment	2	0	1	0	1	0
Increase labour productivity	1	1	2	0	1	0
Reduce put away time	1	1	1	0	1	1
Accuracy in checking	1	0	0	0	0	0
Accuracy in put away and picking	1	1	1	0	1	0
Space utilization cost	1	1	1	1	1	1
Total article highlighted	**71**	**45**	**56**	**13**	**57**	**33**
% of article perceived	**26**	**16**	**20**	**5**	**21**	**12**

Table 3 categorises RFID benefits into four performance metrics. The metrics were subsequently ranked according to their perceived acceptance, which was determined by evaluating the frequency of benefits documented in the literature. The findings reveal that item tracking accuracy at 10% is the most advantageous component of the criteria, accounting for 38% of the quality scoring breakdown. Secondly, the cost evaluation is 31%, with the most significant positive impact on labour costs at 14%. Thirdly, the cycle time scoring is 24%, with the highest potential contribution in the timely information at 6%. Lastly, the productivity score of 7% has the most beneficial impact on the increase in throughput productivity at 5%. Consequently, the results will offer insight into the most significant benefit that is perceived when RFID technology is implemented in an army depot. Understanding these criteria contributes to better decision-making for structuring and optimizing warehouse operations to improve army supply readiness.

Table 3
Evaluation on RFID Benefit Perceived in Warehouse Operations based on Articles Publication.

Performance Metrics (%)	RFID Indicator	Benefit Perceived (%)
Cycle Time (24%)	Timely information	6%
	Reduce material handling	5%
	Reduce picking time	3%
	Reduce inspection time	2%
	Reduce receiving time	2%
	Reduce shipment time	2%
	Reduce packing time	2%
	Reduce put away time	1%
Quality (38%)	Accuracy item tracking	10%
	Accuracy of information	9%
	Increase inventory accuracy	9%
	Accurate shipment	2%
	Improve product quality	4%
	Accuracy in checking	1%
	Accuracy in put away and picking	1%
Cost (31%)	Reduce labour cost	14%
	Reduce inventory shrinkage	7%
	Reduce loss of sale	4%
	Reduce inventory cost	4%
	Space utilization cost	1%
Productivity (7%)	Increase throughput productivity	5%
	Increase labour productivity	2%

RFID Potential in Specific Warehouse Functions

The results presented in Table 2, show that RFID technology is beneficial to warehouse core functions in ensuring product flow and information flow. Enhancing this flow is crucial to the successful of distribution system in warehouse operations in order to maintain high order fulfilment with timely full delivery of orders. The positive contribution of RFID application in warehouse operations are discussed according to the percentage value acquired as follows:

a. *Receiving (26%)*. Receiving is perceived as the vital core function of warehouse operations. Upon the arrival of incoming stock, RFID facilitates warehouse operations by providing timely transfer of accurate data information, which leads to reducing receiving and inspection times. The timely information helps to improves inventory accuracy and minimizes shrinkage. With the ability to track item accurately reduces the necessity for material handling. This technology streamlines warehouse operations, allowing operators to verify documents automatically, which guarantees a seamless product flow.

b. *Shipping (21%).* The second vital core function is Shipping, regarded as the final warehousing process. The system optimizes shipping operations by providing real-time information and accurate tracking data. This real-time data facilitates the tracking of item

transit from the shipping area to the customer location. This real-time information mitigates errors arising from incorrect invoicing or wrong delivery locations.

c. *Order Picking (20%)*. The third vital core function is order picking. RFID offers real-time inventory visibility, directing pickers to correct item locations. Inventory visibility is based on accurate RFID information, which helps pickers efficiently travel within the warehouse, resulting in a decrease in picking time and minimising material handling. The optimised process substantially reduces labour costs.

d. *Put-Away (16%)*. In put away process, organizing inventory requires WMS to pre-assign product locations and provide information to operators regarding product placement (IIMM, 2020; Richard, 2018). However, RFID tags deliver accurate location information, directing operators to the correct storage locations. This information helps optimize the warehouse layout and ensure efficient storage and retrieval processes, minimizing material handling. Furthermore, real-time tracking allows for precise product placement, significantly improving inventory accuracy. The ability to promptly update item locations improves overall warehouse efficiency and accuracy in put-away processes.

e. *Record-keeping (12%).* RFID facilitates the automated and simplified handling of the recording process for incoming and outgoing items throughout the supply chain. Automated record-keeping prevents manual entry errors and facilitates prompt access to item information, location, and movement.

f. *Packaging (5%)*. RFID technology significantly expedites the packing process with real-time inventory visibility, which allows accurate material picking. Reducing searching time for packing material decreases preparation time with real-time information. The automation technology's accuracy reduces material handling and labour expenses.

