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Improving efficiency in inventory management of the procurement agencies of Bhutan

Leki Jungney*, Patchanee Patitad

Faculty of the Logistics and Digital Supply Chain, Meaung, Thapo, Phitsanulok, 65000, Naresuan University, Thailand
*Corresponding author E-mail: lekij65@nu.ac.th/lekeyes999@gmail.com

Abstract

Nowadays, technology plays an increasingly vital role in solving problems in industry. Emerging technology improves a company's performance, thereby increasing the competitiveness of the organization. Bhutan is one of the developing countries that intends to apply technology in many sectors. A procuring agency in Bhutan is a primary sector responsible for the procurement of goods and services for the entire nation. Not only procurement but also inventory management is handled centrally by the agency. All inventory processes are manual operations, leading to time-consuming tasks and data errors in inventory management. This study aims to improve the efficiency of the procuring agency in Bhutan in terms of inventory management by implementing warehouse handling equipment such as a span track and an electric hand pallet jack, as well as technology devices such as radio frequency identification. To illustrate the flow of processes and compare the current processes with the proposed processes, a value stream mapping tool is employed. The inventory processes are identified as value-added activity (VA), non-value-added activity (NVA), and necessary non-value-added activity (NNVA). Using this tool, waste in the value stream can be determined, and new processes can be proposed to reduce waste. As a result, total working time is reduced by 27 %, and the VA percentage is increased by 8.36 %. Utilizing technology in the procuring agency helps in accuracy and efficiency in the field.

Keywords: Inventory management, Value stream mapping method, Information technology, Radio frequency identification, Sustainability, Governance

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1. INTRODUCTION

Over the years, information technology has enabled businesses to foster global connectivity and facilitate changes in agriculture, healthcare, education, finance, and manufacturing. Information technology is the field of computer systems, software, programming languages, data, and information sharing. Information technology devices radio frequency identifications (RFID) are applied in the inventory management process. RFID is one of the best and most enabling technology machines to be used in the inventory management process, comparatively. It is crucial for reducing working time, saving costs, and minimizing waste due to excess inventory and surplus (Rubel, 2021; Schwartz et al., 2021). Additionally, it also plays a vital role in determining the buyer-vendor coordination for replenishment decisions in real retail stores, helping to save time and money (Chiralaksanakul & Sukhotu, 2016). RFID can replace a manual inventory processing system with a computerized inventory system. It makes the inventory process more efficient by reducing working time and increasing accuracy (Erlangga, Yunita, & Satriana, 2022). The study was carried out through data collection by the agencies. The procuring agencies in Bhutan refer to where the procurement of goods, works, and services for the agency and the inventory operations are carried out centrally. All the procurement and management of inventory are monitored and handled by the agencies. The warehouse is the storage facility where the different types of electrical hardware, computers, equipment, stationery, cartridges, and other machinery equipment are stored, and those things were purchased by the procurement office of the agencies on a fiscal year basis. Currently, the inventory management process is paper-based, from receiving goods to issuing them to end users. Paper-based inventory has inaccuracies in data, inefficiencies in the services, and a time-consuming, and inaccurate reporting system (Rubel, 2021). To solve this issue, RFID is applied and it also, enables them to identify, measure, and allocate environmental and social costs; and also, provides managers with strategies and techniques for managing performance across the three dimensions (Onyali, 2014). Further, the value-added activities, non-added activities, and necessary non-value-added activities of the inventory are identified to ensure their impactful alteration during the implementations.

This research aims and objectives are the quantitative study of the current inventory management process of procuring agencies. The data details include process, information, staff, time, and product flow using the value streaming mapping method, which was then further analyzed. The study aims to assess the value of each activity and inefficiencies in terms of data, time, and cost in the current inventory process via the Value Stream Mapping (VSM) tool. The VA, NVA, and NNVA will be identified. Then the new inventory process is proposed based on RFID technology. With the new process, non-value-added activities should be eliminated, leading to increased efficiency in inventory management for the study.

