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Improving the functionality, 5S rating, and inventory management system of the supply department of a regimental academy in the Philippines through industrial engineering applications

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ABSTRACT

The Philippine Military Academy's (PMA) Cadet Mess Supply Room is the institution's essential area for storing and dispatching tableware on a daily basis, as well as during conferences, functions, and events on the premises. Initial inspection and assessments done by the research team and Cadet Mess Supply Room staff revealed a lack of proper storing and inventory management, resulting in over and under-purchasing of supplies due to outdated inventory. The supply room was also cluttered and disorganized, which led to safety concerns and low functionality. Case study methodology and descriptive-comparative analysis were used to analyze collected data before and after the implementation of solutions. Systematic Layout Planning (SLP) was employed to design and implement a new facility layout that improved the workflow and workspaces of the supply room. The 5S methodology was implemented to sort, clean, and organize supplies and furniture in the supply room. Information systems tools were used to develop an Excel-based inventory management system to improve inventory accuracy, timeliness, and traceability. The interventions and solutions implemented resulted in *significant improvements* in the supply room's functionality, 5S practice, and inventory management system from "*moderately satisfactory*" in the pre-test, to "*excellent"* and "*very satisfactory*" ratings in the post-test. The new facility layout also increased productivity and efficiency among the supply clerks, since it minimized the time needed to stack, locate and release supplies. The practice of 5S encouraged cleanliness and orderliness within the supply room. The computer-based inventory management system facilitated accurate and up-to-date inventory data management and timely replenishment of supplies.

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INTRODUCTION

The Philippine Military Academy (PMA) is the largest regimental (military) academe in the Philippines and the country's official training institution for the Armed Forces of the Philippines. Currently, it houses around 1,300 cadets within its 373-hectare space. The Cadet Mess Supply Room, which is the locale of this study, stores all the tableware (plates, silverware, cups, bowls, saucers, trays, linen, etc.) utilized every mealtime in the mess hall. The supply room has an area of 98 square meters. Due to the huge number of cadets and officers that need to be served four meals a day, it is necessary to design workflow and workspaces in the supply room efficiently to ensure high-quality service while avoiding delays, overstocking, and stock-outs due to poor inventory management.

During the initial assessment, it was observed that the supply room was cluttered. Shelves and containers for items were available but not properly used for efficient storage. No standard labels were in place. As a consequence, some supplies were stacked randomly in any open space. Some defective or broken items were also kept among the non-defective or good-condition items. Personal items were also found in the supply room. Because there is no systematic arrangement of supplies, the clerks take more time to locate items that are requested, as well as to re-stack returned items. These issues affected the overall functionality of the supply room- its capability to perform its intended function of receiving, storing, and issuing tableware supplies for the cadet mess.

Before this study, a “manual” inventory system was practiced in the supply room, where the clerks used a logbook to write inventory transactions. With this, there have been inaccuracies and delays due to prolonged inventory checking. Likewise, historical data can only be traced by skimming through the logbooks, as there was no established documentation for the inventory process. Automation tools such as tracking systems were unavailable, leading to inadequate monitoring of supply releases and returns. Stock-outs and over-stocking also happened since the unorganized supply room “hides” existing supplies from sight.

Part of good inventory management is an efficient flow of inventory movement in a facility, which can be achieved by redesigning the supply room facility layout. As defined, facility layout is the physical arrangement of resources, like equipment, furniture, machinery, and materials, into provided spaces (Collier & Evans, 2021). A facility layout’s functionality is the capability of each object in a current layout to accomplish the organization's business objective (Rashid et al., 2015). Knowledge of facility layout can also be applied to stock rooms or warehouses to improve workflow efficiency. Utilizing the knowledge of warehouse management and design can play a vital role in improving operational efficiency, reducing staff fatigue and turnover, as well as increasing customer satisfaction (Collier & Evans, 2021; Koster et al., 2017).

To improve the overall functionality of a facility’s layout and inventory management system, 5S implementation is a necessary initial process. 5S is a methodology designed to optimize productivity by eliminating overall waste through having a safe, clean, organized, and systematized workplace (Nerona, 2022). It is a step-by-step process that stands for Seiri-Sort, Seiton-Set in Order, Seiso-Shine, Seiketsu-Standardize, and Shitsuke-Sustain (Omogbai & Salonitis, 2017). Paulise (2023) mentions that this methodology serves as a tool that achieves lean production systematically and organically, where managing and handling inventory operations will require less manpower, capital, and time.

With the concerns presented, Industrial engineering applications on 5S Principles, Facilities Layout, and Inventory Systems were utilized to address the current problems in the Cadet Mess Facility Supply Room and create a more efficient and effective workflow and workspaces. An improved facility layout, 5S application, and computer-based inventory management system will aid the supply clerks and inventory planners in monitoring supplies, including borrowing and returning materials, checking stocks, tracking supplies, and updating the inventory quickly. It is, hence the goal of this study, to improve the supply room layout, 5S rating, and inventory management system for the Philippine Military Academy, which can serve as a model for a standardized supply department of regimental academies in the Philippines.