RFID Application Impacting Performance Metrics

The inability of MA traditional warehouse techniques to deliver on time and precise data impedes the readiness of the army's supplies. In doing so, RFID technology enhances overall readiness by influencing four critical metrics to increase overall performance: cycle time (timely information), cost (labour cost), quality (tracking accuracy), and productivity (increase throughput). By employing a positive impact on these metrics, RFID contributes directly to the improvement of army supply readiness.

Quality

Product can be transported between companies without the need to employ codes that are unique to each organisation by employing a single code that is universally applicable. Tracking and locating items as they transition from one critical location to another is possible with RFID sensors. The average number of products and the cost of holding them decrease as the accuracy and visibility of tracking products improve. Conversely, the availability of accurate inventory data facilitates the procurement of products during production, thereby reducing lead times and expediting the process. Monitoring tasks are simplified, and less human effort is required when RFID devices are employed for receiving. RFID readers that are fitted into forklifts, products, and shelves can immediately scan items that are stored. This eliminates the possibility of material handling errors, such as incorrect stock counts, misplaced items, missing scans, re-scans, and defective scans. Items are picked at control stations and packaging stations using RFID readers. The shipping process can be monitored immediately by integrating RFID readers into the warehouse's departure gates. RFID tags contribute to the reduction of variations in stocks that may result in errors in record keeping and

documentation by providing precise information. The reduction of the number of times an item is out of stock and the improvement of stock control are both facilitated by accurately recorded information.

Time

RFID applications provide organisations with timely information, which enables them to make decisions in less period of time. The implementation of RFID technology provides real-time information to processes, thereby eliminating uncertainty and increasing the number of products available. Management can make decisions that reduce the risk of stock shortages, thereby preventing financial losses, when they have access to real-time information. The activities of loading and unloading in warehouse operations demand automated technology in addition to manual labour. This activity occasionally entails additional labour to guarantee that the despatch is performed accurately, the quantity is adequate, and the quality is in good condition in accordance with the order picking list. Subsequently, the utilisation of RFID tools to automate the verification process during the receiving process can expedite warehouse distribution. Increasing responsiveness is not feasible when the facilities are well-equipped with tools (tags and readers), particularly in the receiving bay, storage, pallets, and cases. Subsequently, data attached to the product gets delivered immediately to the organization's information system. This reduces the time required to manage materials, including the following: receiving, inspecting, storing, picking, packaging, shipping, and maintaining records.

Cost

RFID ensures that the location, item and quantity of items are accurate by facilitating the management of item availability. Any issue of stock shortages are reduced, when RFID improving the speed of tracking products and determining what is in stock, subsequently reduces costs. The costs are incurred when products are restocked and re-shipped as a result of the customer returning due to order fulfilment error such as incorrect item or incorrect quantity. These errors are due to discrepancies between the organization's actual inventory and its system inventory. As a result, organisations must implement additional measures to ensure their accuracy of inventory. Thus, RFID guarantees precise data, which facilitates the identification of loss by facilitating the tracking and protection of items as they move across the warehouse and distribution process. RFID reduces the average inventory quantity, thereby reducing the inventory management cost. Error rates decrease, resulting in an increase in the number of products available, and loss sales of costs decrease concurrently.

Productivity

The warehouse operation is optimised when RFID tags are attached to pallets, cases, or boxes, as handheld readers or readers at the entrance gate can simultaneously read multiple tags. At the same time, the speed of data collection is increased by eliminating the necessity for individual readings. The removal of the scanning responsibility results in a reduction in the amount of material that must be moved and labours workload, which in turn reduces the time required and balance labour workload to complete warehouse tasks as well as increases both productivity and stock availability. In other words, RFID automates tasks, thereby reducing the cost of labour and the time spent queuing.

