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Improving Storage Room Organization Through 5S Practices and Visual Device Design

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Abstract

Storage rooms are critical to the smooth functioning of organizations across various industrial sectors, serving as hubs for inventory management, storing raw materials, components, finished goods, or essential supplies. Effective management of storage rooms is particularly vital for universities to ensure seamless operations, optimal resource utilization, and a conducive working environment. However, many storage rooms face challenges such as clutter, disorganization, and inefficiency. This study explored the potential for implementing 5S practices (Sort, Set in order, Shine, Standardize, and Sustain) within a university storage room setting to address these issues. The final year project committee members' (JKPSM) storage room at the Universiti Tun Hussein Onn Malaysia (UTHM) Pagoh branch campus was selected as a case study. This project aims to improve floor space utilization and orderliness, enhance cleanliness through regular cleaning, and propose a 5S visual display board to streamline operations, standardize best practices, and sustain work procedures in a storage room. The research examined the challenges, strategies, and outcomes associated with adopting 5S principles, including the use of visual display board to enhance organization and efficiency. Data were gathered through interviews, observations, and documentation review to assess the effectiveness of the implementation process. The main findings significantly highlighted improvements in workplace orderliness, efficiency, and safety following the 5S implementation. This study provided valuable insights into the benefits of systematic organization and cleanliness in enhancing the functionality of university storage rooms.

1. Introduction

The 5S practice is originally a workplace housekeeping method based on five Japanese acronyms, namely Seiri (sort), Seiton (set in order), Seiso (shine), Seiketsu (standardize), and Shitsuke (sustain). Nonetheless, the practice of 5S is not simply about cleaning up, it is a method for organizing, setting up, cleaning, standardizing, and constantly improving a work environment [1]. The primary focus of 5S practice is on the improvement of workplace environment in the pursuit of high quality, low cost and rapid delivery of products, or services [2]. In fact, the effective use of 5S practice could bring potential benefits associated with having a better workplace environment as well as improving quality and safety performance [3].

An essential part of 5S practice is visual management, which uses visual devices to establish an efficient, self-regulating, and self-explanatory workplace environment. This method reduces the need for direct instruction and minimizes errors - using visual devices such as color-coding, labels, signs, floor markings, and visual display boards towards achieving more consistent operational results in the workplace [4]. Visual management enhances efficiency in the 5S practices implementation by making and communicating information essential to the job available immediately, to anybody and everyone who needs it, without having to express a word [5]. Indeed, applying visual management in a storage room at workplace for instance can enhance the understanding of the storage layout, and keeping the items in the proper place [6].

The practice of 5S is widely implemented in the industrial sector, especially in manufacturing [7]. Nowadays, the implementation of 5S practice has been extended to the services sector such as supply chain, banking, hotels, schools and universities, across various areas of the workplace [8]. In the context of a storage room in a university environment, it is an extremely important location to keep many learning materials, operating equipment, and supplies needed for both academic and administrative activities [9]. Its main purpose is to ensure that these things are kept in an organized way, able to be found, and managed effectively. Thus, implementing 5S practice with the aid of visual display has high potential to keep the storage area productive and organized while saving time and minimizing the possibility of lost or misplaced items [10]. This project aims to embark on the following objectives: 1) to improve the floor space utilization and orderliness in a storage room based on the principles of sort and set in order of 5S practices; 2) to enhance the cleanliness of a storage room through the adoption of shine principle of 5S practices by means of regular cleaning and 3) to propose a conceptual design of 5S visual display board towards streamlining the storage room operations, including standardizing the best practices and sustaining the required work procedures.

