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Utilizing Single-Server Multiple Customer Queuing Theory for Production Efficiency in Footwear Manufacturing Operation

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Abstract

The footwear industry has a rich history, and producing comfort and style is one of the critical factors affecting consumers' choices in purchasing. Local shoemakers in the Philippines face challenges due to intense competition in the rapidly growing global market. This study focuses on analyzing the production of the footwear manufacturing industry to identify and provide solutions to pressing problems such as inefficiencies. The goal is to conduct a thorough analysis and improve the company's system performance measures, which include idle time, waiting time, arrival rate, and service rate. This study evaluates the production of the footwear manufacturing industry to determine and resolve inefficiencies using queuing theory, particularly the single-server, multiple-customer model, whereas the strategy provides significant insights into the manufacturing operations, which benefits the company's development and progress. Through queuing theory model application and Promodel Simulation, the three workstations have decreased idle time by 18% in sewing, 8% in upper making, and 6% in shoemaking. It proves that the study has achieved notable results in minimizing idle time thus, increasing work efficiencies using Kendall's notation. However, to further explore, this study recommends examining the monetary sector in the aspect of 5M's using the Game theory, and DEA CCR Model to equal with competitors and market as this approach may offer external factors to enhance the effectiveness and practicality of the solutions that this study has provided.

Keywords
Inefficiencies, Idle Time, Productivity, Queuing Theory, Utilization Rate

Introduction
Company operations rely significantly on analyzing several connected processes, including reaching the system queue, standing in line for a while, and worker utilization rate. One of the effective approaches for analyzing the performance systems is to apply the Queuing Theory, which may be depicted as network queues in the manufacturing business. The Queuing theory model is a fundamental mathematical principle in understanding the behavior of queues, waiting times, and production flow of diverse industries such as transportation, telecommunications, services, and manufacturing (Xiong 2023). It plays a prominent role in aiding and determining where in the manufacturing processes that requires optimization and enhanced efficiency to foster growth and development in the company. Moreover, it facilitates better resource allocations, increased flexibility, and improved quality control within the organization. By leveraging mathematical models and simulations, the queuing theory model provides better development in the systems, improving the overall quality performance of a company.

Single Server, Multiple Customer System is a mathematical framework to optimize manufacturing systems. The single server, multiple customer model provides metrics such as utilization rate, expected parts in the system and queue, and average time in the system and queue that are crucial in determining the performance of the workers. Analyzing these key metrics allows the company to identify bottlenecks, and optimize techniques and overall performance of production (Sandhiya & Varadharajan 2018) With the functions and principles of the queuing theory model single server, multiple customer systems, the study maximizes the capability of the queuing theory in solving the problem in a company. More so, the single-server, multiple-customer model of queuing theory incorporates a thorough investigation through the computation of arrival rate, waiting time, idle time, and utilization rate in the system, which plays a prominent role in providing a comprehensive analysis of the production system. This paper provides an in-depth analysis of the process in a manufacturing context to address issues and solutions in the system. The study will be augmented with the queuing theory single server multiple customer model, highlighting areas for process improvement and assisting in establishing the business's best solutions.

1.1 Problem Statement

The Footwear Company has established a good reputation for trendy and quality footwear for over two decades. The owner has designed and created thousands of footwear for children and adults. Yet, production gaps should be addressed, which are vital in maximizing the company's production numbers. Based on the data gathered from the time study, the study opted to identify the cause of waiting lines, idle time, and queues in the company. In line with this, the study used the Stochastic approach, the Queuing theory. The study will mainly focus on determining the root cause of the company's product inefficiency. The study will use the queuing theory and model simulations to identify where the present process causes the inefficiency and provide solutions for the problem to improve the process. Also to increase workers' utilization rate and minimize the need for materials transportation. Further, this study limits the monetary value, as the company chooses not to disclose its financial status and will solely focus on solving product inefficiency and improving the operational process. The manufacturing company has challenges to increase production efficiency while achieving rising market demand. This study identified the problems by analyzing and optimizing manufacturing processes using the queuing theory. This includes identifying and improving delays, bottlenecks, and overall resource usage in the manufacturing process. Resolving these factors, not only strategies to increase the company's production statistics but also results in a beneficial influence that benefits all involved parties.

