Proceedings of the International Conference on Industrial Engineering and Operations Management

Publisher: IEOM Society International, USA DOI: 10.46254/AF6.20250210
Published: April 8, 2025

A Comparative Analysis of Different Approaches for Stock Counting Systems

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Abstract

Inventory management is a key part of any successful business. One of the most important elements that can affect inventory accuracy is stock counting. An excellent stock counting process means high efficiency and high financial gain as well. Further, using sustainable and technological methods for the process of counting stocks is essential, since it reduces waste and negative impact on the environment. Mistakes and errors in inventory management can lead to lower customer satisfaction and higher expenses. This paper aims to compare technological alternatives with conventional stock counting processes by employing a multi-method approach. A thorough literature review was conducted to gain a theoretical understanding of the process and key aspects associated with it. Following this, to support the findings from research papers, a questionnaire was provided to participants from major companies in Saudi Arabia. After that, the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), which is a multi-criteria decision-making (MCDM) method, was utilized to select the best alternative. Findings show that the drone-based system is the most beneficial solution for stock counting. It also indicated wide-ranging advantages of the technological techniques of stock counting and the need for stakeholders to comprehend the benefits of these approaches to improve both accuracy and efficiency. Lastly, utilizing efficient stock counting methods can lead to better inventory management.

Keywords

Stock Counting, Inventory Accuracy, Technological Techniques, MCDM, and Inventory Management.

1. Introduction

Nowadays, effective inventory management is important for any successful organization. One of the main processes of warehouse operations and inventory control is stock counting. It holds importance as it involves keeping records and monitoring all items. Stock counting helps ensure reliability and financial statements, as a company tracks inventory levels of goods. However, despite the rise of automated options for inventory management and stock counting, many organizations still rely on traditional approaches. Conventional stock counting techniques encounter many difficulties such as discrepancies and errors which hold major risks in the overall financial aspects of the

business. Hence, to address this issue, the need to promote automated and sustainable alternatives is increasing to obtain high accuracy results and streamline warehouse operations.

This paper demonstrates the role of the stock counting process in inventory management, the associated errors, and the challenges. Subsequently, it explores several digital methods that have an impact on lowering the errors of the stock counting process. The study utilizes several analysis methods, starting with analyzing the answers gained from a well-structured questionnaire. Additionally, the TOPSIS method is used to help in determining the best method based on different criteria. Ultimately, the implementation of an effective method for stock counting system is expected to enhance the overall operational efficiency in warehouses by reducing time and errors.

1.1 Objectives

The objective of the study is to assess the current state of stock counting systems in Saudi Arabian warehouses. In addition, to compare the various technological methods of stock counting and to investigate the effect of technology adoption on inventory errors. The study can also help companies in deciding and evaluating the right approach for their stock counting system. The results of the research are hoped to assist organizations in improving their stock counting process, thus achieving greater efficiency, accuracy, and profitability.

2. Literature Review

In this literature review, the breadth of academic and practical insights pertinent to optimizing stock counting systems within warehouse operations is examined. This review aims to fill the gap between current practices and potential enhancements by analyzing relevant literature. First, an investigation of the stock counting process and the common errors and challenges associated will be shown. Secondly, a comprehensive overview of the technological methods used in stock counting. Based on research demonstrating their effectiveness, four key methods will be discussed: Barcode Scanners, Radio Frequency Identification (RFID), Mobile Apps, and Drones.

One of the most important processes that companies must control is the stock counting and tracking process. Each company must have an accurate stock counting system to manage it properly and periodically compare the system's inventory records with the reality in the company's warehouses. The inventory management process is of the utmost importance to ensure good supply and avoid shortages (Chandren et al. 2015). A shortage can prevent the company from being able to fulfill its customers' requests and increase inventory in a way that costs the company additional storage costs and damages the excess inventory. Companies use different systems to manage and count inventory. Some companies use traditional methods of annual counting once a year or multiple times, which have many flaws. Some of these flaws are the inability of these methods to give an overall picture of the inventory's status, and they cannot mitigate the risk of overstock or out stock (Wijffels et al. 2016). On the other hand, several organizations adopt more efficient alternatives for stock counting purposes, which help in monitoring the stock periodically as well as plan the warehousing operations with high efficiency and accuracy (Achieng et al. 2018).