2. Materials and Methods

The research project was carried out within the storage room designated for the committee members of final year project (JKPSM) at the Pagoh branch campus of (UTHM) which is located on the third floor of block B. The study utilized both primary and secondary data collection methods to ensure comprehensive insights. Primary data was gathered through structured interviews and direct observations, enabling an in-depth understanding of the storage room's organization and user preferences for visual display board designs. A two-round structured interview protocols were validated by two experts panel to ensure reliability, and participants included two committee members of JKPSM, two academic staff, and a student. Secondary data was collected through documentation reviews, including 5S implementation plans and performance metrics. Data analysis involved qualitative methods, with the Pugh method employed to evaluate and compare design alternatives for the visual display board based on pre-defined criteria. Additionally, SolidWorks software was used for design optimization through stress and load simulations, ensuring the practicality and effectiveness of the proposed designs.

2.1 Evaluation of Existing Storage Room Organization and Visual Display Board before Implementing 5S Practices

The evaluation of the existing storage organization involved multiple methods to ensure comprehensive insights. Observations and walk-throughs, incorporating both physical contact and visual inspections, were conducted using a 5S audit checklist specifically designed for thorough and systematic data collection. Additionally, structured interviews were used to gather semi-qualitative data from identified participants, providing insights into the storage room's condition and challenges. Further, structured interviews were utilized to assess user preferences for proposed custom visual display board designs based on 5S principles. The feedback from the participants was analyzed using the Pugh method to select the most optimal design.

2.2 Main Components of Prototype Fabrication

The fabrication of the prototype requires the utilization of different components, each chosen for its distinct attributes and role in the overall design and performance.

2.2.1 Hollow Steel

Hollow steel, or hollow structural section (HSS), is a robust, lightweight material featuring a tubular cross-section, perfect for construction and industrial uses. Its design provides great strength, effective material utilization, visual attractiveness, and simple manufacturing, making it adaptable for constructions such as buildings, bridges, and equipment.

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2.2.2 Fiber Wood

Fiberwood, also known as fiber board, is a flexible, environmentally friendly composite wood material created by compacting wood fibers with resins. Renowned for its even surface and consistent density, it is perfect for furniture, cabinetry, flooring, and ornamental applications, providing machinability, durability, and affordability.

2.2.3 Diamond Net

Diamond netting, also known as diamond mesh, is a sturdy, adaptable net with diamond-shaped gaps, constructed from materials such as steel, plastic, or nylon. It is durable, lightweight, and commonly utilized in construction, fencing, and agriculture due to its ventilation, visibility, and enduring performance.

2.2.4 Castor Wheels

Castor wheels are rotating wheels crafted from materials such as rubber or metal, intended for the effortless mobility of furniture and equipment. Offered in different sizes with choices for locking systems, they enhance movement, lessen strain, and safeguard floors, making them perfect for industrial, residential, and office applications.

2.2.5 Carriage Bolt

A carriage bolt is a type of fastener featuring a rounded head and a square neck to stop it from turning, frequently utilized in woodworking and building. Constructed with sturdy materials, it offers a sleek finish and reliable fastening, perfect for furniture, decks, and fences.

2.2.6 Big Flat Head Screw

A big flat head screw features a broad, smooth head that aligns with the surface, offering a neat appearance and enhanced gripping strength. Composed of sturdy materials, it is frequently utilized in woodworking, construction, and metalworking.

2.3 Tools, Equipment for Cutting and Shaping Processes

The cutting and shaping processes involve the use of various tools and equipment, each selected for its specific characteristics and functionality in achieving precise dimensions and desired geometries.

2.3.1 Cut Off Saw Machine

A cut-off saw is a power tool featuring a rotating blade or abrasive disc that is used to create accurate cuts in materials such as metal, wood, and plastic. It comes in both portable and stationary forms, frequently utilized in construction and manufacturing for quick, clean cuts.

2.3.2 Metal Inert Gas (MIG) Welding Machine

A MIG welding apparatus employs a continuous wire electrode along with an inert gas to generate a stable arc for welding, delivering clean and efficient welds. It is frequently utilized in sectors such as automotive and construction for welding materials of thin to medium thickness, like steel and aluminum.

2.3.3 Jigsaw Machine

A jigsaw is a flexible power tool utilized for cutting both curves and straight lines in materials such as wood, metal, and plastic. It includes a blade that moves vertically with adjustable settings for accuracy and is frequently utilized in woodworking, construction, and DIY tasks.