1.2 Objectives

The general objective of this study is to conduct a thorough analysis and improve the company's system performance measures which include idle time, waiting time, arrival rate, and service rate. The queuing theory model was employed as a mathematical principle to understand the behavior of queues, waiting times, and flow of various industries such as transportation, telecommunications, services, and manufacturing (Xiong 2023). The functions and principles of the queuing theory model, the study maximize the capability of the queuing theory in solving the problem in a company. More so, the Queuing Theory Case model incorporates a thorough investigation through the computation of arrival rate, waiting time, idle time, and utilization rate in the system, which plays a prominent role in providing a comprehensive analysis of the production system. This study provides an in-depth analysis of the process in a manufacturing context to address issues and solutions in the system. These elements are crucial in understanding the efficiency and productivity of the system to identify the bottleneck that causes idle time and production inefficiency:

1. To identify the bottleneck that causes idle time and production inefficiency.
2. To evaluate the system performance and improve the shoe manufacturing process using Kendall's notation model of queuing theory.
3. To calculate a maximized worker utilization through the Single Server, Multiple Customer formula to increase productivity and efficiency.
4. To evaluate the existing arrival process and generate an improved workflow with minimized idle and transportation time for a Poisson process.

2. Literature Review

Queuing theory is a fundamental mathematical equation that enables companies to optimize resource utilization and evaluate queues through a thorough computation analysis. It facilitates determining and eliminating bottlenecks, hence increasing operational efficiency. This improves customer service by anticipating and controlling wait times. This also offers a systematic way to study complex systems across several sectors and enables data-driven decision-making by delivering quantitative insights into essential performance indicators. The study of Muhammad et al. (2021), highlights that the queuing theory model offers a systematic and analytical framework for addressing various problems in a small or medium enterprise to improve satisfaction. It provides a data-driven approach to developing a practical implementation of solutions. Further, the key elements of the queuing theory model such as arrival rate, service rate, number of servers, and queuing discipline (First in First Out) are applied to determine the traffic intensity and analyze where the time of the day provides the highest waiting time. Through the application of queuing theory, the study concluded that morning and evening sessions are the busiest times of the day hence, improving bus time schedules, and enforcing different routes will be beneficial in avoiding this problem (Divya & Rekha 2021).

The single-server queuing model is the simplest basic queueing model used within the Footwear Industry, accommodating variations in arrival rates and service times. In this model, clients come to a single server (or service station) and line to be served. Tšernov's (2022) study evaluates systems with a single server method, providing clients based on a Poisson process with an exponential distribution. It optimizes the utilization of resources and service efficiency by analyzing arrival and service rates, queue lengths, and waiting time. This method is usually used in shoe manufacturing to improve assembly operations by simulating queues and bottlenecks. It simplifies the decision-making process for managing production line efficiency. Workstation performance is enhanced by analyzing factors such as cycle time, utilization of machines, and the details of the service, where queuing models are used to provide outcomes such as average queue length and waiting time, which are then compared to standard data to observe possibilities for enhancement (Hernández-González et al. 2018).

Essentially, queuing theory is commonly associated with service systems like banks or call centers, where its principles can be applied to any other situation where entities include them, such as orders in manufacturing, waiting for services, or typically processing production from a limited-capacity resource like a production line. Therefore, this method can be beneficial for optimizing operations within the footwear manufacturing industry. Win (2019) found that Kendall's notation can be used in service sectors like restaurants. Given its concepts, it provided multiple opportunities to improve management in terms of servicing clients differently on weekends and weekdays. Therefore, it can be beneficial in optimizing operations within the footwear manufacturing industry. The study utilizes a single-server, multiple-customer queueing theory method to evaluate and optimize production processes. Using this model, the study intends to identify, reduce, and resolve bottlenecks, minimize waiting times, and improve overall efficiency in manufacturing operations, resulting in increased output and improved utilization of resources in the sector.

3. Methodology

The Footwear Manufacturing Company has seven workstation operations. The allocation of resources and workstations per human resources available ratio is 1:1. The application of the queuing theory model, single server multiple customer systems was utilized to analyze and optimize the performance of the workers and comprehensively determine the areas need for improvement through computation of arrival rate, waiting time, idle time, and service rate. The study will use MATLAB software to develop mathematical equations and statistics to analyze and simulate queuing scenarios to solve the company's predetermined production inefficiency.