OBJECTIVES OF THE STUDY

The study's general objective is to create a more efficient and effective workflow and workspaces in the PMA Cadet mess supply room in terms of functionality, 5S practice, and inventory management principles through direct application of industrial engineering methodologies. Part of this main objective is creating a computer-based inventory management system that would help improve the traceability, accuracy, and accomplishment of up-to-date inventory reports. The following research questions were developed as a guide for this study:

1. What is the condition of the supply room before intervention in terms of
   a. Functionality?
   b. 5S practice?
   c. Inventory management principles?
2. What interventions are proposed to improve the supply room in terms of
   a. Functionality?
   b. 5S practice?
   c. Inventory management principles?
3. How did the condition of the supply room improve after the intervention, in terms of
   a. Functionality?
   b. 5S practice?
   c. Inventory management principles?

Related Studies

A review of related studies revealed the importance of layout optimization, 5S practice, and inventory management in achieving organizational effectiveness in both service and manufacturing industries. Saderova et al. (2020) studied the impact of layout design on warehouse management and productivity by creating alternative layouts based on input parameters, like rack orientation and aisle arrangement. It was found that a well-designed layout increased operators' productivity, efficient use of space, and optimization of storage positions. A study by Karim et al. (2018) entitled Empirical Evidence on Failure Factors of Warehouse Productivity in Malaysian Logistics revealed that poor layout design is one of the top three failure factors of warehouse productivity. The poor layout design caused the underutilization of the warehouse space, which contributed to the decrease in warehouse productivity. Therefore, layout optimization is essential in developing efficient PMA cadet mess supply room operations.

Applying 5S is a necessary step in achieving a functional layout and inventory system, in that it facilitates a clean, orderly, and safe working environment. Chourasia & Nema (2016) conducted a study on the application of the 5S methodology in the service industry and found that optimal utilization of this method can lead to improved service quality and organizational efficiency. Puvanasvaran et al. (2013) accomplished a case study on implementing 5S in a workshop store room to identify the root cause of problems relating to the worker's relationship with their workplace. Sagar et al. (2017), cited in the study of Bharambe et al. (2020), analyzed and executed the 5S methodology in Harsh Polymers, a manufacturing company. Applying 5S resulted in 25% to 20% time savings for the employees. Likewise, this study employed the 5S methodology in the PMA supply room to optimize the inventory storage space by eliminating nonfunctional materials, reducing delays, and improving safety.

Modern inventory management systems use a computerized information processing system to provide real-time, accurate, and traceable data for inventory. A study by Xie et al. (2015) mentioned that implementing a technology-based or automated system will reduce the time consumed in checking and tracking inventory. A study by Abisoye et al. (2013) on designing a computerized inventory management system for supermarkets recommended a computer-based inventory management system that can monitor the stock levels of a supermarket, provide information on when to order more products, and keep track of transactions. By doing so, this system would assist with managerial decision-making, measure progress, and simplify stocktaking. The study by Nadkami & Ghewani (2016) used FSN analysis to strategically locate materials to minimize handling, travel time, and unnecessary motion. Furthermore, a study conducted by Wasnik & Gidwani (2020) entitled "A Study of FSN Analysis for inventory

management in Koradi Thermal Power Station (KTPS), Maharashtra" identified which items should be prioritized and which goods should be lessened. Aside from providing the most efficient layout, categorizing items helped decide whether to procure more fast-moving items or, in contrast, to determine whether a non-moving stock is still required or needs to be disposed of. In the same light, FSN analysis was used to strategically locate items in the PMA cadet mess supply room, hand-in-hand with the optimized layout designed through SLP and the computer-based inventory management system developed using MS Excel VBA Technology.

MATERIALS AND METHODS

Descriptive-comparative analysis and case study design were used to analyze qualitative and quantitative data. This study obtained quantitative data through an assessment checklist, while qualitative data were collected through interviews and observations. An assessment checklist was used as the primary tool to evaluate the supply room's condition before (pre-test) and after intervention (post-test) regarding functionality, 5S practice, and inventory management. The checklist items were derived from a similar study conducted by Nerona, et.al (2018) to improve the inventory management of the food storage facility of the PMA. The reliability scores of the three checklists used to assess the functionality, 5S approach, and inventory of the supply room's inventory system are 0.86, 0.88, and 0.87, respectively, using Cronbach's Alpha internal consistency method. Before implementing proposed solutions, the supply room staff (3) as well as the research team (10) accomplished the checklists as a pretest, to establish a baseline for the study. Direct observation of the activities of the supply room clerks was done, and interviews were also conducted with them to enlighten the team about the details of the operation in the supply room.

To improve the supply room's functionality, Systematic Layout Planning (SLP) was used to analyze the logical connections between functional areas and determine the optimal placement of furniture and supplies, to ensure that the supply room is organized and optimized for maximum functionality. To come up with the total distance traveled through the supply room, the supply room clerks were observed on the "borrowing of items" process for one day, and the average distance traveled by the supply room clerks was calculated. A from-to-chart was developed to show the flow of material, and an activity relationship diagram was created to show the degree of closeness required among the sections in the supply room. From these, a block plan was generated as basis for the development of three alternative layouts.