2. LITERATURE REVIEW

RFID is a system used to track objects, people, or animals using tags that respond to radio waves (Kaur & Sengupta, 2016). RFID tags are integrated circuits that include a small antenna. It is a technology that uses radio waves to passively identify a tagged object. It is used in several commercial and industrial applications, from tracking items along a supply chain to keeping track. Radiofrequency identification tagging reads the most crucial package in the shipment to be opened first at the delivery point, and this technology saves time and improves productivity efficiency (Tao, Fan, Lai, & Li, 2017). The study revealed that organizations' adoption of information and communication technology in inventory management improved inventory capacity through continuous transaction processing, access to information from a centralized database, and enhanced productivity and efficiency across all departments. The tool facilitated checks and balances on all inventory transactions (Dhodi, 2018).The

VSM is an important breakthrough for the traditional value stream applied to the field of procurement management in manufacturing companies and organizations. The ability targets include the following:

1. Reduce the workload of purchasing managers, and
2. Establish a more complete system of scrapping and canceling stocks.

The VSM method has been widely applied in different areas effectively in the procurement process consideration in the public sector (Swilley, Hofacker, & Lamont, 2012). The inventory management flow was analyzed based on time and cost. Following this analysis, an information data inventory system program was developed to decrease overall handling time. This customized program enables users to specify the inventory's position in the warehouse, as well as its storage duration, thereby enhancing the circulation of inventory items (Chao, 2015). The benefits and changes of information technology have not been identified in the 1980s and 1990s in productivity or service improvement. However, gradually, in recent years, researchers have found and proved that it is helpful in the immediate measures, calculation of the consumer surplus, and economic growth of firms (Salahshour Rad, Nilashi, & Mohamed Dahlan, 2018). Technology like RFID helps in the process of collaboration and exchange of information for the material components with the supply chain and is also feasible in the integration of the project management system if you work properly and effectively (Kasim, Shamsuddin, Zainal, & Kamarudin, 2012). The objective was to identify areas for enhancing operational efficiency and to devise strategies for improving warehouse and inventory management (Giorgi & Lily, 2020). RFID technologies have the potential to enhance supply chain management by reducing inventory losses, increasing process efficiency and speed, and improving information accuracy (Sarac, Absi, & Dauzère-Pérès, 2010). The inefficient inventory management is primarily influenced by the unintegrated company's information system and the absence of qualified human resources (Islam, Pulungan, & Rochim, 2019). Conceptually, the review of articles, books, and journals was carried out based on the topic of studying the current inventory process using the VSM method and proposing a new RFID-based inventory process. The review also took further into how efficiency can be improved with the integration of technology in inventory management and further compared the process to know the effectiveness and improvement in terms of time, cost, process, and activities through related literature reviews. For the efficient management of inventory from receipt to issuance, each process comprises specific sub-process activities aimed at maintaining accuracy and organization throughout the inventory lifecycle (Anusha, Praveen Kumar, Lakshmi, & Kumar, 2023). It determines the VA, NVA, and NNVA of the process as disclosed below;

Value-added activities (VA) are those that directly contribute to the creation of value for the customer or end-user. These activities enhance the product or service in a way that the customer is willing to pay for. By focusing on VA and eliminating or minimizing non-value-added activities, organizations can enhance competitiveness, increase profitability, and build stronger relationships with customers. Efficiently allocating resources to VA is essential for achieving sustainable growth and long-term success.

Non-value-added activities (NVA) are tasks or processes that do not directly contribute to the creation of value for the customer or end-user. Identifying and minimizing these activities is essential for improving efficiency, reducing waste, and optimizing resource utilization. The identifying and eliminating or reducing NVA, organizations can streamline operations, improve productivity, lower costs, and enhance customer satisfaction. This allows resources to be redirected toward value-added activities that directly contribute to meeting customer needs and achieving organizational goals.

Necessary non-value-added activities (NNVA) refer to tasks or processes that are required for various reasons but do not directly contribute to the creation of value for the customer or end-user. Despite not adding value in themselves, these activities are essential for compliance, safety, or

operational reasons. While these activities may not directly add value to the product or service, they are essential for maintaining compliance, quality standards, and operational integrity. Therefore, they are considered necessary NNVA that organizations must perform to ensure smooth operations and mitigate risks.