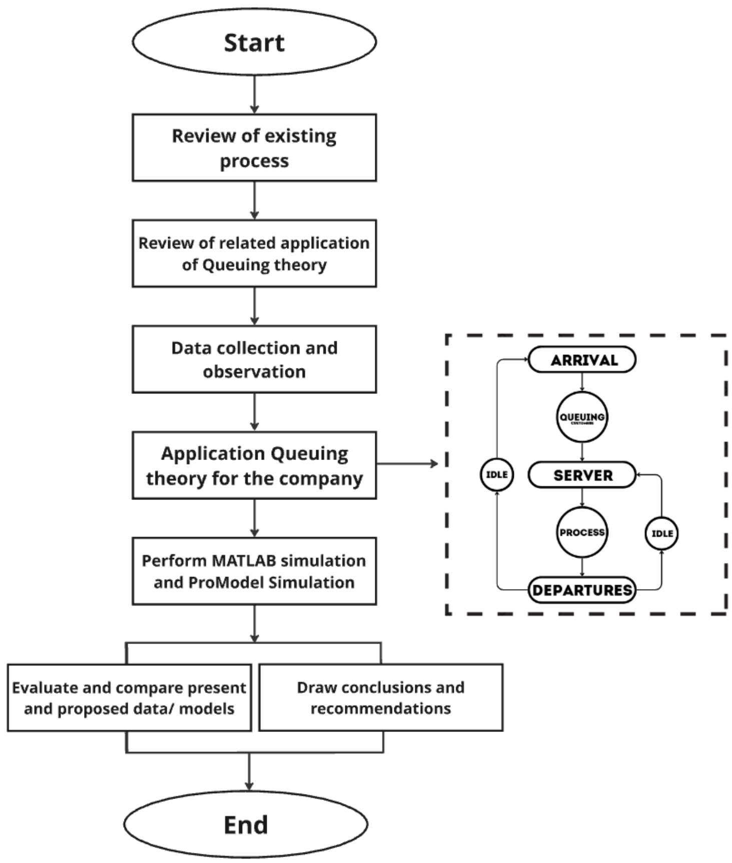

Figure 1. Case Methodology Utilizing Queuing Theory in a Footwear Manufacturing Company

In line with this, the study will also utilize the ProModel simulation to simulate the process and system performance that aids in assessing the utilization rate of each workstation, thus providing interventions to improve the output numbers. Figure 1 shows the steps in solving the company's problem by reviewing the industry process of the company and identifying the relation of queuing theory in the situation, applying the model, and performing the MATLAB Simulation with the accumulated data from solving through the queuing theory principle and formula. Furthermore, the study proposes a new process and comparative result from present data and concludes with practical solutions through statistical and comparative analysis of results.

3.1 Data Collection

The study utilized primary and secondary sources to validate this study. Using the primary data from direct interviews with the co-owner and workers provided insights and experiences that allowed us to analyze the manufacturing process comprehensively. Further, the observation approach enables the study to identify the number of workers, machinery, and availability of raw materials, which were applied to the Time and Motion Study and formulated using MATLAB software. This paper utilizes the time and motion study principle in gathering data to solve the worker's average time and standard time to analyze and test the efficiency of each process. Further, in the study of Kalne & Mehendale (2022), the time and motion study was also used in data gathering to analyze and interpret data needed to increase efficiency and workers' productivity. Also, the study applies the Kendall Notation in MATLAB software to run the gathered data to analyze and interpret valuable insights and propose solutions for the company's betterment. The use of secondary data from related literature, journals, and articles aids in supporting the primary data, which can contribute to the development of the study.

3.2 Queuing Theory; Single Server, Multiple Customer System

This paper indicates the application of the Queuing Theory: Single Server, Multiple Customer System in the shoe manufacturing company. As indicated in Figure 2, the diagram displays the flow of customer arrivals in the queue entering the server. However, in between the process and departures, it was identified that congestions were experienced, thus implying idle time in the operation.