The 5S methodology- *sort, set, shine, standardize, sustain* (Omogbai & Salonitis, 2017) was applied in the supply room, to resolve the cluttered spaces and unorganized items in the supply room. The research team collaborated with the supply room clerks to evaluate the supply room and identify which items needed relocation or disposal. The items for disposal were then moved to an area directed by the supply room supervisor. Deep cleaning of walls, floors, and shelves was done to eliminate any accumulated dirt and dust. Proper labeling of shelves and sections was also done in accordance with cognitive ergonomic standards, following recommended sizes and color coding. Sustain phase was done by creating forms for borrowing and releasing items, and an infographic poster for maintaining 5S in the supply room.

To improve the inventory management of the supply room, FSN (Fast-Slow-Non) analysis was used to determine Fast, Slow, and Non-moving items. To determine the category of each item, whether it is a fast-moving, slow-moving, or non-moving item, the parameters considered were the average stay and consumption rate to compute the % cumulative average stay and % cumulative consumption rate of each item (Wasnik & Gidwani, 2020). Data on the daily withdrawal of supply room items for the past 6 months was provided by the supply room supervisor for this purpose. FSN Analysis aided the research team in designing the optimal layout for the supply room in a way that all the fast-moving or frequently borrowed items were relocated to a place where the supply clerk could easily access them. A computer-based inventory management system was developed using MS Excel VBA Technology, to improve traceability and facilitate generation of real-time inventory reports.

Post-assessment using the three pretest checklists was done to measure the impact of the interventions in the functionality, 5S practice, and inventory management system of the Cadet Mess Supply room. Paired t-test was done

through Jamovi analytical software (2022) to determine significant differences in the condition of the supply room in terms of functionality, 5s, and inventory management before and after intervention.

Treatment of Data

For the checklist items under functionality, 5S practice, and inventory management, weighted mean was computed from a 5-point Likert scale. Table 1 shows the interpretation scale for the mean of the checklist items (Nerona, et.al, 2018 and Nerona, 2022).

Table 1. Checklist Compliance Rating

Numerical value	Statistical Limit	Descriptive Equivalence	Symbol
1	1.00-1.79	Needs improvement (20% or less compliant)	NI
2	1.80-2.59	Moderately satisfactory (21%-40% compliant)	MS
3	2.60-3.39	Satisfactory (41%-60% compliant)	S
4	3.40-4.19	Very satisfactory (61% to 80% compliant)	VS
5	4.20-5.00	Excellent (80% to 100% compliant)	E

FSN Analysis

To determine the category of each item, whether it is a fast-moving, slow-moving, or non-moving item, the parameters considered are the average stay and consumption rate to compute the % cumulative average stay and % cumulative consumption rate of each item (Wasnik & Gidwani, 2020):

$$Average\ Stay\ = \frac{Number\ of\ cumulative\ days\ item\ is\ held}{Number\ of\ stocked\ item\ \ during\ the\ period} \qquad Consumption\ Rate\ = \frac{Total\ number\ of\ item\ issued}{Total\ period}$$

Cumulative values for each item for both average stay and consumption rate using these equations:

$$\%\ Cumulative\ Average\ Stay\ of\ \ each\ item\ = \frac{cumulative\ average\ stay\ of\ an\ item}{end\ \ cumulative\ average\ stay\ of\ all\ items}$$

$$\%\ Cumulative\ Consumption\ Rate\ of\ \ each\ item\ = \frac{cumulative\ consumption\ rate\ of\ an\ item}{end\ \ cumulative\ consumption\ rate\ \ of\ all\ items}$$

To properly categorize each item in inventory as fast, slow, or non-moving, Table 2 serves as reference for this purpose (Wasnik & Gidwani, 2020).

Table 2. FSN Categorization

	FSN category
Fast-moving category	<10% of cumulative average stay and <70% consumption rate
Slow-moving category	<20% of the calculated cumulative average stay and <20% or less consumption rate is slow-moving
Non-moving category	<70 % of the calculated cumulative average stay and <10% or less consumption rate is non-moving.

Distance Traveled

To assess the impact of the improved layout, percentage difference in distance traveled by the supply clerks within the supply room was computed. This was achieved by subtracting the total distance traveled in the alternative design layout from the total distance traveled in the initial layout.

$$\%\ difference\ = \frac{Total\ Distance\ of\ Initial\ Layout\ -\ Total\ Distance\ of\ Alternative\ Layout}{Total\ Distance\ of\ Initial\ Layout}$$

Ethical Considerations

A letter of intent, as well as a research proposal, was submitted to the Human Resource Department of the PMA prior to commencing the study. The study was approved after one month, and the team underwent safety orientation and training as a requirement.

RESULTS AND DISCUSSION

A set of checklists encompassing functionality, 5s application, and inventory management was used to assess the initial condition of the supply room. Table 4 presents the results for the combined rating of the research team (10) and cadet mess supply room staff (3).