2.3.4 Hand Drill Machine

A hand drill is a flexible power tool utilized for creating holes in substances such as wood, metal, and plastic. It includes a rotating chuck and motor, with adjustable speed and reverse capability, and is offered in both corded and cordless models. Hand drills are frequently utilized in construction, woodworking, and fabrication for accurate, mobile drilling.

2.3.5 Screwdriver

A screwdriver is a handheld tool utilized to insert or take out screws, featuring a handle and a shaft that terminates in a tip designed for screw heads. Offered in multiple sizes and varieties, it is crucial for activities in construction, carpentry, and fabrication endeavors, delivering accuracy and resilience for building and fixing tools.

2.3.6 Sandpaper

Sandpaper is an abrasive substance utilized to refine or shine surfaces by rubbing it on the material. It consists of a paper or fabric backing covered with abrasive granules and is available in different grits, making it suitable for activities such as woodworking, metalworking, and finishing.

2.4 Prototype Fabrication Process

As shown in Figure 1, the first step involved preparing raw materials, including hollow steels, fibrewood, diamond net, castor wheels, carriage bolts, and big flat-head screws. For the cutting process, the hollow steels and diamond net were cut to accurate dimensions using a cut-off saw machine, while the fibrewood was cut using a jigsaw machine. Six holes were then drilled into the fibrewood using a hand drill machine. Next, in the welding process, the hollow steel frame parts were joined using Metal Inert Gas (MIG) welding. The diamond net was then welded inside the frame, followed by the assembly of the castor wheels. For cleaning and surface preparation, the steel materials were smoothed using the cut-off saw machine, while sandpaper was used for the wooden parts. The assembly process was conducted in two stages: First, assembling the welded hollow steel frame parts, and second, attaching the fibrewood components. In the painting and coating stage, the steel parts were painted, while the wood materials were coated using wallpaper. Finally, during the inspection and testing phase, the dimensions of the visual display board were measured to ensure accuracy and precision. With all these steps completed, the prototype visual display board was successfully finalized.