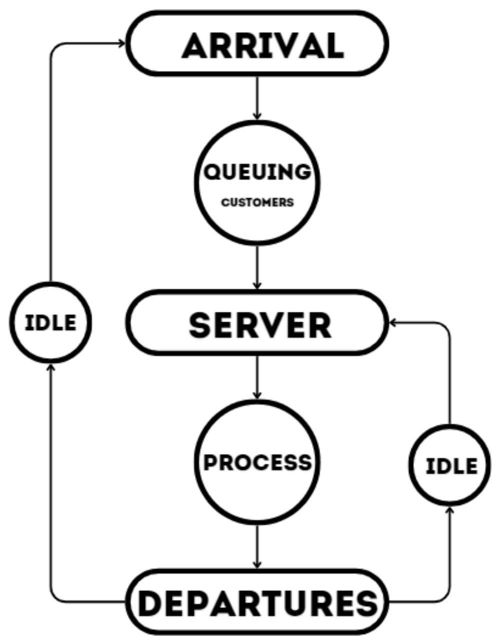

Figure 2. Queuing Theory: Single Server, Multiple Customer System Diagram

Kendall's Notation Model is known as the standardized way of representing and identifying queuing models. In 1953, David Kendall introduced this model and became the most used in queuing theory and operations research. In the article by Tšernov (2022), it was highlighted that Kendall's Notation Model was typically operated in the logistics process of manufacturing. The Markov chain (M) which indicates a Poisson probability distribution can also be observed in the model to determine the future state of the business through the data of the present condition (Rovetto et al. 2023).

Kendall's Notation Model:

$$(A / S / S) : (D / K / N) \text{ or } (a / b / c) : (d / e / f) \quad (1)$$

Where:
a: Input/ Arrival (Inter-arrival) Distribution
b: Output/ Departure (Service) Distribution
c: Service Channels
d: Service Discipline
e: Maximum Number of Customers Allowed in the System
f: Calling Source

M/M/1 (single server, Poisson arrivals, exponential service times)

A queuing system in a manufacturing company involves materials arriving to the workers, the inter-arrival distribution (a) determines the time in between the consecutive material arrivals, which follows various processes in the service distribution (b) at the available service channels (c), following the workstations and assembly lines. In the service discipline (d), the materials are selected for processing in a certain order where in some cases, there is a limit on the maximum number of customers allowed in the system (e). The suppliers and sources from which raw materials and components are sourced are referred to as the calling source (f), and they may be limitless or finite. Manufacturers can maximize manufacturing efficiency by comprehending and evaluating these components.

3.3 Single Server, Multiple Customer System

Pioneering authors Felix Pollaczek and David George Kendall developed the single-server multiple-customer system. Pollaczek solved the M/G/1 problem in 1930, which refers to a single server serving multiple customer classes, while Kendall solved the queue problem in 1953, which is known as the multi-server queues with independent arrivals and Markovian service. It established a theoretical framework for the analysis of single-server, multiple-customer queue systems with these contributions (Nwosu et al. 2018). The Queuing theory model was utilized in the study as the arrival rate, idle time, waiting time, and service rate are crucial in identifying the bottlenecks and inefficiencies in a company. It shows the formulas used in the queuing theory of a single server with multiple customers; the following elements are the assigned formulas to solve the problem.

Utilization Rate of the Workers

$$\rho = \frac{\lambda}{\mu} \qquad (2)$$

The utilization rate of the workers is calculated as shown in the equation above where ρ is the utilization rate, λ (lambda) is the arrival rate of the materials, and μ is the service rate of the workers. The utilization rate of workers measures the worker's efficiently utilized time in the given system or process. It shows how the workers actively engaged in processing materials at the given time.

Probability of an Idle Workstation

$$P_0 = (1 - \rho) \qquad (3)$$

The Idle time probability in the Workstation is solved using 1 - the utilization rate (ρ). It is closely related to the utilization rate of the workers, wherein it provides insight into the workers' efficiency in utilizing resources in the system.

The number of materials in the system

$$L = \frac{\rho}{1-\rho} = \frac{\lambda}{\mu-\lambda} \qquad (4)$$

The expected number of materials in the system (L) are computed as the equation shown above, there are two ways to use the formula wherein the first is using utilization rate (ρ) divided by the 1 - utilization rate (ρ) while the second formula is composed of arrival rate (λ) divided by the subtracted data from service rate (μ) and arrival rate (λ). The expected number of materials in the system is a significant performance parameter that provides insights into the congestion and queuing system usage. It is related to the arrival rate, service rate, and number of servers in the system.