Initially, the supply room had a functionality rating of 2.49 or Moderately Satisfactory (MS), indicating the need for improvement. The reason for this rating is that the initial arrangements of cabinets and shelves were not optimal, leading to longer travel distances. Moreso, despite having shelves, supplies were not being stored efficiently, with some items randomly stacked in open spaces, which caused obstructions in the room and impeded access to supplies and equipment, hence, affecting its overall functionality. As stated by Suradi et al. (2018) and Suhardini et al. (2017), a facility's layout and the warehouse space maximization are crucial factors affecting inventory management effectiveness and overall production efficiency. A good layout properly utilizes space to improve efficiency and effectiveness in material handling as well as in work process flow. Likewise, according to Karim et al. (2018); Saderova (2020) and Suvittawat (2016), an effective layout design is crucial for improving efficiency, productivity, and service quality. The moderately satisfactory rating of the supply room's functionality elicited opportunities to design a more functional and efficient layout that would optimize its operations.

The 5S assessment results exhibited moderately satisfactory mean ratings of 1.96 overall, and 2.22 for each S. Specifically, the assessment scores revealed several concerns, including the presence of unnecessary supplies, defective items, mixed categories of supplies, lack of a designated red-tag area, insufficient labeling, and the accumulation of dust and dirt. It was also determined that the supply room did not have a 5S checklist to standardize and aid in performing the 5S practice. These findings implied significant deficiencies or opportunities for improvement within the supply room. Given the existing awareness of 5S among the supply clerks and other employees involved in the supply room, the results from the assessment highlighted the areas that were in need of focus for improvement. In this regard, strategies under the 5S methodology were proposed, to improve the supply room's orderliness, efficiency, and effectiveness. As study by Malik (2014) and Chourasia and Nema (2016) showed that by allowing a room area to be visually adequate, station by station, orderliness and productivity can be increased.

The supply room rating for the initial inventory management system resulted in 2.56 or moderately satisfactory (MS). This rating is attributed to various factors, including the absence of comprehensive inventory lists, lack of standard procedures, and reliance on a manual system involving logbooks for recording inventory. According to Younis et al. (2013), the lack of a comprehensive inventory list means the supply room may have difficulty tracking its available items, leading to stock shortages, or overstocking. The inaccuracy of inventory records in the storeroom has led to overstocking and shortages, thus reflecting increased costs. These issues indicate a necessity to revamp the current manual inventory management system.

These findings were considered as baseline for the functionality, 5s application, inventory management and hence, demonstrated the need to improve them drastically.

Implemented Solutions to Improve the Supply Room
A. Functionality

Systematic Layout Planning was employed to create three different layout alternatives. These alternatives were presented to the Cadet Mess Supply room staff along with their respective advantages, disadvantages, and a

distance traveled comparison. After considering the options, the staff selected alternative layout 2 for implementation, as it was deemed most practical for their regular activities in the supply room. The chosen layout incorporates two-way shelves, organized cabinets, and strategic placement of items based on their FSN category. The selected design of the supply room layout implemented is shown in Figure 1.

The distance traveled by the supply clerks in executing their tasks is shown in Table 3 for purposes of comparison. In the implemented layout, the total distance traveled was reduced by 18.1% as compared to the initial layout.

Table 3. Comparison of Distance Traveled

Proposed Layout	Distance travelled (proposed, meters)	Initial distance traveled (before changes, meters)	Difference	Difference (%)
Alternative 1	206.55	344.45	137.90	40.03
Alternative 2	282.09	344.45	62.36	18.10
Alternative 3	259.13	344.45	85.32	24.77

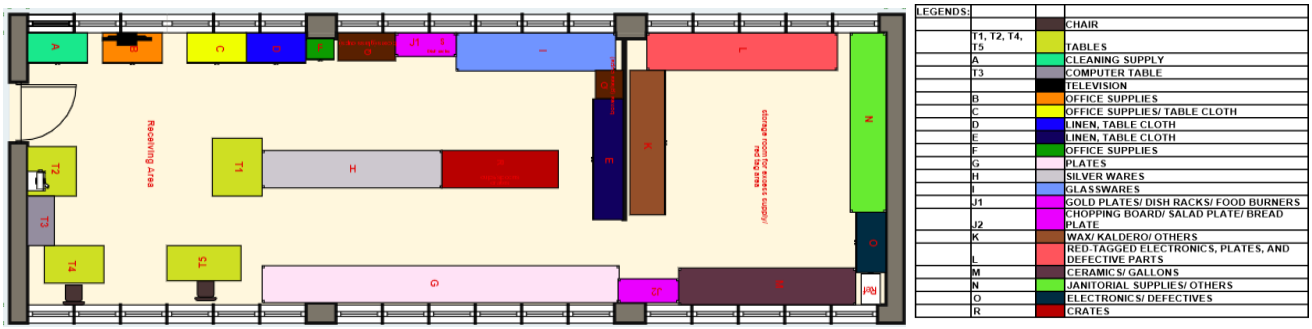


Figure 1. Implemented Layout for Supply Room

B. 5S Practice

The research team implemented a thorough 5S application in the supply room. Starting with the Sort phase, the team collaborated with supply clerks to evaluate the supply room and determine items that needed relocation or disposal. The team then sorted and categorized the items based on their type and size. Defective items were separated and labeled using a red tagging strategy to categorize items as “necessary”, “unnecessary”, or “may need”. This systematic organization enhanced the management and accessibility of the supplies. During the Set-in-order stage, clear and easy-to-understand labels were created, incorporating item identification, cabinet letters, and cabinet-level numbers. The team assigned specific colors to labels based on the cabinet locations, aiding in quick identification and enhancing efficiency. This streamlined approach promoted productivity and facilitated continuous improvement by organizing items and making them easily accessible when needed. Once the supplies were sorted and adequately arranged on the shelves, the team continued to the Shine phase, wherein the team thoroughly cleaned both the shelf surfaces and the floor in the supply room, ensuring the removal of any accumulated dirt and dust.