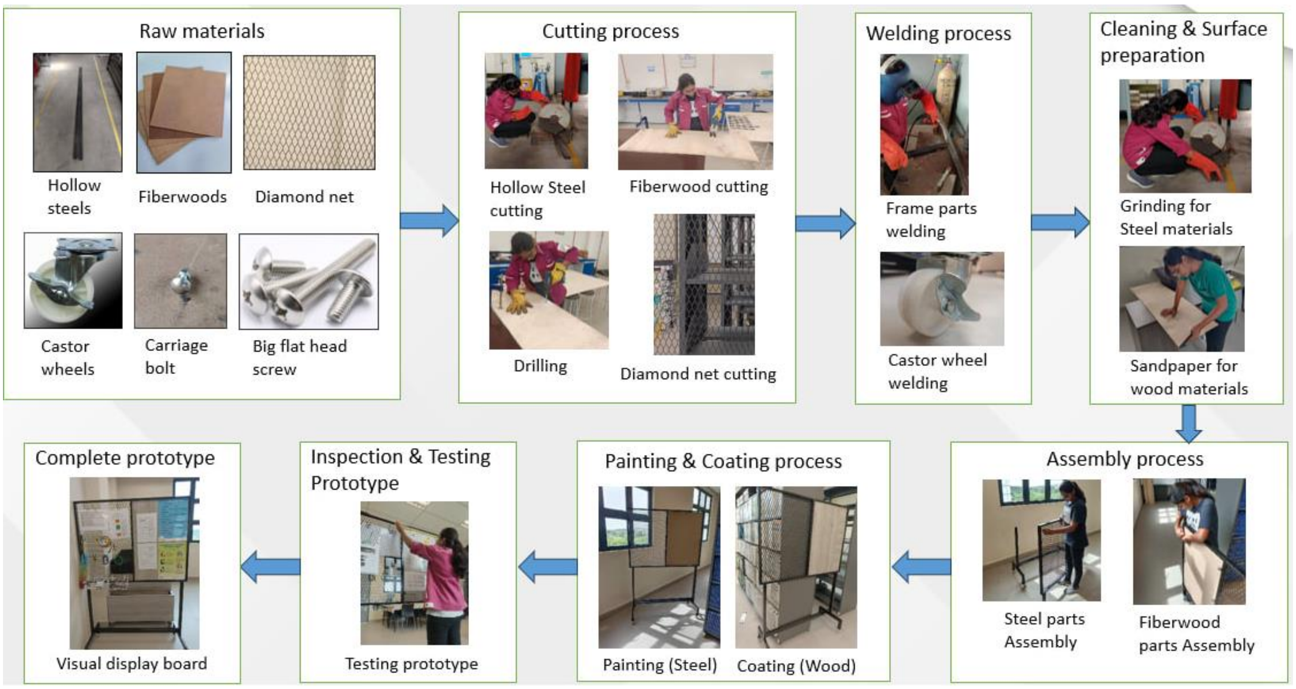

Fig. 1: Fabrication of visual display board

2.5 Inspection and Testing of a Prototype Model

The inspection and testing of the prototype model focused on ensuring quality and functionality through visual and dimensional inspections, as well as searchability and accessibility testing based on 5S principles. Visual inspections were conducted to identify any surface defects, alignment issues, or dimensional inaccuracies in the welded and assembled components. Dimensional measurements were taken to confirm adherence to design specifications. Additionally, searchability and accessibility tests were performed to evaluate the ease of locating and retrieving items on the visual display board, ensuring it met user requirements and improved overall efficiency. These evaluations validated the effectiveness of the prototype in achieving its intended purpose.

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2.6 Evaluation of Storage Room Organization and Prototype Performance after Implementing 5S Practices

The evaluation of storage organization and prototype performance after implementing 5S practices involved observations, structured interviews, and user feedback. Observations and walk-throughs, guided by a validated checklist, assessed efficiency, safety, accessibility, and organization in compliance with 5S principles. Structured interviews were conducted and provided insights into the storage room's improved accessibility and safety while identifying areas for further refinement [11]. The Pugh method, frequently referred to as the decision-matrix method, was employed to identify the best design alternative for a visual display board. Additionally, user satisfaction with the prototype was evaluated using a checklist and structured interviews, with feedback highlighting enhanced storage arrangements and compliance with 5S standards.

3. Results and Discussion

In this study, presents the results and discussions on improving storage room organization and developing a visual display board prototype using 5S practices. It includes validation of the structured interview protocol, analysis of design alternatives, and evaluation of the existing storage organization and user preferences [12]. The optimal design is selected using the Pugh method and analysed through SolidWorks simulations. Inspection and testing results highlight quality and accessibility improvements, while evaluations after implementing 5S practices assess storage organization and prototype performance.

3.1 Design Alternatives, Specifications and Features of Visual Display Board

This section examines multiple innovative designs, each tailored to optimize tool and equipment organization within a storage environment. It highlights the unique attributes of various visual display board configurations, evaluating their practicality, ergonomics, and efficiency in supporting 5S principles. The selection process incorporates criteria like accessibility, capacity, and flexibility to ensure the chosen design meets user needs effectively while improving overall functionality.

3.1.1 Design A: Height Adjustable Foam Type of Visual Display Board

As depicted in Figure 2, tool and equipment storage is made secure with custom-cut foam inserts in the height-adjustable foam type visual display board. Because this board is mounted on a height-adjustable frame, users can increase or reduce it to the preferred height, improving ergonomics and accessibility. Users can modify the board height to fit their own comfort zones, which reduces strain and enhances ergonomics.