The number of expected parts in the queue

$$L_q = \frac{\lambda^2}{\mu(\mu-\lambda)} \qquad (5)$$

The number of expected parts in the queue system vital element in providing insight to the bottlenecks and effectiveness in the queue system.The number of expected parts in the queue (Lq) is calculated through the shown equation above wherein:

L_q: symbol used for the expected materials in the queue system

λ: arrival rate

μ: service rate

The average waiting time in the system

$$W = \frac{1}{\mu - \lambda} \quad (6)$$

The average waiting in the system is crucial in measuring the performance which provides insights into the overall efficiency and responsiveness of the queuing system. The average waiting time in the system is computed through the formula shown above where:
W: average waiting time in the system
μ: service rate
λ: arrival rate

The average waiting time in a queue

$$W_q = \frac{\lambda}{\mu(\mu - \lambda)} \quad (7)$$

The average waiting time in the queue plays a vital role in providing a data-driven perspective into the bottlenecks and efficiency in the queue. The average waiting time in a queue is solved through the equation presented above:
W_q: average waiting time in a queue
μ: service rate
λ: arrival rate

In summary, the formula consists of the arrival rate and service rate these two are crucial in determining the utilization of the workers and the idle time in the system. These factors are then influenced each other, understanding these relationships plays an important role in identifying the needs of areas for improvement and optimizing queuing systems.

4.ResultsandDiscussion

The application of Queuing Theory based on the workstations and process using Matlab application and Promodel found that there are 3 workstations that has low utilization rate which generates waiting from the succeeding workstations. By applying Promodel, the facility was then streamlined to reduce waste in the process.

Table 1. Tabulated Computed Data for Single Server Multiple Customer Present Process

Work Station	Arrival Rate/Min	Average Service Time	Utilization	Idle Time	Length in System	Length in Queue	Waiting Time in the System	Waiting Time in Queue
1	3	6.01	0.50	0.50	0.9967	0.50	0.33	0.17
2	3	14.40	0.21	0.80	0.26	0.05	0.09	0.02
3	3	13.14	0.23	0.77	0.30	0.07	0.0986	0.02
4	3	5.12	0.59	0.41	1.42	0.83	0.47	0.28
5	3	9.32	0.32	0.68	0.47	0.15	0.16	0.05
6	3	17.38	0.17	0.83	0.21	0.04	0.07	0.01
7	3	4.99	0.60	0.40	1.51	0.91	0.50	0.30

Table 1 shows the complete data for the present process in each workstation with stations 2, 3, and 6 having the lowest utilization. Additionally, with only 3 arriving materials in each workstation, their tasks are finished quickly resulting in high idle time during working hours. Table 2 provides an extensive overview of the seven workstations in a footwear production process, demonstrating their efficiency using different evaluations. Work Station 1 has a 68% utilization rate, implying moderate usage, with a waiting time of 0.52 and a queue length of 1.41.

Table 2. Tabulated Computed Data for Single Server Multiple Customer Proposed Process

Work Station	Arrival Rate/Min	Average Service Time	Utilization	Idle Time	Length in System	Length in Queue	Waiting Time in the System	Waiting Time in Queue
1	4	5.92	0.68	0.32	2.08	1.41	0.52	0.35
2	4	14.13	0.28	0.72	0.39	0.11	0.10	0.03
3	4	12.97	0.31	0.69	0.45	0.14	0.11	0.03
4	4	6.01	0.67	0.33	1.99	1.32	0.50	0.33
5	4	17.01	0.34	0.66	0.51	0.17	0.13	0.04
6	4	17.38	0.23	0.77	0.31	0.07	0.08	0.02
7	4	5.06	0.79	0.21	3.77	2.98	0.94	0.75

Workstation 2 has a low utilization rate of 28%, indicating that it is underused, with a waiting time of 0.10 and a queue length of 0.11. Workstation 3, similarly to Station 2, has a low utilization rate of 31% and short wait times of 0.11. Workstation 4 has a 67% utilization rate, a waiting time of 0.50, and a queue length of 1.32, showing the need for optimization. Workstation 5 is at 34% utilization, with low waiting times of 0.13 and queue lengths of 0.17, indicating insufficient use.