The research team devised a 5S monitoring sheet in the Standardization phase to guide sorting, setting-in-order and shining activities in the supply room. Thorough cleaning of storage cabinets, replacing curtains, and red-tagging can be carried out monthly or annually. The Sustain phase involved integrating all aspects of the 5S methodology through routine audits, effective organizational management, and the establishment of a sustainable program. This ensured that the 5S principles continued to be applied consistently in the area. The research team developed the Progress-Performance-Visualize-Schedule-Act Method (PPVSA) through an approach suggested by DuraLabel (2017), that incorporates visual progress techniques to employ a structured approach to maintaining 5S in the workplace. The sustain visual aid in Figure 2 is currently posted beside the entrance door of the supply room.

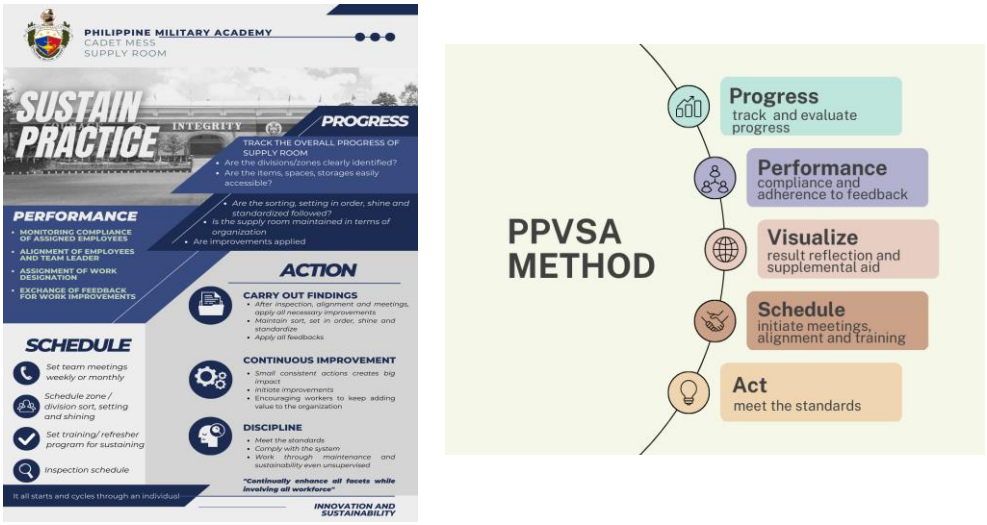


Figure 2. Sustain Visual Aid

C. Inventory Management

The research team employed an FSN Analysis method to effectively manage the inventory, which involved identifying Fast, Slow, and Non-moving items within the supply room's inventory (Wasnik & Gidwani, 2020). The team conducted a physical count of various items and utilized historical data on borrowed items from the past six months to categorize them accordingly. These categorized items served as the basis for organizing the placement of items within the supply room and establishing the inventory management system.

The research team designed a Supply Inventory Management System powered by Excel VBA technology to automate the recording, storing, and reporting of inventory transactions on a periodic basis. The system created stores data within the same Excel file for easy access and updates. Hence, The Supply Inventory Management System (SIMS) streamlines supply inventory transaction management, offers real-time stock availability updates, enables in-depth supply inventory tracking, and allows for managing the Supply Master List. Figure 3 shows the dashboard of the SIMS as viewed from the interface.

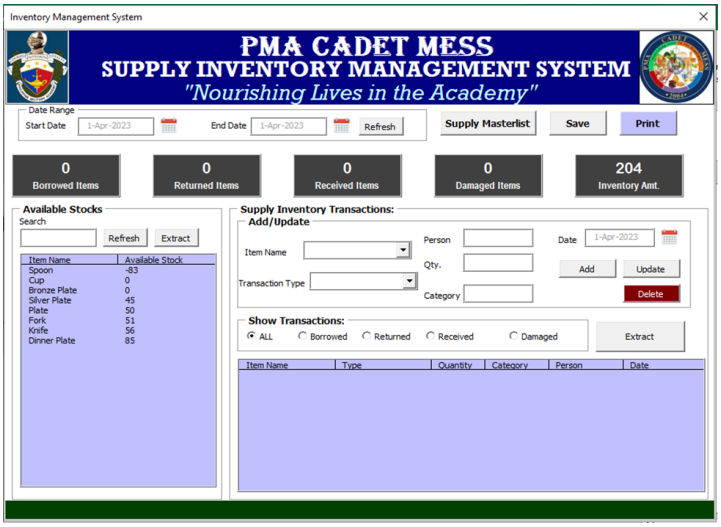


Figure 3. Interface of the Supply Inventory Management System

Evaluation of the supply room of the PMA cadet mess before and after changes

The results of the pre and post-evaluation of the supply room in terms of functionality, 5S practice, and inventory management are shown in Table 4.