High accuracy in inventory management is extremely critical. In contrast, discrepancies and errors, specifically in the stock counting process, hold major risks in the overall financial aspects of the business. Errors are more likely to occur when inventory management procedures include manual labor and human involvement, such as counting and registering goods. Over time, these errors may compound, resulting in notable disparities in inventory records and inefficiencies in operations (Khader et al. 2014). This misalignment is referred to as Inventory Record Inaccuracy (IRI). It is a well-known error that impacts most retailers, warehouses, and manufacturing. Reasons behind IRI are often related to counting errors, transactional mistakes, or mislabeled items (Mohd Mahzani et al. 2021). Furthermore, time is critical in warehouses operations due to their rapid speed. The companies' performance can be negatively impacted by any time-consuming processes in inventory management, which can result in missed deadlines and lower customer satisfaction (Li et al. 2019). Thus, efforts to enhance inventory accuracy and time are usually directed toward the minimization of reliance on manual processing.

With the spread of digitalization and sustainability, many companies use modern technologies to manage their inventory, abandoning traditional paper methods, which have a negative impact on the environment. These modern systems have contributed to protecting the environment by eliminating paper waste in large quantities in conventional operations (Moghrabi et al. 2023). In addition, technological systems have reduced human errors and resulted in effective use of resources, making digitization and sustainability strategic options for companies in their stock counting process. Androod et al. (2024) discuss the sustainability-related impacts of digitalization on supply chain

management. These modern systems give the inventory managers accurate, instant indicators of the inventory status of various goods. They can alert them to any critical variables in the inventory that require action through software. Therefore, taking advantage of modern digital technologies in stock counting provides companies with an accurate picture of the inventory status from all aspects, moment by moment.

In today's business landscape, barcodes are commonly found in warehouses and retail stores, facilitating product tracking and enabling efficient checkout processes (Deepali & Monika, 2024). Implementing stock counting through an application with barcode scanning necessitates fewer human resources. Approximately, it requires only six individuals compared to the 18 needed for manual stock counting, according to the research conducted by Shahridan et al. (2022) focuses on enhancing the inventory management system. Activities related to stock counting using the application can be conducted during regular working hours, over a few days, and involve only the management team without requiring the participation of unit staff. This approach also helps to reduce employee costs. In contrast, the manual stock counting method is completed in a single day, leading to extended working hours, fatigue, inaccuracies, and increased employee costs. The reduced staff required, and the quicker processing time, make the barcode-based stock counting system particularly suitable during a pandemic, addressing the challenges of staff limitations and restrictions.

RFID technology has revolutionized stock counting and inventory management, offering distinct advantages over traditional methods. Utilizing electromagnetic fields to automatically identify and track tags attached to items, RFID significantly enhances accuracy through reduced human error and allows for automatic data collection during inventory counts (Huang & Cummings, 2017). This technology enables rapid scanning of multiple tags at once, greatly minimizing the time needed for stock counting. RFID and barcode technologies have emerged as two prominent options. Each has unique strengths and weaknesses, particularly when considering their performance in various environments and applications. Research conducted by Sandhu and Ukwoma (2012) indicates that RFID tags can be negatively impacted by challenging environments, particularly when they encounter metal or liquids. In contrast, barcodes can be printed on robust materials and remain unaffected by substrate materials or electromagnetic emissions, giving them a competitive advantage in certain industries and environments. Notably, two-dimensional barcodes can still be read even if damaged, further narrowing the gap between these two technologies.

Experiment performed by White et al. (2007) revealed that RFID and barcodes had various errors in 200 timing measurements. The error rate for barcodes was 45.5%, with 91 errors, while RFID had a slightly higher error rate of 46.5%, with 93 errors, suggesting that RFID is slightly more likely to make errors during the scanning process. This could be explained by the fact that barcode technology has been around for many years and, therefore, is more mature. The main issues with barcoding are missing or damaged labels, which means that successful implementation will likely need the suppliers' involvement in defining and sustaining certain levels of labeling.