3. CASE STUDY AND RESULTS

The study was carried out using the questionnaire specifically by eight experts about the procurement agency where the procurement of the goods, works, and services were carried out, and the inventory operations of all the procurement and management of inventory as monitored and handled. This research focuses on applying RFID to reduce time and eliminate the waste through VSM method of the inventory process. This research study covers the case study of the inventory current management process in the agency.

Study the current inventory management process

The inventory management system comprises four main processes: Receiving, Recording, Stocking, and Issuing. The detail process is as exemplified;

1. **Receiving Process**: Involves accepting goods delivered to the purchaser's premises from the delivery van, including unloading goods, verifying their condition, and documenting their receipt.
2. **Recording Process**: Focuses on inspecting and recording received goods through documentation, including checking against purchase orders, recording quantities and details, and updating inventory records.
3. **Stocking Process**: This involves moving goods to storage and performing necessary activities originating from the receiving process, such as transporting them to storage areas, placing them in designated locations, and organizing inventory within the warehouse.
4. **Issuing Process**: This entails providing goods to end users with proper documentation, including retrieving goods from stock, documenting issuance, and delivering goods to end users.

Efficiently managing these activities is crucial for optimizing overall productivity and maintaining the organization's reputation and credibility. The current inventory process using VSM studied process flow, staff involved, and time flow as illustrated by Figure 1;

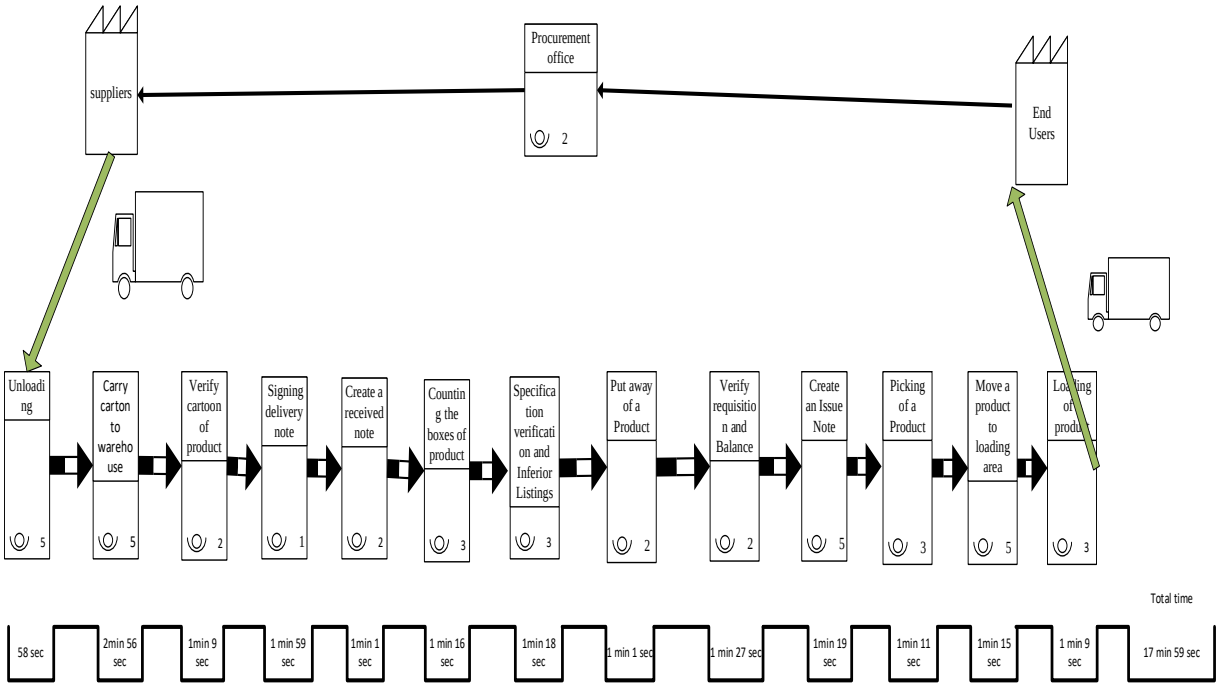

Figure 1 The current data integrated VSM of the inventory process

The four main activities were then broken down into different sub-activities along the VSM process for efficiency and to have accurate data for the study, as shown below:

1. Unloading: the activity where goods are unloaded at the premises of the purchaser and delivery point.
2. Carry a carton of a product to the warehouse. The carton is carried to the warehouse at the unloading site.
3. Verify cartons of product: The packages and cartons are verified and counted inside the warehouse.
4. Signing the delivery note: The purchaser manager ensures the receipt of the goods from the supplier.
5. Create a received note: The details of goods received with quantity, rate, and amount of product are maintained.
6. Counting the boxes of products: The counting of the boxes of products and sorting based on their category.
7. Specification verification and inferior listings: listing the product that is not as mandated in the specification and has defects, and following up with the suppliers.
8. Put away a product: The stocking process of the product in the warehouse includes segregation and stagging.
9. Verify the requisition and balance: seeing the stock balance details in the stock ledger and verifying quantity and type of product requirements by end users in the requisition.
10. Create an issue note: The goods details, including the serial number, type of product, and quantity, are mentioned and signed by both parties.
11. Picking of product: The taking and picking of product from the purchaser's premises by the end users from the warehouse.
12. Move to the loading area: The movement of the product to the area where the goods are loaded.
13. Loading: The putting up of the product in the truck for the end user delivery.

Table 1 The activities in the current inventory process

SL. no	Activities	Time (Min)	Activity Type
1	Unloading	0:58	VA
2	Carry carton of product to the warehouse	2:56	NNVA
3	Verify cartons of the product	1:09	NNVA
4	Sign the delivery note	1:59	NVA
5	Create the received note	1:01	NVA
6	Counting the boxes of the product	1:16	NNVA
7	Specification verification and inferior listing	1:18	NNVA
8	Put away a product	1:01	VA
9	Verify requisition and balance	1:27	NNVA
10	Create an issue note	1:19	NNVA
11	Picking of a product	1:11	VA
12	Move a product to the loading area	1:15	NNVA
13	Loading of product	1:09	VA

VA: Value-added activities, **NVA:** Non-value-added activities, **NNVA:** Necessary but non-value-added activities

These classifications help identify where value is added to the process, where tasks are necessary but don't directly add value, and where activities could potentially be optimized or eliminated to improve efficiency. Based on the information provided, out of the 13 sub-activities, 4 are considered VA, 2 are NVA, and 7 are NNVA. As illustrated in Figure 1, the total cycle time in the current VSM is 17 minutes and 59 seconds in the current inventory management process, and the total required in the scenario is 41 staff.

Percentage of Value-Added Time= (Total Time/Value-Added Time) ×100

$$Given:$$

- $Value - Added\ Time\ =\ 4\ minutes\ 19\ seconds$
- $Total\ Time\ =\ 17\ minutes\ 59\ \ seconds$

$$First,\ convert\ all\ times\ to\ seconds\ for\ easier\ calculation.$$

$Value - Added\ Time$: $4\ minutes \times 60 + 54\ seconds = 4 \times 60 + 19 = 259$ seconds

$$Total\ Time:\ 17\ minutes \times 60 + 59\ seconds = 17 \times 60 + 59 = 1079\ seconds$$

$$Percentage\ of\ Value - Added\ Time = \left(\frac{259}{1079}\right) \times 100 \approx 24.00\ \%$$

The application of radio-frequency identification (RFID) technology

RFID is applicable in the inventory management process, specifically after the purchasing process. Here's a breakdown of the process, as proven below:

1. RFID in Inventory Management: RFID technology is utilized to monitor, track, and trace items within the warehouse after they have been purchased. By employing RFID, the cycle time is

reduced, leading to improved efficiency in management and increased accuracy in data tracking.