Table 4. Summarized Pre- and Post- Assessment Results using Paired T-Test

Checklist item		Pre-test	Post-test	T-value	P-value	I
	FUNCTIONALITY					
Q1	The heavy objects (> 5kg) are stored at the waist level.	2.31 (MS)	4.85 (E)	8.7165	0.0000	S
Q2	Appropriate shelving/racking systems are clean & in good condition. If wooden shelving is used, it must be maintained smoothly & efficiently clean.	2.15 (MS)	4.54 (E)	9.8858	0.0000	S
Q3	The shelving is stable and well-maintained.	2.92 (S)	4.31 (E)	4.7823	0.0004	S
Q4	The shelves are at most 2 meters.	3.77 (VS)	4.15 (VS)	1.4434	0.1745	NS
Q5	The step stools/ladders are used to reach high shelves.	2.15 (MS)	4.69 (E)	6.3120	0.0009	S
Q6	All supplies are stored so that they cannot fall from shelves or suffer damage in other ways.	2.38 (MS)	4.46 (E)	7.2161	0.0000	S
Q7	Appropriate stacking is used to store supply items for proper monitoring & recording.	2.69 (S)	4.23 (E)	6.3246	0.0000	S
Q8	The stored supply items are accessible/ easy to reach (no obstruction)	2.54 (MS)	4.77 (E)	7.3660	0.0000	S
Q9	The arrangement of supply items is positioned strategically for efficient flow of borrowing/releasing of items.	2.61 (S)	5.00 (E)	13.2184	0.0000	S
Q10	The process is automated.	1.38 (NI)	1.77 (NI)	1.8058	0.0961	NS
	Overall Supply Room Functionality	2.49 (MS)	4.35 (E)	6.7552	0.0000	S
	APPLICATION OF 5S					
Q1	Defect or non-conforming items are identified, and a specific area is designated to store these items for appropriate disposition.	1.69 (NI)	4.69 (E)	13.2476	0.0000	S
Q2	The supply area has signage/label that helps personnel locate specific products.	1.31 (NI)	4.85 (E)	13.1878	0.0000	S
Q3	Materials are appropriately stacked (heavy cartons and glass jars stored on lower shelves).	1.92 (MS)	4.69 (E)	9.8590	0.0000	S
Q4	Garbage containers are clearly identified, covered, leak-proofed, and internally lined with a plastic bag.	2.31 (MS)	3.38 (S)	2.9406	0.0124	S
Q5	The supply area is lockable to prevent unauthorized	2.92 (S)	4.62 (E)	4.6380	0.0006	S

	access.					
Q6	Adequate provisions are made for obsolete and inactive items in inventories.	1.61 (NI)	3.92 (VS)	11.0782	0.0000	S
Overall Supply Room 5S PRACTICE		1.96 (MS)	4.36 (E)	6.5219	0.0013	S
	SORT					
Q1	Red Tagging is explicitly practiced.	1.38 (NI)	4.23 (E)	14.8997	0.0000	S
Q2	There is no obvious excess or unused material.	1.62 (NI)	3.92 (VS)	7.0386	0.0000	S
Q3	The items stored in the supply room are all sorted and identified according to their category/type.	2.23 (MS)	5.00 (E)	12.0000	0.0000	S
Q4	No safety hazard (water, damaged floor, exists.	1.92 (MS)	4.08 (VS)	8.6410	0.0000	S
Q5	No personal things on counters, tables, and other storage areas for equipment	2.54 (MS)	3.85 (VS)	2.6232	0.0223	S
Overall Supply Room SORT		1.94 (MS)	4.22 (E)	8.2515	0.0012	S
	SET IN ORDER					
Q1	Items are correctly labeled, categorized, and identified.	1.54 (NI)	4.23 (E)	11.3555	0.0000	S
Q2	The supply room practices visual management.	1.92 (MS)	4.77 (E)	8.4514	0.0000	S
Q3	The items and those of the same type are appropriately positioned.	2.08 (MS)	4.62 (E)	7.2299	0.0000	S
Q4	The supply room (physical condition) is in good condition.	2.46 (MS)	4.23 (E)	6.2988	0.0000	S
Q5	Items are returned to their proper place immediately after use.	2.46 (MS)	4.15 (VS)	7.1377	0.0000	S
Overall Supply Room SET IN ORDER		2.09 (MS)	4.40 (E)	9.5832	0.0007	S
	SHINE					
Q1	Everything is in place.	2.08 (MS)	4.15 (VS)	9.8590	0.0000	S
Q2	Items, equipment, or materials are properly maintained and do not need replacement.	2.31 (MS)	4.62 (E)	7.5000	0.0000	S
Q3	Furniture, equipment, and items are properly cleaned and repaired.	2.15 (MS)	4.77 (E)	8.4128	0.0000	S
Q4	Cleaning materials are easily accessible.	2.92 (S)	5.00 (E)	6.3058	0.0000	S
Q5	The supply room is clean (floor, wall, surfaces, cabinets).	2.38 (MS)	4.54 (E)	9.6995	0.0075	S
Overall Supply Room SHINE		2.39 (MS)	4.62 (E)	22.1285	0.0000	S