The integration of smartphone applications in stock counting represents a transformative shift from traditional manual methods to technology-driven solutions, leveraging advancements in computer vision, sensor fusion, and mobile computing. Ablidas et al. (2019) discuss the application of image processing technology in counting rebars as an alternative to the manual counting process, highlighting its effectiveness and efficiency. It has been demonstrated that using an image counter was more effective and reliable than manual counting methods. With this system, all items could be checked and validated, reducing the chances of miscounts. Furthermore, Abubakar et al. (2023) present the "Stock Count" application system, which is designed for accurate object counting and tracking using mobile devices. It accesses advanced inventory tools by utilizing on-device machine learning, enabling users to capture or upload images for object detection and counting. The app features real-time processing, customizable detection parameters, and cloud-based logging via Firebase. While it simplifies tasks for small businesses and warehouse managers, challenges persist in low-light conditions, cluttered scenes, and computational limits, achieving 95% accuracy in controlled tests. Meanwhile, the evaluation of the proposed system analyzed by Lertsawatwicha et al. (2022) concludes that the overall accuracy is 84.17%. However, some numbers were missing due to poor image quality, thus, one promising approach is using deep learning techniques to detect unstructured text in images.

Drones or unmanned aerial vehicles (UAVs) can be remotely or autonomously controlled. They are adaptable devices that leverage wireless technology for a range of applications, including video recording and emergency assistance. As technology advances and global connectivity increases, their usefulness is expected to expand further. While they operate with minimal human intervention, navigation, and data verification oversight are required, maintaining a hybrid model that balances automation with human decision-making (Burke & Ewing 2014). Moreover, drone systems

reduce inventory processing time, enhance accuracy, lower labor costs, and improve worker safety by eliminating manual access to elevated storage. These systems decrease errors and boost inventory efficiency by reducing reliance on manual processes. Combining automation and human oversight ensures faster, reliable operations, improving customer satisfaction and reducing operational costs (Atieh et al. 2016). A survey conducted by Thomaidis and Zeimpekis (2024) investigates the operational parameters that affect the use of drones in the goods' stock count process, demonstrating significant improvements in efficiency and accuracy. The results revealed that most respondents (86%) expressed interest in using UAVs to automate the stock counting process. In addition, the findings of this study are significant as they identify the factors that affect drone performance in stock counting. Several factors and their combinations that affect drone efficiency were identified through analysis. It also shows that scanning multiple rack levels at once reduces stock counting time. Also, higher UAV speed minimizes the time taken for stock count as the drone can cover the same distance in a shorter time. However, a study conducted by Cidal et al. (2019) highlighted that there are higher costs associated with the implementation of semi-automated systems, and there may be interference with the signal in environments that have high amounts of metal, such as military warehouses.

To sum up, the identified gap in literature stems from a lack of comparative research focused on the technologies used in stock counting. While various stock counting methods and technologies have been individually studied, there has been insufficient exploration of how these technologies perform relative to one another. Hence, this gap presents an opportunity to analyze and compare the applicability of different stock counting technologies, providing valuable insights for businesses seeking to optimize their inventory management processes.

3. Methods

In any research project, the initial step is to define the research methodology. In the context of stock counting, applied research is the most suitable choice, as it focuses on addressing practical challenges in organizations. This methodology facilitates the development of targeted solutions, such as optimizing stock counting processes by evaluating various alternatives, ultimately benefiting stakeholders and improving operational efficiency. Additionally, this research utilizes different analysis methods, including qualitative and quantitative. A comprehensive literature-based analysis is conducted, followed by analyzing the answers obtained from the questionnaire. Also, a comparative analysis using TOPSIS multi-criteria decision-making, to assess the viability of each alternative, guiding the decision-making process among the options. The analysis is further strengthened through a Monte Carlo simulation, which generates 10,000 datasets. This approach enhances the reliability of statistical conclusions by capturing the variability present in real-world settings. Additionally, Monte Carlo simulation allows efficient data generation, eliminating the need for time-consuming and costly real-world experiments (Harrison 2011).

