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RESEARCH ARTICLE

Application of Discrete Event Simulation for Enhancing Queuing System at Lotus Alor Setar

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ABSTRACT - Queue management is a critical challenge for hypermarkets, where prolonged wait times can negatively impact customer satisfaction and operational efficiency. The congested checkout areas at Lotus Alor Setar are caused by a high number of customers and insufficient cashiers, resulting in slower transaction times for scanning, payments, and assistance. Such queuing problems cause delay to the overall service, thus reducing customer satisfaction. In response to the issue, this study aimed to enhance the queueing system at Lotus Alor Setar through a simulation model and to propose the most efficient hypermarket queueing system. Discrete Event Simulation was used to replicate the existing systems, followed by the testing of three scenarios to determine their respective performance in addressing the issue. The significance of this study lies in identifying ways to efficiently allocate resources, such as personnel and checkout stations, to promote cost savings and higher service quality. These findings offer useful insights not only for improving the queuing system at Lotus Alor Setar but also for guiding other hypermarkets alike.

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1. INTRODUCTION

Hypermarkets are large shopping centres that combine the features of a department store with a supermarket. These stores usually offer a large selection of products under one roof, such as food, household items, apparel, electronics, and even furniture. To accommodate many customers, hypermarkets are usually located in suburban areas and have extensive parking spaces. The idea of hypermarkets was initially developed in Europe circa the 1960s, with the French company Carrefour frequently regarded as the first authentic hypermarket. Since then, hypermarkets have grown globally and gained popularity in other nations. Its impact also extends to Malaysia's retail sector, which has been expanding due to the growing number of hypermarkets, including Giant, Tesco, Carrefour, and MYDIN (Mohamad & Saharin, 2019). Most hypermarkets are in massive, warehouse-style buildings with numerous parking spaces. They frequently have wide pathways and a layout intended to encourage customers to explore various product categories. Many hypermarkets also feature extras like food courts, cafes, and entertainment sections to make shopping more enjoyable. Malaysia's grocery retail stores have given way to supermarkets and hypermarkets in the country's retail landscape.

Since December 2020, Lotus Stores Malaysia Sdn. Bhd., commonly known as Lotus's Malaysia, has become part of Charoen Pokphand Group Co Ltd. or C.P. Group. It is an international assembly that works in a number of sectors, including the industrial, service, and agricultural domains. Currently, the C.P. Group is invested in 21 economies and nations. After purchasing Tesco Malaysia operations in December 2020, Lotus Malaysia has taken over all the company's activities. Tesco employs 9,000 people in 62 stores, two distribution centres, and one head office spread across Peninsular Malaysia. The first two fully authentic Lotus stores were opened in January 2022 at Bandar Puteri Jaya, Kedah, and Pulai Hartamas, Perak, bringing the total to 64. With more than 100 delivery vehicles and locations across Penang, Johor Bahru, Melaka, Negeri Sembilan, and Ipoh, Lotus boasts the largest online grocery home shopping network in Malaysia. As the retail industry grows, the efficiency of the management system must be increased. The Malaysian retail industry is expanding rapidly because of the high demand for products from local customers to industrial retailers, such as Lotus Alor Setar. Accordingly, most services provided by Lotus Alor Setar are closely related to queuing problems, which can affect customer satisfaction. Such issue stems from limited resources, thus preventing Lotus Alor Setar from giving excellent service to its customers.

Meanwhile, queuing problems may develop from uneven customer arrival patterns. For example, congestion and higher waiting times can be caused by peak-hour traffic or on certain days of the week. Moreover, the inconvenience of carrying physical cash or cards can lead to queuing problems at Lotus Alor Setar. Compared to digital payments, these transactions usually take longer as they involve processes like counting cash, processing card payments, and waiting for receipts to be printed. This can slow down the checkout process, especially during peak hours. Congested checkout areas can also affect the queueing system at Lotus Alor Setar, subsequently impacting customer satisfaction. This happens because there are more customers and fewer cashiers available, typically causing slower transaction processing times. For

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example, cashiers may take longer to scan products, handle payments, and help customers, leading to delays in handling a crowd of customers and causing queuing problems at Lotus Alor Setar.

This research aims to improve the queuing system at Lotus Alor Setar through a traditional to technological transition method. The shift hopes to ease the customers in making payments for their goods and reduce their queuing time at the checkout counter. The objectives of this research are threefold, namely (1) to develop a simulation model for the queueing system at Lotus Alor Setar using Discrete Event Simulation, (2) to evaluate the efficiency of the current queueing system using the developed simulation model, and (3) to recommend strategies to improve the queueing system. The significance of this research lies in its effort to enhance the queuing system at Lotus Alor Setar. This will significantly improve customer satisfaction as higher levels of patron satisfaction can be attributed to reduced waiting times, optimised procedures, and improved customer flow. The research also paves possible ways to optimise the distribution of resources, such as personnel and checkout stations, through the use of simulation. Better resource use can result in potential cost savings on operations without sacrificing or raising the service quality. Additionally, having a carefully designed simulation can increase overall productivity. This research also hopes to facilitate a more efficient and effective queuing system at Lotus Alor Setar by reducing barriers and improving workflow. This research scope is concentrated on the current queuing system at Lotus Alor Setar, especially concerning the waiting time and congestion at the cashier counter. It also identifies areas for improvement and the best solutions to increase agility and produce a smoother customer experience for the patrons.

2. LITERATURE REVIEW

This section presents a thorough review of past literature related to the topic. It begins with an overview of the history of hypermarkets in Malaysia. Next, the chapter explores the definition of checkout management and how it affects hypermarket performance. The discussion further extends to various techniques that can be used to solve queuing problems in the retail industry. This is followed by an explanation about simulation and Discrete Event Simulation, and how they can help solve problems in the retail industry. Finally, the section ends by reviewing the implementation of simulation into checkout management in hypermarkets.