Table 3. Tabulated Summary of Idle Rate of Present and Proposed Data

Workstation	Idle Time	
	Present	Proposed
1 Cutting	0.50	0.32
2 Sewing	0.80	0.72
3 Uppermaking	0.77	0.69
4 Trimming	0.41	0.33
5 Pasting	0.68	0.66
6 Shoemaking	0.83	0.77
7 Polishing	0.40	0.21

Workstation 6 has the lowest utilization rate of 23% and the shortest waiting time of 0.08. Workstation 7 has the greatest utilization rate of 79%, the longest waiting time of 0.94, and the longest queue length of 2.98. These findings indicate the necessity to allocate workload and optimize processes among workstations in order to increase productivity and minimize delays. Table 3 summarizes the current and suggested idle time rates for the system's processes after the process was streamlined using Promodel Simulation software. The cutting section accumulated 50% of the current data, but the proposed solution reduced it by 18%; the sewing process decreased it by 8% from 80% to 72%; the upper making process minimized from 77% to 69% as a result of the proposed solution; and the trimming section decreased from 41% to 33%: The pasting process's 68% idle rate lowers to 66%; the shoemaking sector, which had the highest idle rate at 83%, is now reduced to 77% by the proposed measure; and, lastly, the polishing section's 41% idle rate is reduced to 33%. It is evident that every workstation in the proposed process significantly reduces the idle rate in the current process. It indicates that the working time the workers spent in each process has been efficiently utilized and spent productively. Overall, the proposed solution leads to higher output and process, which reduces delays thus allocates a better system of shoe manufacturing.

Table 4. Tabulated Summary of Utilization Rate of Present and Proposed Data

Workstation	Utilization Rate	
	Present	Proposed
1 Cutting	0.50	0.68
2 Sewing	0.21	0.28
3 Uppermaking	0.23	0.31
4 Trimming	0.59	0.67
5 Pasting	0.32	0.34
6 Shoemaking	0.17	0.23
7 Polishing	0.60	0.79

The paper proposes a new arrangement of workspace processes within the company, hence these improvements provide better accessibility from workers to the materials needed, through computation Table 4 displays the difference in the utilization rate between the present and proposed utilization ratings for the seven identified workstations. As gathered, it was recorded that the polishing station has the highest present rating, thus indicating that the worker spent most of the time at 60%. Further, the sixth workstation, shoemaking, is not fully utilized and experiences inefficiencies with a 17% rating gaining the lowest record. Comparatively, the proposed process has adversely increased the production number. In the Cutting section, an improved rating of 18% was observed showing that it can generate more work value. Although the polishing of workstations only increased by a percent, still minimal changes could lead to better utilization.

Scoreboard

Name	Total Exits	Average Time In System (Min)	Average Time In Operation (Min)	Average Cost
Raw Materials	172.00	75.06	72.67	430.00

Figure 3. Entity Summary of the Proposed Process of Footwear Manufacturing Company

Through the ProModel Simulation, Figure 3 shows the accumulated increase of production in the new process, from 136 pairs from the present process, the footwear company increased the production to 172 pairs of footwear.

5. Conclusion

In applying queuing theory to the single server multiple customer model, this paper identified bottlenecks and idle time that caused production delays in the shoe manufacturing procedure. Utilizing Kendall notation allowed this paper to highlight arrival rates, server availability, and the capacity of a system and thus, derived an in-depth system analysis in the shoe manufacturing company. The main goal of the study was to identify bottlenecks that lead to idle time and ineffectiveness in production, the analysis in Tables 4 and 5 shows that the utilization rate in workstations 2, 3, and 6 was low. These workstations operated the lowest station rating where the task was finished quickly due to the arrival of only three materials, resulting in higher idle time. Utilized the queuing theory Kendall notation model, the paper was used to define system performance and unveiled issues within shoe manufacturing, findings also uncovered the difference in workstation efficiency, resulting in the transfer of workload to increase productivity and decrease time delays. In Table 2.

Tabulated Computed Data for Single Server Multiple Customer Proposed Process, workstation 1 gained a 68% utilization rate, whereas workstation 6 had only 23% which points out a need to improve the production procedure. Table 4 Computed Data for Single Server Multiple Customer Current Process and Utilization Rate, workstation 1 shows an 18% increase in utilization, workstation 7 only an increase of 1% but in combination improves the total utilization rate. Lastly, the goal was to evaluate and measure the current arrival process to improve and minimize transportation time and idle time of a Poisson process. Table 3 provides the results of the reduction in idle time across different sections when the process was restructured and using promodel simulation software. The idle time decreased workstation 2 by 8%, workstation 3 by 8%, and workstation 6 by 6%. The queuing theory is utilized to delineate the states of the stages of the company's process through a quantitative data-driven framework (Marsudi & herlina, 2018). The final recommendation from the study is to utilize the calculation of utilization rate and probability of idle workstations. These calculations are critical factors in identifying system improvements within the three stations and thus aid in theorizing methods that can reduce idle time and increase production level and work performance.