***Fig. 2*:** Design A visualize a height adjustable foam type of visual display board

3.1.2 Design B: Two-Sided, Different Peg & Shadow Type of Visual Display Board

As shows in Figure 3, the dual-sided visual display board combines the advantages of a shadow board and a peg board on each side. Similar to the special qualities of every kind of board, this design maximizes the management of tools and equipment while offering clear benefits. A comprehensive approach to tool management is offered by the dual-sided board, which makes sure that every tool is easily accessible, neatly stored, and quickly identifiable.

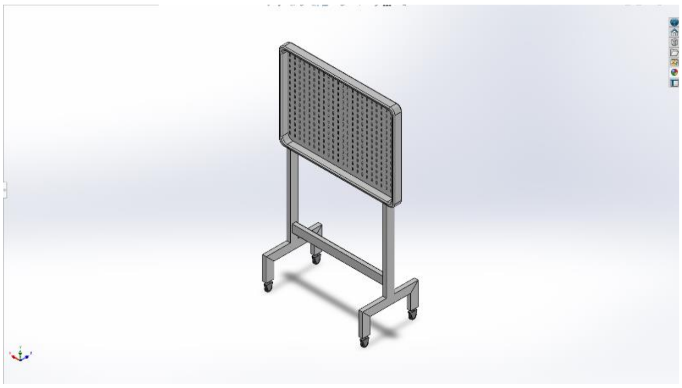

Fig. 3: Design B: Two-sided, different peg & shadow type of visual display board

3.1.3 Design C: One-Sided, Two Different Foam and Peg Type Visual Display Board

As shows in Figure 4, visual display board will have a single side that uses a different type of board to optimize organization and functionality. The design allows use of the advantages of both systems by combining peg boards and foam into a single visual display board, offering comprehensive tool management and organization.

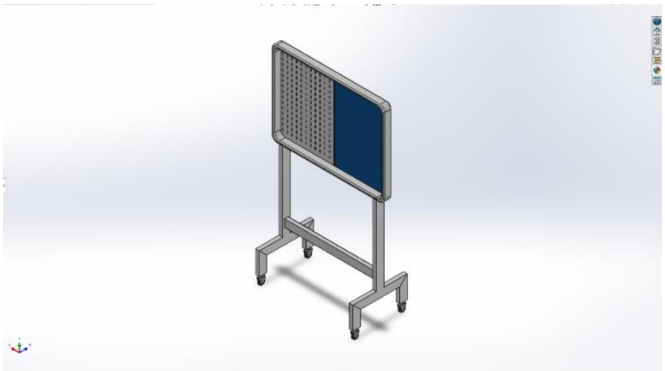

Fig. 4: Design C: One-sided, two different foam and peg type visual display board

3.2 Evaluation Results of the Existing Storage Room Organization and Visual Display Board before Implementing 5S Practices

The evaluation of the existing storage organization through observations and structured interviews highlights significant inefficiencies and safety concerns. Unnecessary items clutter the storage area, reducing space utilization and causing disorganization. Items are stored randomly without designated places, complicating retrieval and storage. The area is cluttered and unsafe, with hazards such as spills, leaks, and damaged units, as well as hazardous cable setups posing safety risks. The lack of consistent organizational practices and failure to sustain 5S principles contribute to ongoing neglect, hindering improvements in storage efficiency, safety, and overall upkeep [13].

3.3 Pugh Method Analysis for Selecting Design Alternatives of Visual Display Board

Using Pugh matrix method [14], the three design alternatives for the visual display board were evaluated based on capacity and the 5S methodology (Sort, Set in Order, Shine, Standardize, and Sustain) as summarized in Table 1. Design C, which combines foam and peg boards on a single side, scored the highest across all categories, offering the best capacity, flexibility, and long-term sustainability. It allows for efficient sorting and organization, supports reconfigurable arrangements, and promotes easier cleaning and maintenance. In contrast, Design A, featuring a height-adjustable foam layout, offers moderate capacity but lacks flexibility, scoring lower in several 5S categories. Design B, a two-sided peg and shadow board, provides slightly higher capacity but struggles with sorting and maintaining order due to its dual-sided nature, resulting in lower scores in terms of efficiency and sustainability.