2. Effectiveness and Efficiency: The implementation of RFID technology results in faster progress in effectiveness and efficiency within the inventory management process. This improvement extends to accountability and tranquility, as the accuracy of data reporting is enhanced.
3. Illustration of New Inventory Process: The study suggests that the new inventory process for future scenarios can be depicted using Value Stream Mapping (VSM), as shown in Figure 2. VSM is a method used to visualize and analyze the flow of materials and information within a process. By incorporating RFID technology into VSM, the efficiency and effectiveness of the inventory management process can be illustrated and optimized.

Overall, the study highlights the transformative impact of RFID technology on inventory management processes, emphasizing improvements in efficiency, accuracy, and accountability. The use of RFID and VSM methods also helps to visualize and optimize the new inventory process, enabling organizations to streamline operations and enhance overall performance.

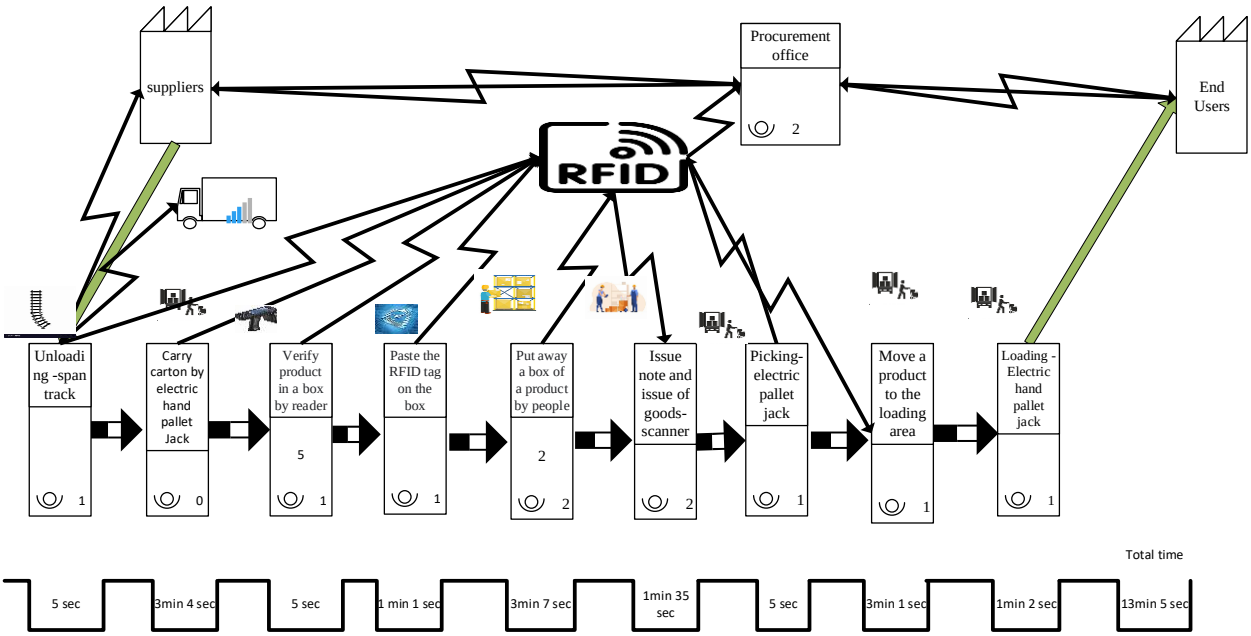

Figure 2 New value stream mapping process

Each step in the new process describes a specific task or action taken during the process of receiving, storing, and dispatching goods.

1. Unloading with Span track: Goods are unloaded at the purchaser's premises and delivery point using a span track, which is likely a type of equipment or system for efficient unloading.
2. Carry two cartons of product to the warehouse by electric hand pallet jack: Using an electric hand pallet jack, the goods are transported from the unloading site to the warehouse or storage area.
3. Verification of a product by a reader: Packages and cartons are verified and counted inside the warehouse using an RFID reader, ensuring accuracy in inventory management.
4. Paste RFID tag on the box: RFID tags are manually applied to the products in the warehouse, likely to enable tracking and identification throughout the supply chain.
5. Put away a box of product by people: Employees or warehouse staff handle the stocking process of products in the stores, including staging and segregation to ensure efficient storage and retrieval.