2.1 History of Hypermarkets in Malaysia

Hypermarkets are among the distribution channels that contribute to product sales, especially for household demands (Bashir et al., 2020). They are often perceived as typical retail stores that offer a wide variety of products, mainly house-related, to customers in massive quantities (Wang, 2021). The past years have witnessed a significant rise in the quantity of hypermarkets across various locations in Malaysia (Morris et al., 2019). This is in conjunction with the government's support towards open commerce, which prompted foreign investors to open their businesses, such as hypermarkets, in this country (Mohamad & Saharin, 2019). Furthermore, the Malaysian economy is growing rapidly within the framework of religious-based cultural modernisation (Sern & Mahadevan, 2019). Since the primary forms of entertainment in many cultures are dining and shopping in shopping centres and malls, having hypermarkets inside shopping centres and malls also serves as a place for Malaysians to relax and recharge (Ngadimin et al., 2019).

2.2 Overview of Checkout Management

One of the latest innovations in retail technology is checkout management, which reduces waiting times and improves customer satisfaction (Hassan, 2015). In the retail industry, customers often hate long queues. Therefore, managers must strike a balance between reducing idle times and accommodating fluctuating consumer traffic at the checkout zone (Pallikkara et al., 2021). This is because the checkout area is the last step in hypermarket management, where customers will make payments for their shopping (Vinish et al., 2022). Most hypermarkets in Malaysia have problems in queuing management due to excessive disturbance in the checkout area as a result of inevitable factors such as peak hours, holidays, and promotion days (Mohamad & Saharin, 2019). Today, advancements in technology and development have enabled checkout management systems to offer more features in hypermarkets. This ultimately reduces customers' queuing time, which is the main measure of customer satisfaction (Antczak et al., 2020).

2.3 Checkout Process

According to Antczak et al. (2020), the checkout area is one of the crucial places that determine customers' shopping experience. The lack of attention towards customers at the checkout area often carries similar weight as those invested during the earlier stage of the shopping activities (Falcão et al., 2021). Accordingly, an elevated degree of contentment in the earlier phases could result in greater expectations in the checkout area; otherwise, customers might give up on their shopping cart (Vinish et al., 2022).

Cashiers are responsible for assisting hypermarket customers with the checkout process by helping them register their purchases, calculating the amount payable, and collecting payment (Pallikkara et al., 2021). Most hypermarkets offer two methods of payment: cash and credit or debit cards. Additionally, cash registers are typically located at the checkout counters to safely hold money. Figure 1 illustrates the flow of customers at hypermarkets.

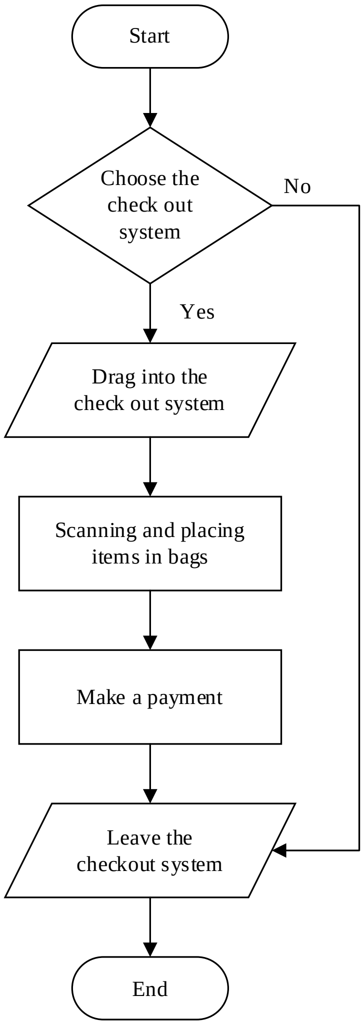

Figure 1. Customer flow at hypermarkets
Source: Mohamad & Saharin (2019)

2.4 Issues in Checkout Management

Minghelli et al. (2019) stated that cashiers may be the only service providers that customers deal with while shopping at hypermarkets. The tasks associated with cashiering are repetitive and routine, with most cashiers able to fill more than 80 bags in an hour and handle 500 to 1,000 products at one time. To properly greet customers, cashiers must anticipate customers' wants, extend a warm greeting, and pay attention to customers' needs (Wang, 2021a). They should prioritise two things, namely the efficiency or flow of products and services or customer flow, which could cause conflict and frustration among customers. The pressure from other customers in the line forces cashiers to speed up their work as well (Mohamad & Saharin, 2019).

2.4.1 Cashier Work Layout

According to Silva (2024), the nature of cashiers' jobs at their workstations may cause postural issues. Cashiers' workstations often have a transporter belt, a scanner, and a bagging area (Shinnar et al., 2004). They are required to work while standing, repeatedly transferring items towards the conveyor belt, scanning them, and then putting these items in bags (Muda & Rethnakumar, 2022). These procedures are common across many retail companies.

Minghelli (2019) found that heavy products can be dangerous for cashiers to handle using their hands. As a result, most cashiers will resort to lifting and dragging (Rodacki et al., 2006). Aside from inflicting more stress, handling heavy goods may expose cashiers to sustaining injuries from their repetitive movements, which can negatively affect their comfort, well-being, and job satisfaction (Falcão et al., 2021). Cashiers may slow down the pace of work as a form of protest or resistance, resulting in a high turnover rate of the profession (Morris et al., 2019).

2.4.2 Waiting Time at Checkout Counters in Hypermarkets

According to Cruz-Mejía et al. (2019), most customers go to hypermarkets to buy household equipment that is necessary for their daily life. Consequently, flexible timing is highly preferred (Mantrala et al., 2009). Although customers' perceptions of time may differ, time constraints often prompt them to pay more attention towards the activity duration in hypermarkets (Chetthamrongchai & Davies, 2000). Three factors contribute to customers' waiting time at hypermarkets: selection time, queuing time, and transaction at the checkout counter (Kumar, 2005).

Furthermore, 60% of the checkout process in hypermarket operations comprises three major time-consuming procedures, namely scanning (20%), packing (18%), and payment transactions (22%). Waiting for customers to receive service makes up one-fifth of the cashiers' workday, while 10% of their time is spent transferring bags (Antczak et al., 2020). As a result, the costs of waiting should be considered when comparing the cost of service (Mohamad & Saharin, 2019). On the other hand, inefficient employees can cause the waiting time to be longer than usual due to factors like work motivation and level of discipline (Ingason & Eskerod, 2024). Work motivation can often encourage both individuals and groups to work towards set goals (Irawati et al., 2022). Employees with high work motivation will work optimally and demonstrate higher performance than those with low motivation (Ingason & Eskerod, 2024).