5.1 Practical Implications of the Study

Utilizing the queuing theory is a vital instrument for a manufacturing company as it elaborately identifies where and how the process can be streamlined and optimized through a capacity objective. The study found that implementing the queuing theory approach it may increase the utilization rate of the worker and a key to be efficient in performing work at the most effective rate. Furthermore, in an article by Salawu et al. 2020, the studies were conducted to create a method in an advanced manufacturing environment where waiting time was minimized by the queuing theory case model found also in the study with data illustrating the queuing model level achieved optimal values showing how the queuing model approach can amend the waiting time in an advanced manufacturing setting.

This paper offers solutions that can aid the manufacturing problems experienced by the company through the use of queuing theory, the study determines that there are bottlenecks in the process. By implementing the queuing theory, businesses were able to strive for the better (Stevens, 2021).

5.2LimitationsandFutureResearch

The study focuses on four M's aspects, which are the man, machine, material, and method, limiting the monetary sector. This paper addresses issues by applying the queuing theory model in the shoe manufacturing industry. Further, future studies could explore integrating the analysis to measure the cost-effectiveness of suggested solutions. Additionally, exploring how workforce training programs and job rotation may impact the adoption of manufacturing and JIT practices could add value to the company.

Also, future research could enhance the queuing theory model by incorporating more operations research methodologies such as Game Theory and the DEA CCR Model to keep up with the competitors and trends of the market. These approaches could offer insights into the external factors that affect the company's production. To improve the effectiveness and practicality of the solutions, additional investigation of the fluctuations in demand, interruptions in the supply chains, and regular machine maintenance.

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Biographies

Mari Dane M. Agra. is a dynamic and ambitious student of the Industrial Engineering Department; she chose to explore Industrial Engineering at the Technological Institute of the Philippines- Quezon City. Mari's commitment to her educational journey is evident as she has consistently placed on the honour roll over those years. Her goal is to create sustainable solutions and contribute to advancing industrial engineering. She believes everyone has limitless potential, especially those who want to strive for excellence and pursuit of knowledge.

Christine Anne L. De Guzman. is a third-year BS Industrial Engineering Student at the Technological Institute of the Philippines in Quezon City. As an innovator, Christine aspires to provide optical solutions that can improve the disciplines of the field. With her acquired skills and knowledge in Ergonomics, Quality Management, and LEAN manufacturing, she contributes ways to develop the world through research investigations. Christine's unique drive toward success continuously shaped her to conquer the realms of life-long learning. As a student, she strives for an economically viable environment where we can foster efficiency and effectiveness.

Ali P. Deocareza. Is a third-year BS Industrial Engineering student studying at the prestigious Technological Institute of the Philippines, as he is a lifelong learner and determined to be ambitious. He is not just dedicated to his education; he's also a determined entrepreneur with a vision for the near future. In addition to his learning, Ali is the proud owner of a small online business that he developed with optimism and passion.

Robin Kenshin R. Sanchez. Is a third-year student studying Industrial Engineering at the Technological Institute of the Philippines. He is a consistent vice president at the institution embracing the lifelong learning of the institute. Robin's goal is to apply the theoretical knowledge learned in school to the real world and contribute to the industry that he belongs to.

Maricar M. Navarro. holds the esteemed titles of ASEAN Engineer (AE) and Professional Industrial Engineer (PIE), accredited by the ASEAN Federation of Engineering Organisations (AFEO) and Philippine Institute of Industrial Engineers (PIIE). She currently serves as a Professor in both Undergraduate and Graduate School Program of Technological Institute of the Philippines, bringing over 17 years of combined experience in industry, academia, and research. Her expertise spans optimization of production processes, facility layout design, warehouse operations, and service delivery. Dr. Navarro's current research interests focus on financial optimization and decision-making in operations research. She earned both her master's and Ph.D. in Industrial Engineering from MAPUA University. As an active associate member of the National Research Council of the Philippines (NRCP) and member of PIIE, Dr. Navarro contributes significantly to advancing research initiatives and professional standards in Industrial engineering and related fields. Her dedication and expertise make her a pivotal figure in both academic circles and national research endeavors.