6. Create issue note and issue of goods: A formal document, such as an issue note, is generated to record the issuance of goods, including details such as quantity, rate, and amount. This helps in maintaining accurate records of transactions.
7. Picking by electric pallet jack: End users pick products from the purchaser's premises using an electric pallet jack, presumably for further distribution or usage.
8. Move a product to the loading area: Using an electric hand pallet jack, products are transported from their storage location to the loading area in preparation for dispatch.
9. Loading by electric hand pallet jack: Goods are loaded onto trucks using a jack, likely a span track, for transportation to the end user or final destination.

The improvement process

These steps collectively represent a sequence of actions involved in the logistics process, ensuring the efficient movement and handling of goods from receipt to dispatch. The integration of RFID components, such as authorization tags, readers, and scanners, into every process within the VSM process, has led to significant improvements in inventory management efficiency. Here's a breakdown of the key points:

1. Integration of RFID Components: Authorization tags, readers, and scanners are integrated into every stage of the inventory management process. This integration allows for real-time tracking and monitoring of items, improving overall visibility and control.
2. Efficiency Improvements: By utilizing RFID technology, the VSM process has been streamlined, resulting in a reduced total time of 6 minutes and 4 seconds. This represents a significant improvement from the previous process, which took 22 minutes and 39 seconds.
3. Staff Requirements: The implementation of RFID technology has also reduced the total staff requirement to 18 individuals. This reduction in staffing suggests increased efficiency and potentially lower labor costs.
4. Further Improvements: The incorporation of RFID components into the VSM process is expected to lead to further improvements in inventory management. This may include enhanced accuracy, faster processing times, and improved overall process integration.

Table 2 The value-added and non-value-added activities of the new process

SL. no	Activities	Time (Min)	Activity Type
1	Unloading using span track	0:05	VA
2	Carry cartons to the warehouse by Electric hand pallet Jack	3:04	NNVA
3	Verify the product in cartons in the box by the reader	0:05	NNVA
4	Paste the RFID tag on the box	1:01	NNVA
5	Put away a product by people	3:07	VA
6	Create Issue Notes and Issue the goods	1:35	NNVA
7	Picking of the product by Electric and pallet jack	0:05	NVA
8	Move the product to the loading area	3:01	NNVA
9	Loading span track and electric hand pallet jack	1:02	VA

VA: Value-added activities, **NVA:** Non-value-added activities, **NNVA:** Necessary but non-value-added activities.

Comprehensively, the integration of RFID technology into the inventory management process has proven to be highly beneficial, resulting in significant efficiency gains and improved overall

performance. This demonstrates the importance of leveraging technology to optimize business processes and achieve operational excellence. The non-values and values were again illustrated for the new process as well as for portraying efficiency values in terms of percentages.

In the new inventory management process, there are a total of nine activities. Out of these, 3 activities are deemed VA, one is classified as NVA, and 5 are considered NNVA to the process. Figure 2 shows the new VSM process, with a total cycle time of 13 minutes and 5 seconds and staff involved in the process totaling 11.

$$\boldsymbol{Percentage\ of\ Value-Added\ Time} = (Total\ TimeValue - Added\ Time) \times 100$$

$$Given:$$

- $Value - Added\ Time\ =\ 4\ minutes\ 14\ seconds$
- $Total\ Time\ =\ 13\ minutes\ \ 5\ seconds$

$$First,\ convert\ all\ times\ to\ seconds\ for\ easier\ calculation.$$

$$Value - Added\ Time\colon\ 4\ minutes \times 60 + 14\ seconds = 4 \times 60 + 14 = 254\ seconds$$