2.5 Techniques to Solve Queuing Problems in Hypermarkets

Various techniques can be employed to solve challenges in the queuing system, thus enhancing the efficiency and system performance at Lotus Alor Setar.

2.5.1 Queuing theory

Past researchers have used a number of methods to solve queuing problems without interrupting the actual system (Mohamad & Saharin, 2019). This includes the queuing theory (Zaki et al., 2019), which defines queueing as a typical procedure before receiving service and a queue as the people lining up or items waiting to be serviced (Harchol-Balter, 2021). The queuing theory is associated with the inquiry of a queue or waiting line, which is a crucial component of the business and a tool that operations managers utilise for evaluation (Zaki, 2019). According to Harchol-Balter (2021), the queuing theory uses mathematical solutions to study the delays of waiting in hypermarkets, covering all aspects from arrival time to the number of servers. Delays and queuing issues are frequently observed not only in everyday situations like a bank, post office, ticket office, traffic jams, or public transit, but also in more technical situations like manufacturing, computer networking, and telecommunications (Zaki et al., 2019). Operational techniques are one of the ways that management can adopt to reduce the waiting time (Mohamad & Saharin, 2019).

2.5.2 Simulation

Simulation is a technique to evaluate model behaviour in a variety of situations that enables decision-making (Ingason & Eskerod, 2024; Mohamad & Saharin, 2019). According to Durán (2020), a simulation is an experimental representation of a real-world model that allows the study of how the system functions. Any changes in the variables will offer a forecast of the actual impact. Consequently, the simulation will function as a system and the actual impact of each alternative and course of action will be determined following the model simulation (Durán, 2020). It can also be used as a tool to virtually examine the system performance (Mourtzis, 2020).

Using simulation to improve the real system is crucial to evaluate the system's overall performance (Ghelichi et al., 2024). A sequence of "what if" can also be used to clarify simulation (Mohamad & Saharin, 2019). Additionally, the use of simulation can prevent system breakdowns caused by the impacts of change (Morris et al., 2019). Aspects like new adjustments, processes, and information flow in the systems can be studied without affecting the operation of the actual system (Durán, 2020). Modelling helps predict the consequences of system changes while understanding how the system behaves (Mohamad & Saharin, 2019).

2.5.3 Discrete event simulation

Patel et al. (2020) said that system functioning is modelled by Discrete Event Simulation (DES) as a discrete series of events throughout time. According to Mohamad & Saharin (2019), every event signifies a shift in the structural state and occurs at a specific moment in time. Because of the modifications made to the structure, this replication can protect against failure without interfering with a real structure. Agalianos (2020) further stated that the manufacturing system typically uses DES and it has significantly risen in the service industry.

Cruz-Mejía et al. (2019) believe that DES is a simple-to-use and flexible tool for implementing computer-based modelling to solve complicated systems. It also stands as a flexible modelling technique capable of simulating complex interactions and behaviours among people, populations, and their surroundings (Mohamad & Saharin, 2019). The DES model can be formulated via three methods. First is using the system entities, process classification, and requirements as input (Mohamad & Saharin, 2019). The second method involves using the comprehensive categorisation of the actions done by the system component entities as input, while the third method is to specify the possible state changes at each event (Agalianos, 2020). DES is frequently used by specialists to identify solutions without including stakeholders in the development process (Mohamad & Saharin, 2019).

2.6 Implementation of Discrete Event Simulation in Checkout Management

Wang (2021) suggests that checkout management in hypermarkets is mainly related to the operation field. Hence, the DES criteria are suitable for enhancing checkout management. To solve congestion during checkouts, Mohamad & Saharin (2019) adopted DES to design a business model for improving queuing at hypermarkets. In the marketing field, Antczak (2020) developed a market DES to help answer questions in the market, including the operation system in hypermarkets. Finally, in the retail industry, Mourtzis (2020) proposed a DES model for managing the queueing system in hypermarkets. The findings highlight the need to pay more attention towards the waiting line and congested checkout stations to achieve a better performance of the queueing system and increase customer satisfaction.

3. RESEARCH METHODOLOGY

This quantitative study adopted the modelling research design to answer the research questions and achieve the set objectives. The following section explains the data collection method, the components and steps of DES, and the validation and verification processes.

3.1 Data Collection

Data collection is the process of gathering and analysing related information from various sources to determine the results, forecast trends and probabilities, and identify solutions to the research problems. In this study, interviews were conducted with the hypermarket supervisor to understand the checkout counter process and the overall hypermarket's operations. The researchers also conducted observations to gain further information, including the customers' arrival time and movement inside the hypermarket. These data were crucial for identifying the issues related to the overall process of the hypermarket. Table 1 shows the data collection process at Lotus Alor Setar.

Table 1. Data collection process at Lotus Alor Setar

Date	Person in Charge	Information
8/7/2024	Supervisor	Observe and understand the current queue in the Lotus hypermarket.
24/7/2024	Supervisor	Obtain information about the company, issues faced, and the layout of the hypermarket.
8/8/2024	Supervisor	Record the arrival time of customers.
30/9/2024	Supervisor	Confirm the data collected.

3.2 Components of Discrete Event Simulation

Discrete Event Simulation is an approach to stimulate the behaviour and performance of real-life processes, establishments, and systems. It comprises various components, including entities, attributes, variables, resources, and events, which are imperative in defining a simulation model. Many researchers are of the view that both entities and resources stand as the two most important components of DES. It is crucial to define entities before doing a simulation, particularly since they are usually created by users based on the system descriptions and represented as a dynamic component in replication that moves around, status shift, and often affect and are affected by other entities in the modelled systems. Eventually, entities are disposed of from the system. On the other hand, resources can be defined to handle the entities before proceeding to the next process in the simulation model. They usually represent things like personal equipment and rooms within a storage area of limited dimensions. In a simulation model, resources will work when they are assigned to handle and release entities to the subsequent process. There are numerous actions that resources can do in simulation, including delay, seizes delay, seizes delay release, and delay release.

3.3 Steps in Discrete Event Simulation

A simulation is defined as a time-based recreation of a real-world process. Subsequently, simulators can be utilised to evaluate system performance at the current moment. This study developed a simulation model to evaluate customer queues at the Lotus Alor Setar hypermarket. Figure 2 shows the processes involved in conducting a simulation.