TOPSIS is a widely used multi-criteria decision-making method that ranks alternatives based on their relative closeness to an ideal solution. Introduced by Hwang and Yoon in 1981, TOPSIS follows the concept that the best alternative should have the shortest distance from the positive ideal solution (PIS) and the farthest distance from the negative ideal solution (NIS) The fundamental premise of TOPSIS is its ability to provide a structured approach for decision-making by considering both benefit and cost criteria, ensuring a rational and objective selection of alternatives. It calculates a closeness coefficient, which quantifies how close an alternative is to the optimal solution and ranks all available options accordingly (Behzadian et al. 2012). According to Taherdoost and Madanchian (2024), TOPSIS offers several advantages. Its computational simplicity and intuitive approach make it easy to implement in practical decision-making scenarios. Additionally, it effectively handles both qualitative and quantitative data, making it highly versatile. This ranking is based on mathematical distance measurements, ensuring a logical, structured, and repeatable approach to decision-making. In addition, the method is particularly effective in complex decision-making environments where multiple conflicting criteria exist, making it a preferred choice across various industries such as supply chain management, healthcare, and manufacturing. Madanchian and Taherdoost (2023) provided a comprehensive guide to the TOPSIS method; accordingly, the following steps were implemented:

1. Normalizing the Decision Matrix: Convert the decision matrix into a normalized form to eliminate the effects of different units.
2. Calculating the Weighted Normalized Matrix: Multiply each normalized value by its corresponding weight to reflect the importance of each criterion.
3. Determining the Positive Ideal and Negative Ideal Solutions: Identify the best (positive ideal) and worst (negative ideal) values for each criterion across all alternatives.

4. Calculating the Separating Measures: Compute the distance of each alternative from the positive and negative ideal solutions.
5. Calculating Relative Closeness: Determine the relative closeness of each alternative to the positive ideal solution
6. Ranking the Alternatives: Rank the alternatives based on their relative closeness values, with higher values indicating better options.

4. Data Collection

The data was collected from various sources such as direct observations, surveys and a series of virtual and in-person interviews, which resulted in both quantitative and qualitative data to analyze. Moreover, a thorough review of existing studies, research papers, and available companies' reports were investigated to gather the needed information and data on technological methods for the stock counting process. In addition, a cross-sectional study is conducted using a questionnaire to analyze the warehouse's status with the stock counting process.

5. Results and Discussion

This section provides the results of this research aimed at evaluating the stock counting process. The section will highlight the survey results, followed by TOPSIS outcomes, and finally, the cost analysis.

5.1 Survey

The survey is designed to gather insights about the stock counting process in Saudi Arabian warehouses, gaining a total of 83 answers from different-sized organizations. It includes 13 questions, and it was distributed to companies across various sectors in Saudi Arabia, including FMCG, medical supplies, stationery, spare parts, and general supplies, as indicated in Figure 1. The FMCG sector emerged as the most prominent, with 30 respondents choosing it, while the supplies sector was also quite close, with 15 responses. Approximately nine responses were in the pharmaceuticals, electronic parts, and stationery materials sectors. Moreover, the medical items category had a relatively moderate level of participation, and the spare parts sector had the fewest respondents.

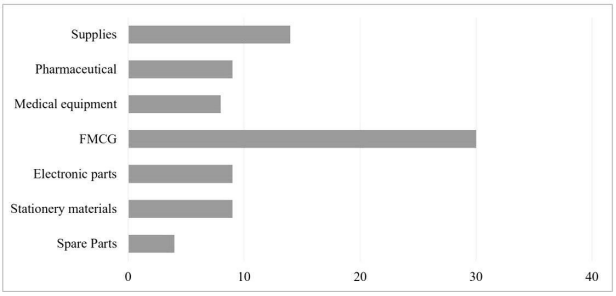

Figure 1. Type of Business

Subsequently, the answers demonstrate that most participants used manual stock counting methods, with 62% of the responses, as Figure 2 shows. In comparison, only 38% of them reported using technological methods for stock counting, indicating that there is a prevailing practice in organizations to continue with traditional methods rather than adopting technological advances, which could improve the efficiency, operational performance, and accuracy of the inventory management system.