$$Total\ Time\colon\ 13\ minutes \times 60 + 5\ seconds = 13 \times 60 + 5 = 785\ seconds$$

$$= (254/785) \times 100 \approx 32.36\ \%$$

Comparison of the current VSM and the new VSM of the inventory process

As illustrated in Figure 1, the total cycle time in the current VSM is 17 minutes and 59 seconds in the current inventory management process, and the total required in the scenario is 41 staff. Figure 2 depicts the new VSM process, which has a cycle time of 13 minutes and 5 seconds and a total of 11 staff members. To compare the time efficiencies and staff percentage differences between the current and new inventory management processes, it's calculated the time efficiency improvement and the percentage difference in staff requirements. To calculate the percentages of time reduction and efficiency between the current and new inventory management processes, we'll use the following formulas:

1. $Percentage\ of\ Time\ Reduction$:

$$Reduction\ in\ Cycle\ Time = \frac{Current\ Cycle\ Time - New\ Cycle\ time}{Current\ cycle\ time}$$

$$= \frac{(17\ minutes\ and\ 59\ \ seconds) - (13\ minutes\ and\ 5\ seconds)}{17\ minutes\ \ 59\ seconds}$$

$$= 0.27\ seconds\ * 100 = 27\%\ of\ time\ reduction.$$

4. DISCUSSION AND CONCLUSION

Technologies like RFID potential to further enhance speed, accuracy, and efficiency while enabling paperless inventory processes. Specifically, the new information technology system decreased the total current processing time from 17 minutes and 59 seconds to 13 minutes and 5 seconds and reduced the required staff from 41 to 11 in the inventory process. In 2017, Tao, the researcher, concluded that the integration of RFID technology in inventory management processes has been shown to enhance efficiency, reduce workload, and save time. Therefore, careful evaluation of time and cost-benefit and prioritization of budget allocations are necessary. This research investigated the effects of integrating IT into inventory management processes within Bhutan's procurement sector. It reveals that adopting IT-based methods significantly reduces both time and staffing requirements compared to traditional approaches. In terms of percentages of efficiency in the value-added activities, it was 24.00 % in the current process and 32.36 % of VA percentages in the new process which has increased the efficiency by 8.36 %.

The study employs the VSM model to identify inefficiencies, streamline operations, and enhance overall effectiveness. Despite the benefits, concerns arise regarding the initial investment's profitability due to high maintenance and operational costs. The researcher found that changes in cost savings because of changes and improvements in process and identified the energy saving now and in the future by VSM method identified and reduction of energy with lean and green manufacturing (Verma & Sharma, 2016). It's true that in the modern era with technological changes, the VSM helps in identifying value, time, and cost. Our findings addressed the identification of waste of time, reduction of staff, and process using the VSM method. This would ensure the accuracy and efficiency of the real-time data of inventory in the stores and warehouses. In 2022, Erlangga also concluded that technology supports monitoring systems maintains the existing stock, and obtains real-time data by using RFID. The findings were valid in that the technology ensures real-time data accuracy and effectiveness.

The research has shown the study of the current inventory process and gaps, and proposed process for improvement and its efficiency in the long run. The findings have implications for budget planning and resource allocation in Bhutan's procurement sector, empowering organizations to make informed decisions about technology investments. Indeed, facilitating training and coordinating efforts to improve IT infrastructure are essential steps in ensuring the successful adoption and utilization of RFID-based inventory systems in agencies as per this research. The research also acknowledges various factors influencing IT performance, including infrastructure, training, organizational culture, and stakeholder collaboration. The security of the RFID devices is a concern as Bhutan doesn’t have independent satellites and depends on other countries like India. Overall, it contributes insights into the benefits and challenges of IT integration in Bhutanese procurement, aiding decision-makers in optimizing processes, resource allocation, and service quality enhancement. If needed for future research it also emphasizes how RFID data can be leveraged for more accurate demand forecasting. By analyzing RFID-tagged inventory movements and customer purchase patterns, researchers can develop predictive models to anticipate future demand trends and optimize inventory levels accordingly and also integrate this study barcoding system.

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