The first step in the simulation modelling process is problem identification, which involves determining the problems that occur with the systems and developing the system requirements. Next, the objective of the simulation must be established to ensure that the researchers have all the necessary information to accomplish the research objective. This is followed by the process of gathering and preparing data about the current systems, which will be entered into the simulation software before modelling the simulation. Any mismatch between the collected data and the simulation objectives must be addressed. The next step is to verify and validate the model and to conduct any refinement, if necessary. Finally, the experiment and model analysis are administered before making recommendations and implementation.

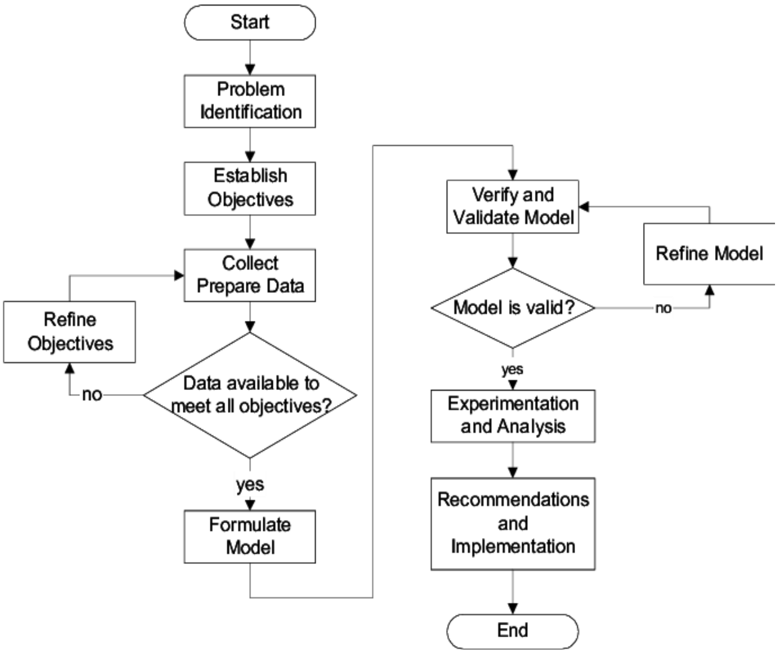

Figure 2. Steps in discrete event simulation
Source: Mourtzis (2020)

3.4 Validation and Verification

Before making any modifications to the real system, the simulation model is utilised to help with problem-solving and decision-making by allowing researchers to observe the effects of the changes. The simulation model must undergo a validation and verification process before a decision can be made. This is to ensure the accuracy of the model and that the computer software used to construct the computerised model is correct, known as the verification model. This study model was validated by contrasting its behaviour with that of the actual structure, namely the Mean Absolute Percentage Error (MAPE) test. It assesses the compatibility of the data estimates with the actual data by referring to the relative indicator of the percentage of errors. The MAPE test can be calculated using the formula below:

$$MAPE = \frac{1}{n}\sum_{i=1}^{n}\left|\frac{Actual_i - Forecasted_i}{Actual_i}\right| \times 100 \tag{1}$$

Source: Mohamad & Saharin (2019)

Table 2 shows the description of MAPE percentages, with values less than 5%, between 5% and 10%, and more than 10% indicating that the model is very accurate, accurate, and not accurate, respectively.

Table 2. Description of MAPE percentage
Source: Mourtzis (2020)

MAPE Percentage	Description
MAPE<5%	Very accurate
5%<MAPE<10%	Accurate
MAPE>10%	Not accurate

4. RESULTS

In this study, the base case was simulated using DES to analyse changes in terms of customer waiting time and the number of customers queuing at the checkout counter. The model logic revealed numerous modules that were used to simulate this base case, such as create, process, station, decide, route, store, unstore, delay, remove, pickstation, and dispose. All these modules were important in simulating this model to demonstrate the process at Lotus Alor Setar.

4.1 Customer Shopping Processes

Figure 3 illustrates part of the processes of customers shopping for their household items. It begins with customers arriving at the entrance of Lotus Alor Setar to look for household items. The hypermarket has five different aisles for customers to seek their household items, each having its respective route, station, store, delay, unstore, and decide modules. These modules make the model logic more realistic with the reality process at Lotus Alor Setar. When customers arrive at the entrance, the function route will decide which aisle they will go to based on their preference, which is controlled by the station module. When customers enter the respective aisle, the process will continue with the store, delay and unstore modules to convert their real-life shopping experience into virtual reality. Once the customers have obtained their household items, the decide module will prompt them to make payment or to look for other items and other aisles and proceed to make payment at the checkout counter.