	STANDARDIZE					
Q1	The supply room is being monitored.	2.92 (S)	4.15 (VS)	5.3333	0.0002	S
Q2	Standard procedures are observed.	2.38 (MS)	3.31 (S)	4.3818	0.0009	S
Q3	The procedures are clear and easily understandable.	2.15 (MS)	4.15 (VS)	6.2450	0.0000	S
Q4	Employees comply with the legal procedures.	3.15 (S)	4.15 (VS)	4.4159	0.0008	S
Overall Supply Room STANDARDIZE		2.65 (S)	3.94 (VS)	5.2361	0.0136	S
	SUSTAIN					
Q1	The employees involve themselves in maintaining the excellent quality and good condition of the stockroom/supply room.	2.85 (S)	4.23 (E)	5.7401	0.0001	S
Q2	Sort, Set in Order, and Shine are implemented well.	1.61 (NI)	4.08 (VS)	9.1741	0.0000	S
Q3	Improvement charts or a daily basis of 5S practice monitoring sheet is present.	1.69 (NI)	4.08 (VS)	6.8191	0.0000	S
Overall Supply Room SUSTAIN		2.05 (MS)	4.13 (VS)	5.9865	0.0268	S
	INVENTORY MANAGEMENT					
Q1	There is a list of all inventory items available in an Inventory system, including their descriptions, stock-keeping units (SKUs), and quantities.	3.08 (S)	3.77 (VS)	2.2500	0.0440	S
Q2	Physical inventory count of all items in the warehouse or storage location is conducted periodically or once a month.	3.08 (S)	3.15 (VS)	0.2673	0.7938	NS
Q3	A physical inventory count is conducted by authorized personnel.	2.54 (MS)	4.31 (E)	8.7986	0.0000	S
Q4	Physical inventory count is compared to the inventory records to determine the accuracy of the inventory. It ensures that their inventory records are accurate and up to date.	2.15 (MS)	4.31 (E)	7.2701	0.0000	S
Q5	Proper identification and classification of fast-moving inventory (items issued 3-7 times a week) commonly needed among inventories is done.	3.15 (S)	4.38 (E)	3.5927	0.0037	S
Q6	Properly identifying and classifying slow-moving inventory (items issued 2 times a week or less) that takes up valuable space is done.	2.85 (S)	4.46 (E)	4.8824	0.0004	S
Q7	Proper identification and removal of obsolete goods (expired or not in use anymore) from the inventory is ensured.	2.00 (MS)	4.15 (VS)	4.9369	0.0003	S
Q8	Damaged goods are properly identified and removed from inventory.	2.31 (MS)	4.54 (E)	5.0610	0.0003	S

Q9	The appropriate level of safety stock to maintain is determined to ensure that inventory is always available when needed.	1.69 (NI)	3.31 (S)	5.5794	0.0001	S
Q10	There is a record of all inventory movements, including receipts, issues, returns, and adjustments.	3.00 (S)	4.31 (E)	2.9445	0.0123	S
Q11	Reorder points for each item based on demand, lead time, and safety stock are calculated.	2.38 (MS)	2.92 (S)	2.2136	0.0470	S
Q12	Inventory records are updated regularly to show real-time movement of materials.	2.46 (MS)	3.61 (VS)	3.4262	0.0050	S
	Overall Supply Room Inventory management	2.56 (MS)	4.00 (VS)	8.6283	0.0000	S

47 out of 50 items in the checklists showed significant differences after intervention in the functionality, 5s practice, and inventory management of the Cadet Mess supply room. In terms of functionality, the mean score increased from 2.49 (MS) in the pre-test to 4.35 (E) in the post-test. The main contributor to this drastic improvement was the implementation of the new layout in the supply room, which merged the previous three divisions into two, strategically positioning items and supplies for improved accessibility and increased productivity. The adoption of this two-way design created more space and facilitated smoother operations. The results agree with other previous layout studies. In their respective studies, Saderova et al. (2020) and Suradi et al. (2018) demonstrated that a well-designed layout increased operators' productivity, efficient use of space, and optimization of storage positions, as well as minimized hazards. Moreover, improving the layout contributed to improved production capacity and reduced cost of material handling (Suhardini et al., 2017 Nerona et al., 2018 Xie et al.,2018). Such are the longer-term effects expected from a drastic improvement in the supply room's layout.