Ultimately, Design C is the most adaptable and effective solution, meeting both short-term and long-term needs for tool organization.

Table 1: Pugh matrix for custom visual display board

Criterion (5S Principles)	Design A	Design B	Design C
C-1S (Sort)	1	0	3
C-2S (Set in Order)	1	0	3
C-3S (Shine)	1	0	3
C-4S (Standardize)	1	1	2
C-5S (Sustain)	1	0	3
Total	5	1	14

3.4 Design Analysis using SolidWorks Software

The design analysis using SolidWorks software provides a comprehensive evaluation of the visual display board's structural and functional integrity. By simulating stress, load, and displacement scenarios, the analysis identifies potential weaknesses and ensures the design meets safety and performance standards. This process helps optimize material usage, validate design reliability, and enhance the prototype's durability under real-world conditions. The insights gained from these simulations play a crucial role in refining the design for practical implementation.

3.4.1 Stress Analysis

The stress analysis of a visual display board likely performed using SolidWorks software. As displayed in Figure 5, the colour scale represents the magnitude of the von Mises stress, with red indicating the highest stress and blue the lowest. The maximum stress observed is 57.66 MPa, while the minimum stress is 0.002 MPa. The yield strength of the material is indicated as 220.594 MPa.

The stress distribution appears to be concentrated around the mounting points, the edges of the board, and the holes. This is expected as these areas experience higher loads due to the applied forces and constraints. The overall stress levels seem to be well below the yield strength, suggesting that the design is safe under the given loading conditions. However, it's important to note that this analysis is based on a specific loading scenario and assumptions made in the simulation. It's crucial to consider other factors like manufacturing tolerances, material properties, and environmental conditions for a complete evaluation of the board's structural integrity.

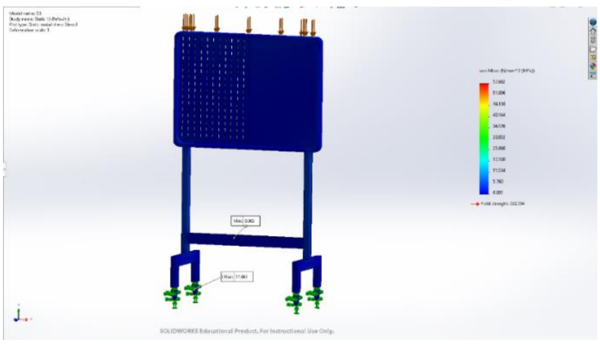

Fig. 5: Stress analysis

3.4.2 Simulation of Load and Performance Scenarios

Displacement analysis shows how much a part will move under a certain load. In this case, the color scale represents the magnitude of the displacement as shown in Figure 6, with red areas experiencing the most displacement and blue areas experiencing the least. The maximum displacement observed is 0.121 mm, while the minimum displacement is 0 mm.

Unfortunately, without additional context about the material properties and boundary conditions of the simulation, it's difficult to say definitively whether this amount of displacement is acceptable. However, any deformation can potentially affect the functionality of the board, so engineers will compare the displacement results to their design goals to determine if the design is sufficient. SolidWorks Simulation allows engineers to define various load scenarios to virtually test the performance of the board under different conditions. This helps identify potential weak points and optimize the design for better performance before a physical prototype is even built.