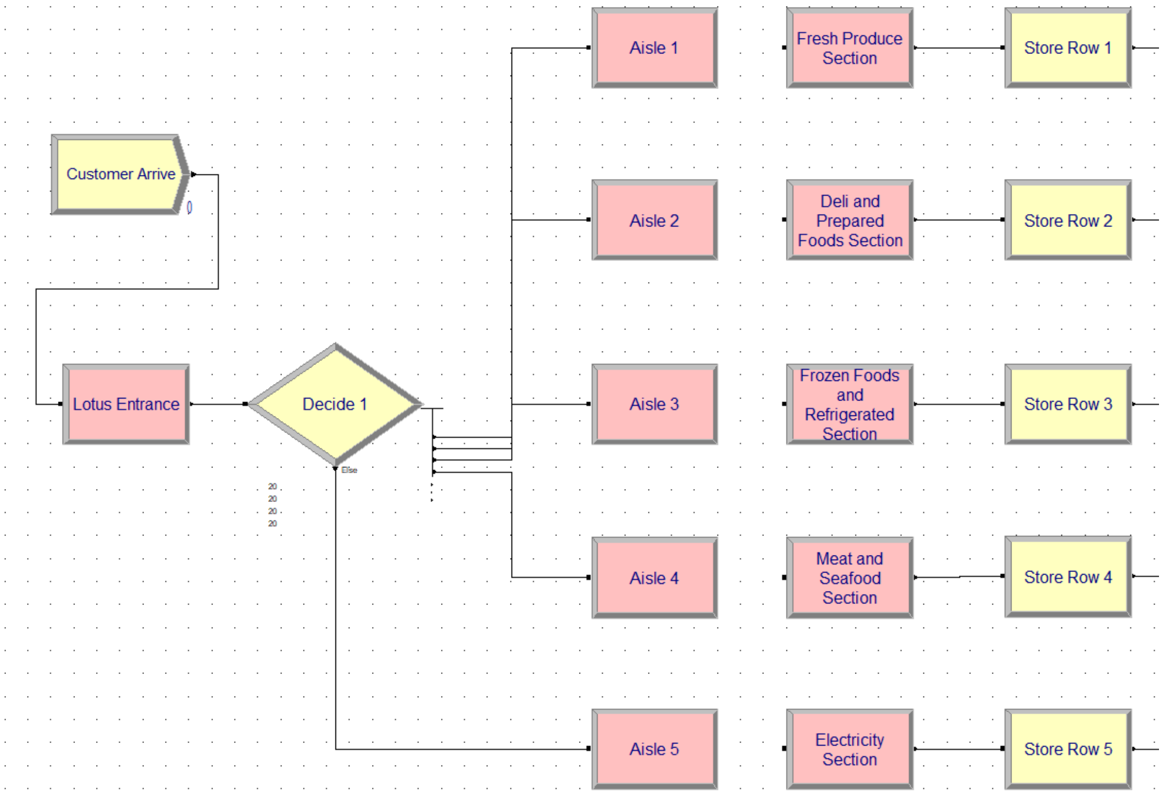

Figure 3. Part of the customer shopping process

Figure 4 shows part of the checkout process and customers leaving Lotus Alor Setar. There are three checkout counters (Manual Checkout 1, Manual Checkout 2, and Manual Checkout 3) manned by cashiers. Customers can select the counter with the shortest queue to proceed with payment. Nevertheless, it was noted that the process of cashiers changing shifts created delays, prompting customers to go to another checkout counter to make their payment. The model logic ends with customers leaving Lotus Alor Setar upon completing the payment process.

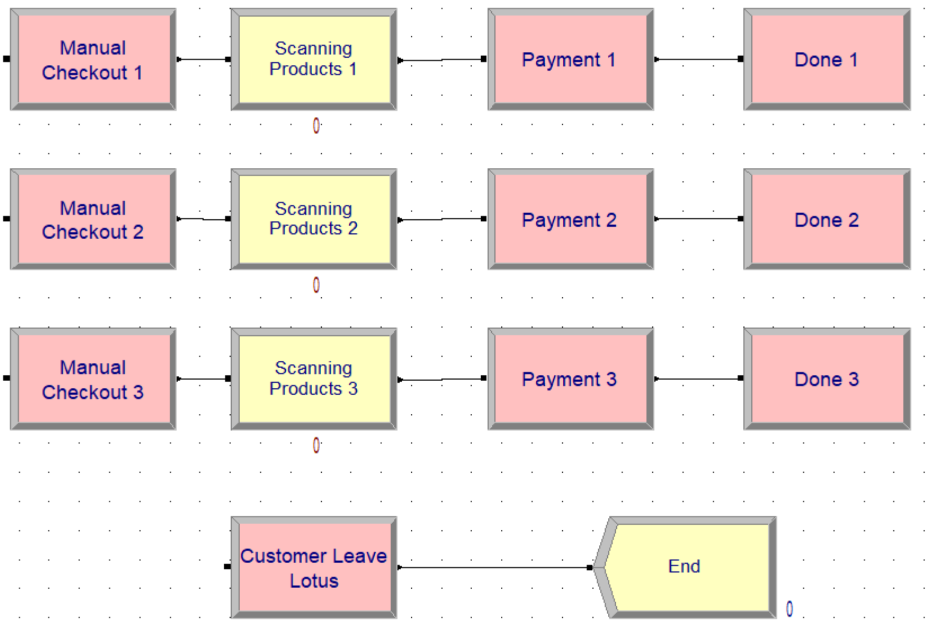

Figure 4. Part of the checkout process and customers leaving

4.2 Animation of Lotus Alor Setar

Figure 5 shows the animation of the queuing system at Lotus Alor Setar. The entrance is located at the top right corner, while the exit is positioned at the bottom right near the checkout counters. There are several aisles connecting the different areas with directional arrows to guide customers' movement. The first aisle is the "Fresh Produce Section", which displays fruits, vegetables, and other fresh items. Next is the "Deli and Prepared Foods Section" offering ready-to-eat meals and deli products. The subsequent aisle is the "Frozen Foods and Refrigerated Section" where frozen and chilled items like dairy and frozen vegetables are stored. Meanwhile, the "Electricity Section" is designated for electrical appliances and gadgets. Lastly, the "Meat and Seafood Section" stores fresh food like meat, poultry, and seafood. To facilitate shopping, three checkout counters are placed near the exit, each with its own queuing pathway clearly marked. The layout ensures a smooth customer flow that allows easy access to all sections while maximising product visibility. This animation promotes a convenient experience for customers.