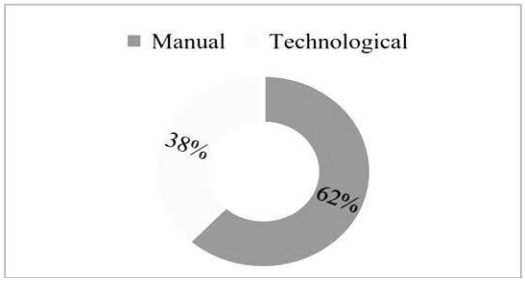

Figure 2. Stock Counting Methods

Moving to Figure 3, the participants were asked if they selected that they are using technological methods for stock counting and what these methods are. The bar chart highlights the stock counting preferences among participants, with barcode scanning leading significantly at 23 responses, reflecting efficiency and popularity. Phone applications for stock counting garnered only six responses, indicating a limited adoption. Notably, RFID technology and drones received no responses, suggesting a lack of integration of these advanced methods in inventory management.

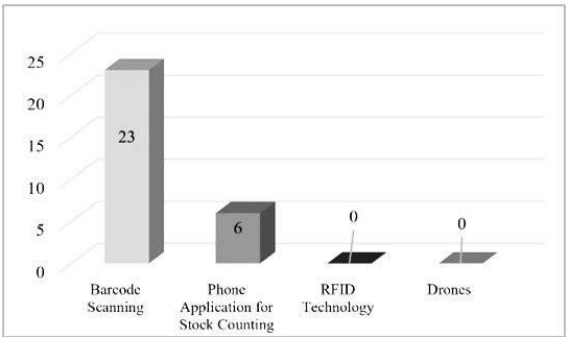

Figure 3. Technological Techniques

The pie chart in Figure 4 shows how stock counting discrepancies affect operational performance. While 55% of respondents reported minor financial losses, indicating manageable discrepancies, 33% experienced significant losses, highlighting the serious impact on profitability. Additionally, 12% reported no losses, likely due to effective stock management. Overall, most companies face minor losses, but a substantial portion encounters significant financial challenges, underscoring the need for more accurate stock counting methods.

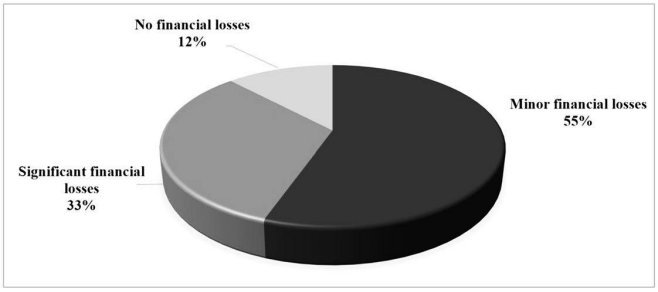

Figure 4. Stock Counting Discrepancies Impact

Moreover, Figure 5 shows the problems encountered with stock counting. The main problem with the manual methods is human error, which was identified by 29 participants, while time-consuming is an issue for 20 participants. On the other hand, technological methods also have their challenges, including human error, which was reported by 17 participants, time and cost, reported by nine and five participants, respectively. Four respondents mentioned integration problems with current systems. In general, manual methods are more inaccurate and slower than technological methods, but technological methods are expensive and have problems integrating with existing systems.