RFID Benefits on the Army's Supply Readiness

The importance of RFID technology influences warehouse operations, enabling them to achieve supply availability by tracing and tracking products throughout the supply chain. The availability of supplies can be demonstrated by measuring the importance benefits of this technology, which are classified into 4 performance metrics: productivity, cost, quality, and time. These four performance metrics facilitate an efficient and effective warehouse process by providing timely information, accurate item tracking, increasing throughput productivity, and reducing cost of labour and inventory, as illustrated in Figure 2. These important benefits highlighted the potential of implementing RFID in army depots to ensure stock availability to fulfil orders. On-time orders and full delivery require stock to be sent without damage and correct documentation, label, and invoice. Thus, by utilising RFID technology, the army depots can reduce poor order delivery performance due to poor information flow and product flow within the warehouse. With real-time data on inventory levels and locations, the depot can quickly restock items, track shipments, and maintain accurate records. This level of efficiency and efficacy is crucial for military operations, as agility is vital for the maintenance of operations on the battlefield.

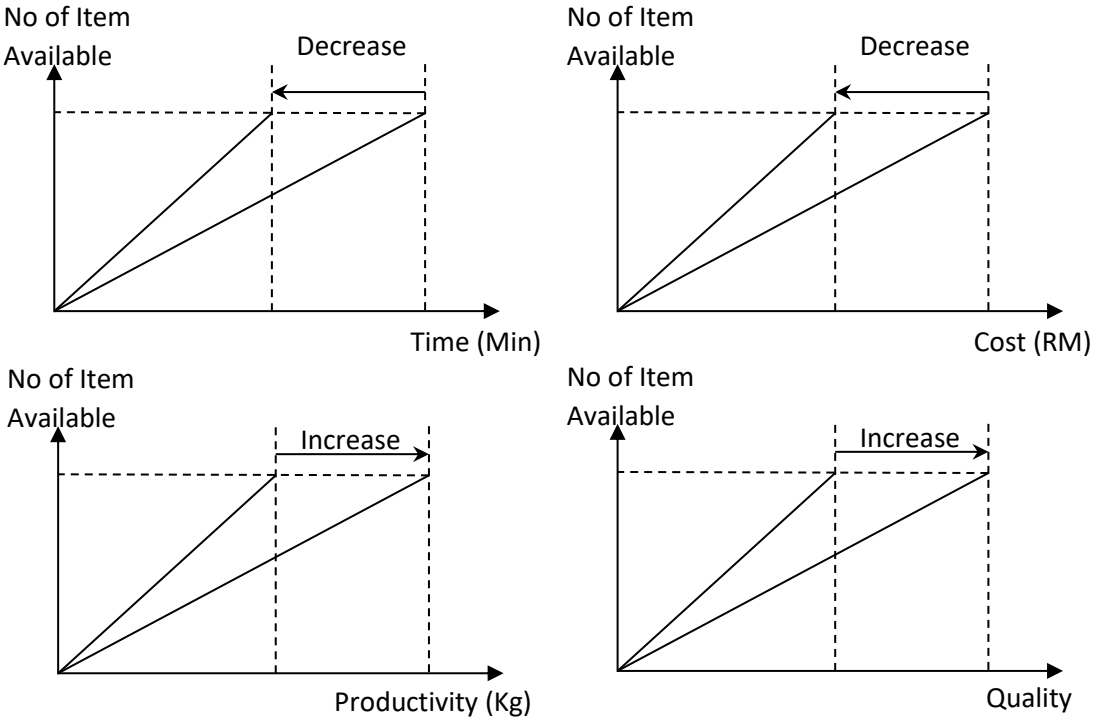

Figure 2 Effect of Readiness by Applying RFID on Performance Metrics.

Integration CODIMS-RFID Enhanced Army Supply Readiness

A consistent and efficient logistics chain is critical for the success of the MA operations, especially in unpredictable situation. A well-managed WMS enables an organization to accurately track inventory, maintain optimal levels of inventory, improve accuracy, decrease labour costs and ensure correct maintenance and storage of stock (Karimi et al., 2014). When it comes to keeping track of essential supplies and keeping an exact inventory level, traditional practices typically encounter resistance, which causes supply delivery delays. To eliminate this issues, full automation technology marks a significant change by integrating CODIMS-RFID. The potential outcomes of this automation technology have resulted in streamlined warehouse operations in several distribution centres. It has transformed the public sector into a successful organisation with remarkable outcomes in managing vast amount of inventories.

Several years ago, Amazon.com recognized the importance of robotics and automation in enhancing warehouse efficiency, thereby allowing them to remain at the forefront of these emerging technologies (Christopher, 2023).