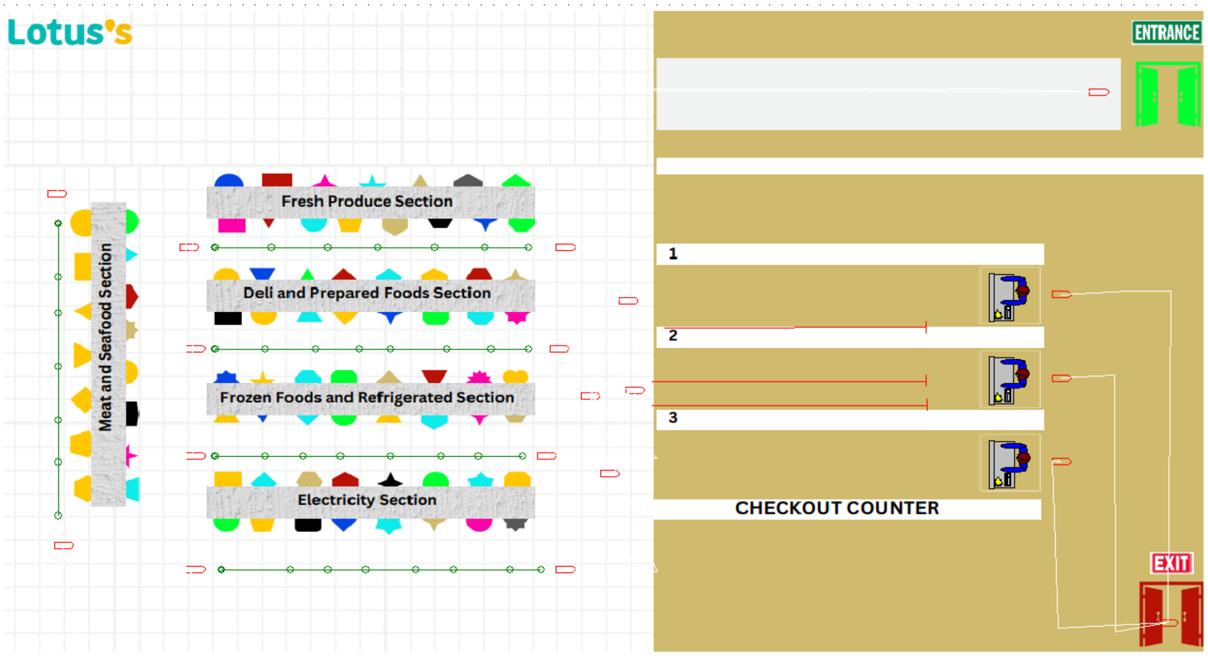

Figure 5. Animation of customer shopping process at Lotus Alor Setar: Base case

4.3 Base Case

4.3.1 Customer waiting time in queue (minutes)

This metric shows the customers' average waiting time at the checkout counter. The base case denoted a significantly high customer waiting time while queuing at each manual checkout counter. This was evidenced by the 40.9 minutes, 43.7 minutes, and 38.1 minutes of customer waiting time recorded at Manual Checkout Counters 1, 2, and 3.

4.3.2. Number of customers in queue

This metric shows the average number of customers queuing at each checkout counter. Manual Checkout 1 had 7 customers, while Manual Checkout Counters 2 and 3 both had 6 customers.

4.4 Validation – Mean Absolute Percentage Error (MAPE)

The observation data indicated a total of 210 customers released from Lotus Alor Setar, while the model simulation had 221 customers. These results were used to conduct the MAPE test. A MAPE value below 10% typically represents a highly accurate model, while values between 10% and 20% indicate reasonable accuracy. This study obtained a MAPE value of 5.24%, indicating that the model simulation was accurate and compatible with the actual system. The result was used to perform the scenario analysis and showed a 5.24% difference between the predicted and the real number of customers, which is within an acceptable range and indicates reasonable accuracy.

4.5 Scenario 1

Scenario 1 consists of several experiments for checkout counters, namely one self-checkout and two manual checkout counters. The aim was to determine whether replacing the one manual checkout with a self-checkout counter can positively impact the number of queuing customers and their waiting time, thus improving the level of customer satisfaction.

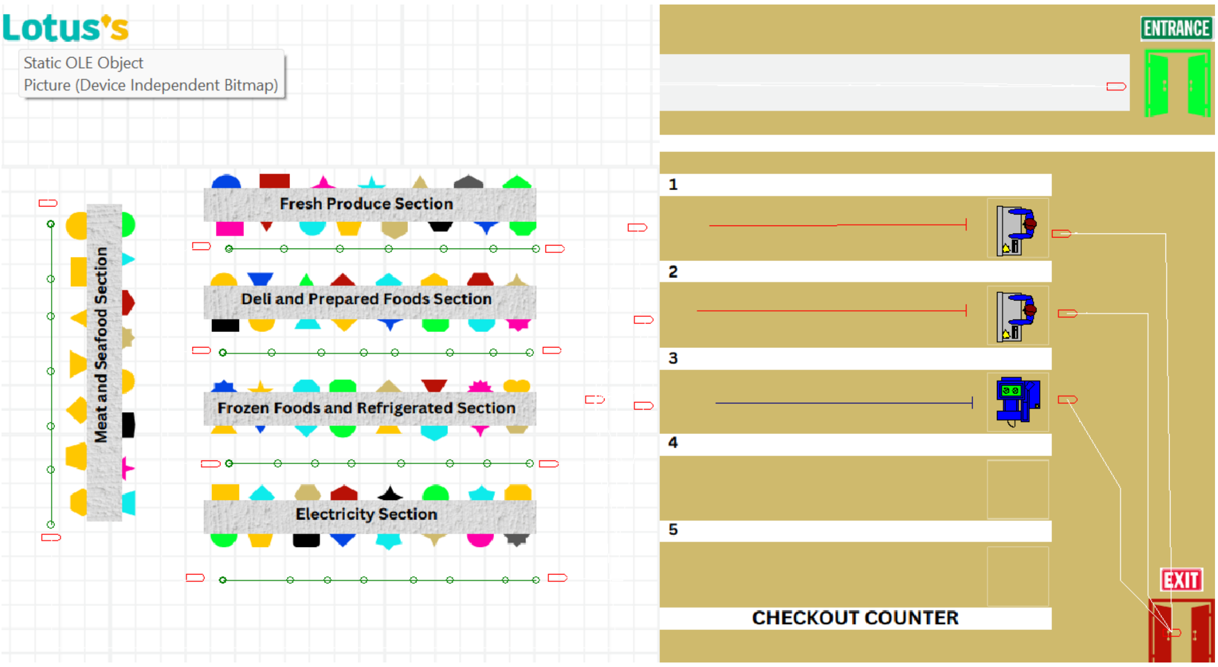

Figure 6. Animation Scenario 1: Adding one self-checkout and two manual checkout counters

4.5.1 Customer waiting time in queue (minutes)

This metric shows the customers' average waiting time at the checkout counter. Based on Scenario 1, the customer waiting time in queue was 21.2 minutes for Manual Checkout Counter 1, 18.1 minutes for Manual Checkout Counter 2, and 15.7 minutes for Self-checkout Counter 1.

4.5.2 Number of customers in queue

This metric shows the average number of customers queuing at each checkout counter. All checkout counters had two customers queuing.