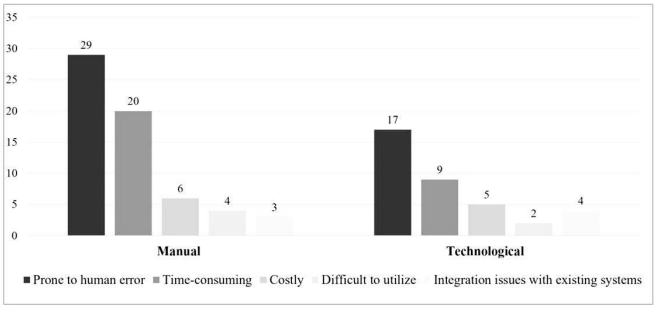

Figure 5. Stock Counting Challenges

5.2 TOPSIS

The data gathered from surveys, interviews with industry professionals and experts, direct observations, and comprehensive literature reviews yielded valuable insights. This information was meticulously analyzed to identify the ranges for each criterion associated with various alternatives, as well as to assess the relative importance of each criterion. This analysis ensures that the evaluation framework accurately reflects the priorities and challenges faced in the real-world industry. The next step involves comparing the alternatives based on multiple criteria. In this research, the approach for determining criteria weights was informed by the framework developed by (Dammak et al. 2015)**,** which examines the effects of criterion weights techniques in the TOPSIS method for multi-criteria decision-making. The evaluation framework assigns weights to each criterion based on importance: Accuracy (35%), Time of Counting (22%), Compatibility (18%), Ease of Use (13%), and Cost (12%). This weighting reflects the critical factors for assessing alternatives in line with industry priorities. After generating the dataset through a Monte Carlo Simulation, we calculated the averages for each method across all criteria. The results from the TOPSIS method implemented in Python are presented in Table 1. Drone has the highest TOPSIS score and is therefore the best of the methods identified for stock counting. Furthermore, the Barcode method is ranked second with a TOPSIS score of 0.745534, demonstrating a strong balance between cost and performance. The RFID method is ranked third with a score of 0.634976, which indicates that it has reasonable performance but at a higher cost. The phone app method had a score of 0.522939, which shows moderate effectiveness, while Manual counting was the worst with a score of 0.199581. In general, the results of the study indicate that the Drone method is the clear leader in accuracy and efficiency, while the other methods, particularly Barcode, offer competitive alternatives with varying trade-offs.

Table 1. TOPSIS Results

Method	Time per Item (min)	Total Cost ($)	Ease of Use (1-10)	Accuracy (%)	Compatibility (%)	TOPSIS Score	Rank
Drone	0.50	74530.55	8.50	98.50	80.55	0.864049	1.0
Barcode	0.85	33285.71	8.01	90.02	67.00	0.745534	2.0
RFID	0.95	66096.33	7.55	82.61	63.07	0.634976	3.0
Phone App	1.20	44831.47	5.00	77.42	70.20	0.522939	4.0
Manual	2.00	32057.94	3.98	62.27	44.91	0.195951	5.0

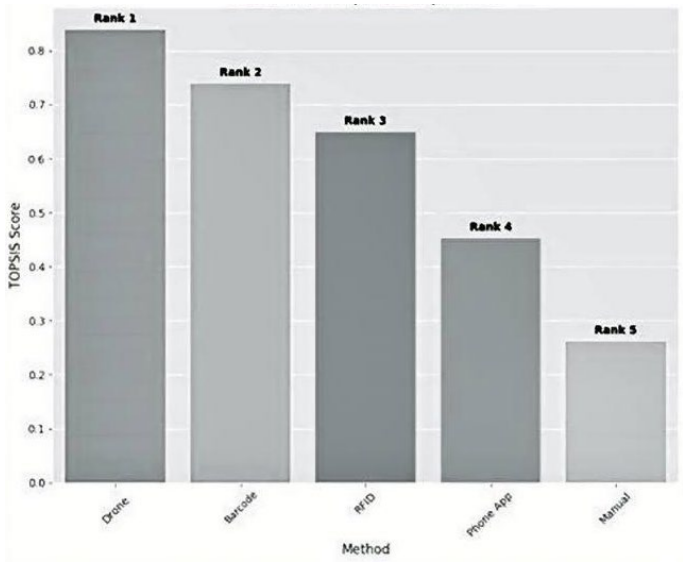

Figure SEQ Figure * ARABIC 6. Bar Graph of TOPSIS Scores Ranking

Figure 6 presents a bar graph displaying the ranked alternatives. The drone method stands as the most efficient one because it operates at high speed and achieves precise results. The barcode system ranks second because it provides reliable results, although it operates at a lower level of sophistication. The third position goes to RFID technology which provides real-time tracking yet encounters obstacles related to cost and system complexity. The phone app holds the fourth position, which implies its efficiency level is lower than the top methods. Lastly, the manual method receives the lowest ranking because it demonstrates both inefficiency and error-prone operations, thus showing why advanced inventory management technologies should be adopted.