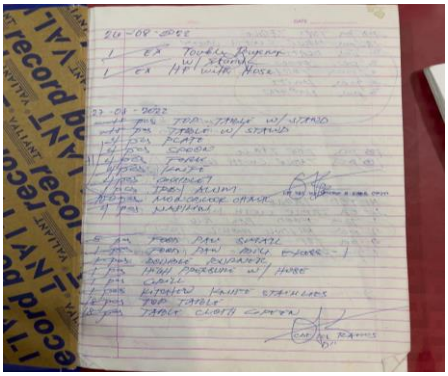
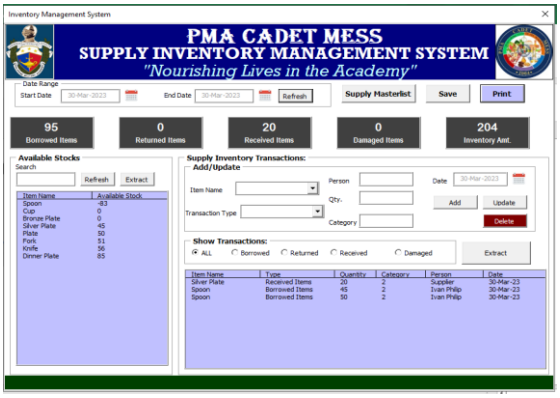
Regarding 5S practice, the mean score increased form 1.96 (MS) in the pre-test, to 4.36 (E) in the post-test. This happened because effective sorting and organization of items occurred, with proper classification of fast-moving and slow-moving items. Thorough cleaning and appropriate labeling of cabinets and shelves were also carried out, resulting in reduced waste, heightened productivity, and a safer working environment. Previous studies have also shown evidence of improving organizational efficiency. A study by Puvanasvaran et al. (2013) concluded that the 5S approach contributed to reducing delays and waste of time spent searching for items by 50%, and the percentage of accidents has been effectively decreased by more than 50% or 87.5%. Further, 5S practice is an excellent way to help the organization improve discipline, and the successful application of 5S depends on the commitment and adherence of the people to the rules and standards (Malik, 2014; Chourasia & Nema, 2016). Ultimately, applying 5S improves working efficiency and employee satisfaction.

As for the inventory management system, the mean assessment score increased from 2.56 (MS) in the pre-test, to 4.00 (VS) in the post-test. This happened because the manual process was replaced by an electronic logbook or inventory management system, ensuring accurate and error-free inventory records. The supply room clerks felt relieved that they are now utilizing a system that gives timely and accurate information, and at the same time, facilitates report-making. This agrees with the study by Ismail & Al-Hadi (2021) which emphasized that a developed inventory system aids in increased quality and productivity through controlled stocks, efficient processing in terms of registering new items, lessening the serving lead time, ensuring the availability of the products, as well as up-to-date tracking of transactions.

These results contributed to the improvement of operations in the supply room. Positive feedback was also received from the PMA Supply Accountable Office and cadet mess staff following the interventions conducted by the research team. Notably, the interventions resulted in a more orderly and clean supply room, increased productivity among operators, efficient use of space, and optimized storage positions. The automation of the inventory management system further improved the room's condition by reducing the chances of errors, improving inventory

accuracy, and saving time. A visual comparison of the condition of the supply room before and after interventions were made is presented in Table 5.

Table 5. Snapshots of the Supply Room Before and After Implementation of Changes

BEFORE	AFTER
Functionality and 5S Practice	
	
INVENTORY SYSTEM	
	

CONCLUSION AND RECOMMENDATION

Conclusion:

The initial condition of the supply room's layout functionality, 5S practice, and inventory management were all rated moderately satisfactory, indicating potential for improvements. To improve the supply room, the research team proposed three alternative layouts, with Alternative Layout 2 being implemented due to its efficient two-way alley function that reduces material traffic. A comprehensive 5S implementation was carried out, covering sorting, setting in order, shining, standardizing, and sustaining. Additionally, an Automated Supply Inventory Management System powered by Excel VBA technology and PK's Utility tool for Excel was developed to provide an efficient and effective solution for inventory management in the supply room.

Overall, significant improvements have been observed in the supply room. The ratings for each aspect have progressed from moderately satisfactory in the pre-assessment to excellent and very satisfactory in the post-assessment. The new layout has created more space in the supply room, improving accessibility and increasing the productivity of the supply clerks. Implementing the 5S practice has resulted in a cleaner and more organized supply room. Furthermore, developing an automated inventory management system has enhanced the accuracy, timeliness, and efficiency of inventory management processes.

Recommendation:

The following recommendations were submitted to the military academe administration office to further advance the efficiency of operations in the cadet mess supply room. The research team recommended incorporating two mezzanine layouts, measuring 36 square meters each, to house the slow-moving and non-moving items. This was suggested to increase the open spaces on the main floor, which will then contain the fast-moving items only. This recommendation was made to improve ventilation and overall safety in the supply room. Small shelves were proposed to be installed in the mezzanine area, and storage crates designed for plates were suggested for acquisition to facilitate quicker retrieval and assist in stock identification. Utilizing a stainless-steel hand cart was also suggested to aid supply clerks in lifting and transporting items within the supply room. The academe's administrative staff welcomed the recommendations but will be subject to further evaluation and budget requests.

To enhance inventory management, the research team proposed the establishment of a red tag area for storing damaged items and implementing guidelines for responsible disposal. To date, there was already an identified red-tagging area which would serve as a temporary storage area for items due for disposal. Also, the importance of conducting internal audits and regular inventory checks was emphasized. To sustain the Inventory Management System, the team provided the supply clerks with a user manual for system maintenance and troubleshooting. The user manual was given to them in both soft copy and printed material for easy reference or if there were new employees assigned to the supply room.

Another recommendation put forth by the research team was the implementation of a Material Requisition Form, which would enable efficient tracking of borrowed and returned items. This form is needed for control purposes, to establish standard practices in borrowing and returning items to the supply room. They also advised implementing an inventory item coding system to streamline the flow of borrowed materials within the supply room. This coding system would facilitate identifying and locating specific items, reducing the likelihood of errors or discrepancies in inventory records.

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