4.6 Scenario 2

Figure 7 shows Scenario 2 where two self-checkouts and no manual checkout counter were applied. The purpose of this experiment was to determine whether the manual and self-checkout counters gave the best output.

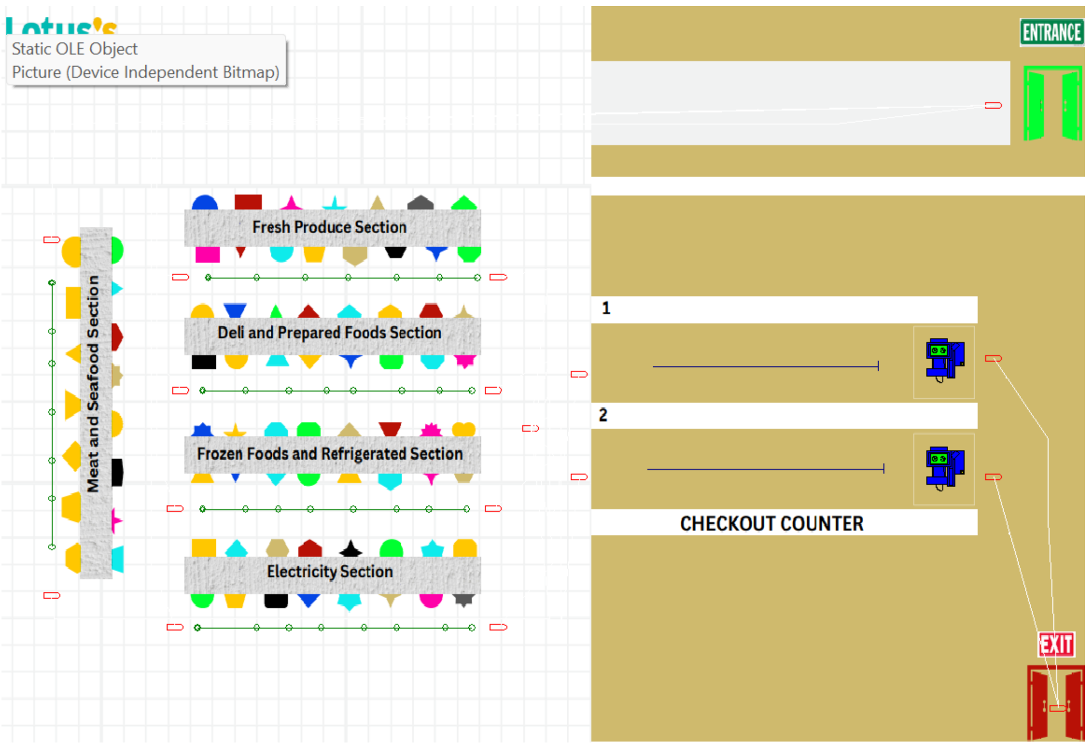

Figure 7. Animation Scenario 2: Adding two self-checkout counters

4.6.1 Customer waiting time in queue (minutes)

This metric shows the customers' average waiting time at the checkout counter. Scenario 2 revealed that the customer waiting times in queue for Self-checkout Counters 1 and 2 were 22.2 minutes and 23.8 minutes, respectively.

4.6.2 Number of customers in queue

This metric shows the average number of customers queuing at each checkout counter. The results revealed that Self-checkout Counter 1 had two customers while Self-checkout Counter 2 only had one customer.

4.7 Scenario 3

The experiment in Scenario 3 was similar to that of the base case with the addition of two self-checkout counters. The purpose of this experiment was to fulfil Lotus Alor Setar's requirement of maintaining three manual checkouts. This makes a total of five checkout counters, each demonstrating positive results.

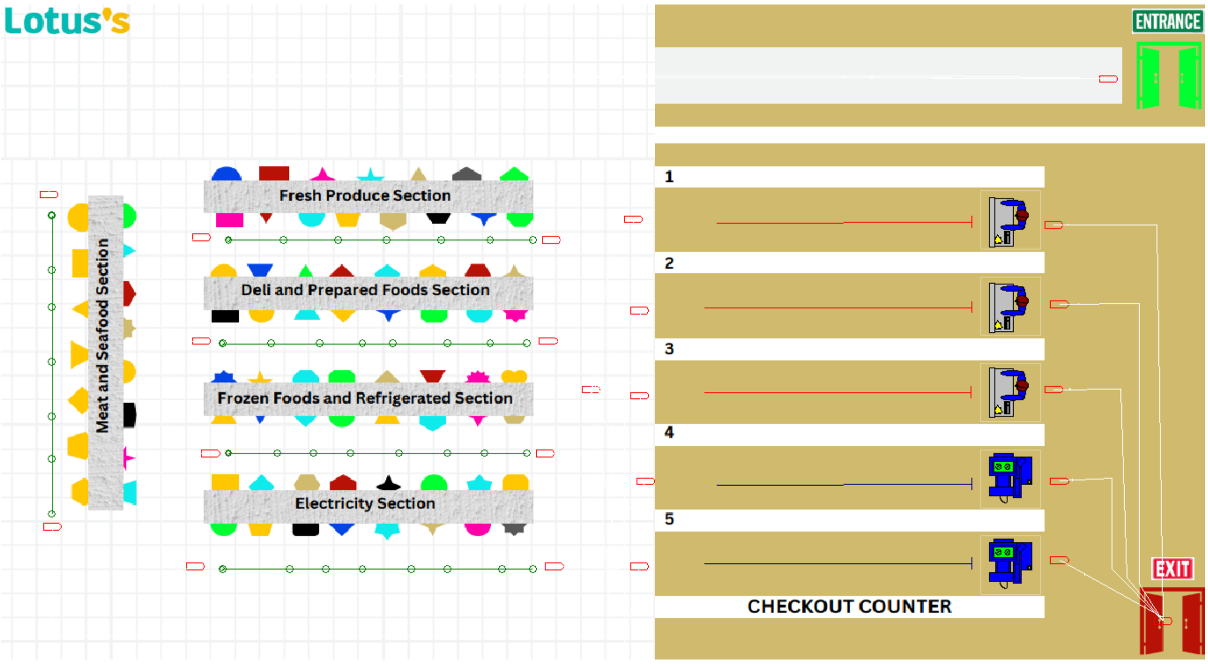

Figure 8. Animation scenario 3: Adding two self-checkout and three manual checkout counters

4.7.1 Customer waiting time in queue (minutes)

This metric shows the customers' average waiting time at the checkout counter. The results in Scenario 3 revealed a drop in the customer waiting time for Manual Checkout Counters 1, 2, and 3 (27.5 minutes, 24.9 minutes, and 19.2 minutes, respectively) compared to the base case. Similar improvement was also evidenced by Self-checkout Counters 1 (22.1 minutes) and 2 (19.3 minutes) compared to Scenarios 1 and 2.