Overall, findings from the survey provide valuable insights into current stock counting practices among various sizes of organizations' warehouses in Saudi Arabia. The results indicate that a significant majority of participants rely on manual stock counting methods. Within technological methods, barcode scanning is the most popular choice, demonstrating its efficiency, while other advanced technologies like RFID and drones remain largely unused. The responses also highlight that companies with manual stock counting methods are facing problems with accurate results, which suggests that technological methods are important for more efficient and accurate inventory management systems. Moreover, most participants indicated that errors in the stock counting process can lead to both minor and significant financial losses. Therefore, alternative solutions are favored to mitigate the negative impacts of these errors and discrepancies. A range of technological methods is available for stock counting. Hence, the TOPSIS method was utilized to identify the optimal solution based on multiple criteria. The results revealed that drones are the most effective option, likely due to their demonstrated superior accuracy in various research studies. At the same time, barcode scanning is preferred in general-use cases for its balance of speed, accuracy, and affordability. RFID technology is favored in high-tech environments where both speed and precision are crucial, whereas drones excel in large warehouses that require rapid scanning capabilities. Additionally, phone-based counting is a popular choice among small businesses, prioritizing less time and ease of use, but not high accuracy. However, manual counting is the least preferred method to be selected, except when the cost is the primary concern.

6. Conclusion

In conclusion, stock counting is the process of physically counting the actual items in the company's warehouse to ensure that records are accurate. This paper analyzed and compared technological alternatives with traditional stock counting methods using a multi-method approach. A comprehensive literature review was conducted to establish a theoretical framework for understanding the process and its key components. Following this, a questionnaire was administered to participants from major companies in Saudi Arabia to validate the findings from existing research. The Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), a method for multi-criteria decision-making (MCDM), was employed to identify the optimal alternative. The results indicated that the drone-based system

was the most advantageous solution for stock counting. Additionally, it was found that manual stock counting is still dominant in Saudi Arabian Businesses, while barcode scanning is the most popular technological solution used. Also, companies face minor and major financial losses due to errors resulting from the stock counting process. Finally, adopting effective stock counting methods contributed to improved inventory management. These methods reduce waste, paper use, and resource misuse, which not only streamline operations but also support sustainability

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Biographies

Farheen Bano is an Assistant Professor in the Department of Industrial Engineering at King Abdulaziz University, with a strong background in academia and a Ph.D. She possesses expertise in ergonomics, focusing on designing systems that enhance human well-being and productivity. Her knowledge of human factors, psychology and cognitive ergonomics informs her of work on user-friendly systems and human-machine interactions. Committed to health and safety, she develops effective safety protocols and risk assessment strategies.

Arwa Nabil is a senior industrial engineering student at King Abdulaziz University, where her passion for new technologies has grown. She is captivated by the art of optimization and the principles of industrial engineering, which emphasize continuous improvement and growth of her mindset. Her involvement in various student clubs has also helped her build valuable connections and collaborate with others. Arwa excels in data analysis, problem-solving, and analytical thinking, allowing her to tackle complex challenges effectively.

Afnan Albukhari is a senior industrial engineering student with a strong focus on supply chain and inventory management. Throughout her studies, she has developed a solid foundation in key areas such as Operations Research, Industrial Management, and Quality Control. Afnan is particularly passionate about integrating sustainability practices within industrial processes, believing that optimization can enhance both efficiency and environmental responsibility. She aims to apply her theoretical knowledge to real-world challenges and is committed to continuous improvement and excellence. This dedication positions her as an asset in any professional environment. Afnan is excited about the prospect of contributing meaningfully to the field of industrial engineering.

Shatha Alghamdi is a senior industrial engineering student at King Abdulaziz University. She has excelled in courses such as Decision Analysis, Supply Chains, Material Handling, Engineering Management, and Design of Experiments, demonstrating exceptional proficiency and a deep passion for these subjects. Shatha is particularly passionate about data analysis and its application in optimizing processes and supporting informed decision-making. Throughout her academic career, Shatha has been a participant in various university clubs and communities, where she has contributed to multiple initiatives, honing her leadership and teamwork abilities.

Mariam Balamash is a senior industrial engineering student at King Abdulaziz University. She has obtained a strong interest in process optimization and data-driven problem-solving. Throughout her academic journey, she has engaged in a variety of collaborative projects aimed at enhancing operational efficiency across different sectors. Mariam is skilled in several programming languages, including Python, Java, Oracle, and C#, she utilizes her technical abilities to analyze data and develop effective solutions. She is committed to continuous learning, exploring innovative engineering solutions, and staying abreast of industry trends.