In order to obtain the full potential of RFID, the integration of both technologies will enhance army supply tracking and traceability within the military logistic system, subsequently facilitating more efficient decision-making. The integration provides technological support to minimize errors and ensure data reliability, increasing the speed and accuracy of resource allocation and supply requirements. Moreover, this strategy provides decision-makers with more precise data, making them easily accessible when needed for analysis. As a result, integration of CODIM-RFID is seen as the game-changer in logistics operations by streamlining the delivery process into the operational theatre, improved inventory management system and real-time visibility, ultimately contribute to the army's supply readiness.

Challenges in Implementing RFID Technology

An automated WMS become a critical solution for a manual management system. The primary aim of fully automating the WMS is to track and trace the product movement and storage location, to provide accuracy in product availability and expedited handling process. However, implementing RFID in army depot faced significant challenge that need to be consider.

The major challenge implementing a fully automated solution necessitates a large investment as well as effort for implementation (Vijayakumar and Sobhani, 2023). Installing RFID technology equipment may lead to high installation and maintenance cost (Luo et al. 2017). Long term investment especially in the non-profit organisations requires a large amount of money from the government to invest in. However, the investment in return will benefits the overall performance of the army and increase high operational readiness. The second challenge is sensitive data that is crucial in the context military environment as they are vulnerable to the cyber threats, and traditional threat. Consequently, high security and encryption measures guarantee that data and information are accessible solely to authorised individuals. As stated by Christopher (2023), data and information must be integrated into a ledger system that are accessible to authorised users, validated, and permanent. He proposed Blockchain technology as it offers useful transformation, functioning as distributed ledgers system that shared among network users, securing sensitive data from cyber threat.

Therefore, these challenges must be carefully addressed to ensure successful implementation. Although these challenges appear to be limiting the effort, the perceived benefits of RFID technology outweigh them, whereas RFID implementation in army depots has the potential to improve total asset visibility and reduce inventory discrepancies.

Conclusion and Future work

Today, military logistics are constantly seeking technological advancements to enhance their logistical performance and ensure their personnel are adequately equipped and prepared for battle. Therefore, the constant evolution of technology has directly or indirectly impacted the MAF, particularly the Malaysian Army. RFID is an emerging technology tool in logistics activities, mostly concerned with the warehouse operation process. The benefits of RFID in warehouse operations are critical to the Army's supply readiness performance. Readiness is

about the availability of supplies in the warehouse that requires improvement to guarantee the force's readiness for deployment and employment in the theatre of operation at any given time. RFID is seen as the solution to problems that arise in army depots.

Upon examining the problems associated with warehouse operation and also identifying some of the solutions RFID technology can offer, this study gathers data from 21 relevant articles, identifying recurring data patterns and categorising them accordingly. The articles' data support the findings of these repeated patterns. The interpretation of these data is based on the important benefits perceived from RFID application in warehouse operations reported in previous studies and were then evaluated accordingly. These potential benefits demonstrate the influence of RFID on warehouse operation efficiency; receiving has the highest rank, followed by shipping, picking, put-away, record-keeping, and packaging. Organisations that use this technology will see several positive improvements, such as a reduction in labour costs, an increase in tracking item accuracy, timely information, and an increase in productivity throughput. Most of the reviewed articles acknowledged these four benefits of RFID applications. These 4 significant benefits of RFID have a great influence on the performance of warehouse operations: quality, cost, time, and productivity, ensuring army supply readiness. The analysis revealed that among the four significant RFID benefits, the quality benefit is the most influential metric in enhancing supply readiness in the warehouse. This is followed by the cost benefit, cycle time benefit, and productivity benefit.

In order to increase high level of Army’s supply readiness, the MA should integrate the CODIMS-RFID in warehouse operation. Therefore, all associated problems will be solved surely, whereas Army’s supplies will be tracked easily, personnel preparedness will be increased, and data will be in organise manner. The inclusion of RFID in the Army’s warehouse will offer better opportunities by integrating with CODIMS function. These will provide better decision making for command-and-control function via the benefits of real time information. Integration of these technologies, CODIMS-RFID, will offer the total asset visibility as well as increase supplies availability. The technology would finally save the army large sums of money that could be used for vital programs. The current system needs to be update not only for the purpose of saving the Army’s budget, but also to the Army personnel on the fields who are lack of supplies to run the systems including weapons, vehicles, equipment and so on. Therefore, the research indicates the current inventory system which is CODIMS will be more effective and efficient if it is integrate with RFID application in Central Ordnance Depot.

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Ethical considerations
Not applicable.

Conflict of Interest
The authors declare that there are no conflicts of interest.

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