4.7.2 Number of customers in queue

This metric shows the average number of customers queuing at each checkout counter. Both Manual Checkout Counters 1 and 2 had three customers, while Manual Checkout Counter 3 had two customers. Additionally, Self-checkout Counters 1 and 3 had two customers, while Self-checkout Counter 2 had three customers.

4.8 Key Output Performance

This metric offers valuable insights into the performance of the queuing system at Lotus Alor Setar, particularly focusing on customer waiting time in queue and the number of customers in queue at each type of checkout counter. Table 3 presents the results for all scenarios in comparison to the base case, aiming to determine the most suitable scenario that can promote significant improvement for Lotus Alor Setar.

Table 3. Results of the three scenarios

Metrics		Base Case	Scenario 1	Scenario 2	Scenario 3
Number of Customers Out		222	223	256	396
Customer Waiting Time in Queue (Minutes)	Manual Checkout 1	40.9	21.2	-	27.5
	Manual Checkout 2	43.7	18.1	-	24.9
	Manual Checkout 3	38.1	-	-	19.2
	Self-Checkout 1	-	15.7	22.2	22.1
	Self-Checkout 2	-	-	23.8	19.3
Number of Customers in Queue	Manual Checkout 1	7	2	-	3
	Manual Checkout 2	6	2	-	3
	Manual Checkout 3	6	-	-	2
	Self-Checkout 1	-	2	2	3
	Self-Checkout 2	-	-	1	2

5. DISCUSSION

Queues and waiting time are common problems in the service or production lines of companies such as Lotus. In response to the issue, this research investigated the congested queuing system at Lotus Alor Setar. Inefficient queuing systems can cause frustration and reduce customer satisfaction (Mohamad & Saharin, 2019). Like other hypermarkets, customers at Lotus Alor Setar must complete several processes like queuing at the checkout counter and waiting for the cashiers to scan the items and placing them into plastic bags before they can proceed with payment (Harchol-Balter, 2021). However, the management of Lotus Alor Setar is facing hesitations to add more checkout counters as it involves higher costs.

This study addressed such issue using the Arena Simulation Software, which allowed the researchers to produce simulations of possible solutions and identify potential outcomes without interrupting the existing system (Zaki, 2019). It enables a faster and more reliable decision-making process, particularly since the model is developed based on the actual system. Several factors were accounted for in the analysis, including the length of waiting time and the average waiting line. The results showed the system performance in terms of customer waiting time in queue (minutes), the number of customers in queue, and the types of checkout counters needing improvement in the actual system.

Furthermore, this study implemented five scenarios using DES to improve the checkout system performance at Lotus Alor Setar (Mohamad & Saharin, 2019). These scenarios were based on the types of checkout counters, the number of checkout counters opened, and the level of efficiency of the cashiers and machines (Muda & Rethnakumar, 2022). All scenarios were tested in the simulation tool to consider the best alternatives related to having more checkout counters. Positive results were inclined towards Scenario 3, which reduced customer waiting time by 50% compared to the base case. Although it involves the additional costs of opening both manual and self-checkout counters simultaneously, Scenario 3 is the best option that can be implemented by the management to reduce customer waiting time.

Finally, this study successfully achieved the intended research objectives. Objective 1 was met through the use of DES in developing a simulation model for the queueing system at Lotus Alor Setar. Objective 2 was achieved by evaluating the efficiency of the current queueing systems using the developed simulation model. It identified key output performance metrics, including customer waiting time in queue and the number of customers in queue. Meanwhile, Objective 3 was met by recommending Scenario 3 as a potential strategy to improve the queuing system at Lotus Alor Setar, ultimately enhancing customer experience and satisfaction.

6. CONCLUSION AND IMPLICATIONS

Lotus Alor Setar must improve its service operations to attract more customers, earn their loyalty, and fulfil customer satisfaction. Although customer waiting time and queue are normal situations in retail organisations, improvements are needed to ensure the best shopping experience. This study adopted the use of a simulation model to analyse the problems faced by Lotus Alor Setar across five processes: customer choosing the checkout counter, getting into the checkout system, scanning and placing items into bags, making payment, and leaving the checkout system. The model was validated and verified before it was used to analyse several scenarios for improving the queueing system without interrupting the actual system. The most efficient queueing system was demonstrated by Scenario 3, which involves opening five checkout counters (i.e., three manual checkout and two self-checkout counters). The proposed strategy has the highest potential to reduce customer waiting time in queue and the number of customers in queue, ultimately enhancing customers' shopping experience and satisfaction.

However, it should be noted that this study is limited to only Lotus Alor Setar, which may restrict the generalisability of the findings to other hypermarkets. Also, the DES model relies purely on static data rather than on real-time data, which can influence the accuracy of the prediction in dynamic, rapidly changing environments. These limitations underscore the need for future research to include aspects like digital transformation and hybrid systems that employ human and automated resources together.

This study also shows that the application of DES as a computer-aided tool can help the management to improve the queueing system at Lotus Alor Setar. Therefore, it is recommended for future research to consider calculating related costs when deciding the best scenario. Also, the basic model for this study can be generalised to other hypermarkets or retail stores with similar operating systems.

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AUTHORS CONTRIBUTION

Each author was involved and contributed equally to this manuscript. All authors read and approved the final manuscript.

AVAILABILITY OF DATA AND MATERIALS

The data supporting the findings are available on request from the corresponding author.

ETHICS STATEMENT

This study was conducted according to ethical standards.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest regarding the publication of this manuscript.

GENERATIVE ARTIFICIAL INTELLIGENCE DECLARATIONS

The author(s) declare that no generative AI or AI-assisted technologies were used in the writing of this manuscript. All content, including text, figures, and tables, was created by the author(s).

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