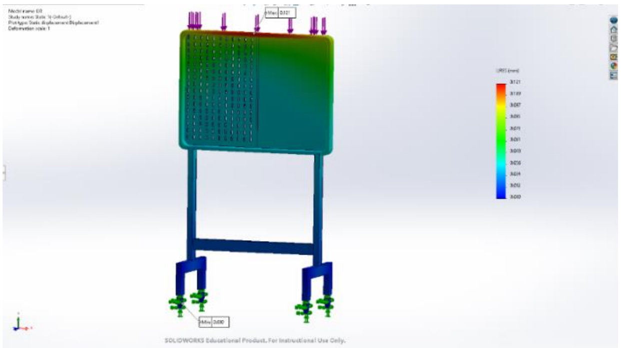

Fig. 6: Simulation of load and performance scenarios

3.5 Inspection and Testing Results

The inspection and testing of the prototype visual display board focused on ensuring its quality, functionality, and adherence to 5S principles [15]. Visual and dimensional quality inspections were conducted to identify any surface defects, alignment issues, or dimensional inaccuracies in the welded and assembled components. Measurements were taken to verify that the dimensions matched the design specifications, ensuring precision and reliability. These inspections confirmed that the prototype met the expected standards for build quality and accuracy. Searchability and accessibility testing evaluated the ease of locating and retrieving items using the visual display board. Users performed tasks involving the organization and retrieval of materials, with the results indicating significant improvements in efficiency and usability. The board's design facilitated better storage management and reduced time spent searching for items. Overall, the testing results validated the prototype's effectiveness in enhancing storage room organization and compliance with 5S practices, meeting both functional and user expectations. The Table 2 shows the complete data collected of the retrieval time.

Table 2: Data collected of the retrieval time

Condition	Retrieval Time (seconds)
Before implementation	22.91
	23.13
	24.96
After implementation	11.21
	11.82
	11.98

Average Retrieval Time
Before implementation : (22.91+23.13+24.96) / 3 = 23.67 seconds
After implementation : (11.21+11.82+11.98) / 3 = 11.67 seconds

The results demonstrate a significant improvement in retrieval efficiency following the implementation of the custom visual display board. The mean retrieval time reduced by 12cseconds, from 23.67 seconds to 11.67 seconds, achieving over 50% time savings highlighting the effectiveness of the new system in optimizing performance.

3.6 Evaluation of Storage Room Organization and Prototype Performance after Implementing 5S Practices

The evaluation of the storage room organization and prototype performance after implementing 5S practices revealed significant improvements in efficiency, organization, and user satisfaction. Observations and walk-throughs showed a transformation from disorder to a systematic and productive space, with features like a designated safe zone, red-tagged areas, and a visual display board serving as an information hub. Documents were organized chronologically and alphabetically, enhancing accessibility and functionality. Structured interviews highlighted user satisfaction with the improved cleanliness, specific item placements, and usability of the room. Expert feedback praised the visual display board for effectively displaying labels and aiding item organization, while designated zones improved storage and retrieval efficiency. These enhancements collectively contributed to a safer, more organized, and user-friendly storage environment [16]. Figure 7 shows the visual display board.

***Fig. 7*: Visual display board**

3.7 Discussion of Main Findings

The discussion of the main findings highlighted the significant improvements achieved through the implementation of 5S practices and the visual display board in the storage room. The project successfully enhanced floor space utilization, cleanliness, and orderliness, transforming the storage room into a more efficient and accessible space [17]. The adoption of systematic organization reduced time spent searching for items and minimized clutter, while designated safe zones and red-tagged areas improved safety and usability [18]. User feedback emphasized satisfaction with the enhanced organization, functionality, and aesthetics of the storage room, validating the effectiveness of the visual display board in streamlining operations [19]. These findings underscore the potential of 5S principles in improving storage room management and promoting a more productive and user-friendly environment [20].

4. Conclusion

The implementation of 5S practices in the university storage room at UTHM Pagoh has yielded transformative results, addressing initial challenges such as disorganization, inefficiency, and safety risks. By systematically applying the principles of Sort, Set in Order, Shine, Standardize, and Sustain, the project achieved significant improvements, including optimized use of floor space, systematic labelling and storage, enhanced cleanliness, and reduced time in locating tools and materials.

The introduction of a conceptual visual display board served as a pivotal tool for improving visual management, facilitating better adherence to 5S principles, and promoting user engagement. This project demonstrates the effectiveness of 5S practices in enhancing operational efficiency and safety, even in non-industrial settings such as educational institutions. Furthermore, it establishes a practical framework for fostering continuous improvement and long-term organizational discipline, positioning UTHM as a model for similar initiatives in other academic and administrative spaces.

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