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Queuing System Simulation to Optimize Waiting Time using the Quality Function Deployment Approach at KFC Pontianak

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A B S T R A C T

The aim of this research is to find the best scenario to optimize the queuing system so that it can reduce waiting time during customer service at KFC Pontianak. Queue systems are prevalent in public services. The research employs Quality Function Deployment (QFD) and Discrete Event Simulation (DES) methodologies. Alternatives generated are simulated using ARENA Simulation. 70 respondents participated in the KFC Pontianak customer questionnaire, comprising 48.6% females and 51.4% males aged between 18-45 years. The results of the questionnaire showed that 51.4% of respondents were dissatisfied with the speed of service at KFC Pontianak. Customer needs identified through QFD include service speed, order accuracy, ease of use, customer satisfaction, queue comfort, food quality, and payment integration. Analysis reveals three queue system scenarios, two of which propose improvements. The second scenario involves 2 cashiers and 2 self-service cashiers. Self-service allows customers to order by scanning a QR code integrated with the service provider's application. Arrival type employs an exponential distribution with an average of 61 seconds, unlimited max arrival, and first creation with a value of 0. In self-service, there is a value difference of 1 and a standard deviation of 0.2. Simulation results indicate that 51 customers choose cashier 1, 41 choose cashier 2, 39 opt for self-service cashier 1, and 53 prefer self-service cashier 2. The total successfully served customers are 94, with a success rate of 51%. In the third scenario involved 4 self-service cashiers only, the values of 1 and standard deviation of 0.2. The total number of successfully served customers is 173, with a success rate of 80%. In conclusion, this research offers valuable insights for optimizing KFC Pontianak's queue system, addressing customer dissatisfaction with service speed. The proposed scenarios, especially those involving self-service options, demonstrate potential improvements in customer satisfaction and operational efficiency.

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1. INTRODUCTION

PT Fastfood Indonesia Tbk. is the sole owner of the KFC franchise in Indonesia, established by the Gelael Group in 1978 as the first entity to acquire the KFC franchise in the country. The company initiated its restaurant operations in

October 1979 on Melawai Street, Jakarta, achieving success. The triumph of this establishment was followed by the introduction of subsequent outlets in Jakarta and the expansion of coverage to major cities in Indonesia, including Bandung, Semarang, Surabaya, Medan, Makassar, and Manado. The continuous success in brand development positions KFC as a widely recognized and influential fast-food franchise in Indonesia (Sutarsa, 2019). This success is further evidenced by the growing number of KFC outlets, from initially having just one branch to the current 730 branches scattered across 163 cities or regencies in Indonesia. The public's enthusiasm for fast food is notably high, with KFC in Pontianak on Gajah Mada Street being a favored choice. The strategic and easily accessible location of this KFC branch is a significant attraction for visitors. Moreover, being the first KFC in Pontianak Regency adds to its allure, ensuring a steady stream of customers.

The high influx of visitors congregating at the restaurant results in long queues at the service counter, causing customer impatience due to the extended waiting and order fulfillment times. People often form queues when accessing services from facilities that offer various services. This occurs when the number of customers exceeds the available service capacity, leading to some customers not being served immediately due to the busy schedule of employees (Imansuri, 2022). When customers arrive at the service location, they receive a queue number. This marks the official beginning of the queuing process, where customers wait if they cannot be served immediately. After being served, customers leave the service location and await another opportunity for service. Customers naturally desire facilities that offer the best service with minimal wait times to receive optimal service. Additional facilities can be introduced to reduce queue waiting times, enhancing customer satisfaction and reducing the likelihood of customers leaving due to long waits (Levana Puspanegara et al., 2020).

Queue issues may arise due to the facility's limited capacity to provide services compared to the demand for existing services (Dewi Melinda et al., 2018). The implementation of an enhanced service system is an effort to improve customer satisfaction, ensuring that the company remains highly competitive against its competitors (Agyei et al., 2015). The queue model applied at KFC Pontianak determines the characteristics of the queue system used. Therefore, an analysis of the applied queue model is necessary to make it effective and recommend a queue model that can enhance customer satisfaction and reduce queue times (Ratnasari et al., 2018).

The simulation method is a decision-making approach that creates a simulated model of a real system without involving actual conditions but rather through computer programs (Satya, 2010). This method allows for the modeling of random arrival patterns and provides a more detailed and realistic depiction over a specific period. ARENA is a simulation software developed by the Rockwell company and applied in industrial engineering (Harahap, 2018). Arena is a Microsoft Windows-based software designed for modeling and executing simulations. Its reliability and interactive interface classify Arena as a high-level simulation program. As a general-purpose simulation software, Arena enables users to easily shape models, templates, and even create custom modules (Kelton, 2002).

Quality Function Deployment (QFD) is a method for designing products or services based on consumer needs and helps establish appropriate product or service standards (Setiawan & Wahyuni, 2023). The goal of QFD is to translate consumer needs into tangible product characteristics and identify priority areas that require attention in the design and development process. Discrete Event Simulation (DES) is a computer simulation typically conducted before the opening of a restaurant to depict the flow of services. DES serves as a numerical solution for queuing network problems. The main advantage of DES is understanding a system's behavior before its creation and discovering unforeseen discrepancies. By using the QFD and DES methods, key quality indicators for KFC can be identified based on consumer interest levels and technical requirements for KFC. Known quality-shaping factors can be used as benchmarks or service quality standards for KFC, which can then be utilized as references in efforts to enhance the quality and service of KFC. This can also serve as a guideline in KFC service to improve customer satisfaction, encouraging them to visit KFC more frequently.

2. LITERATURE REVIEW

Several research studies serve as references for this writing regarding queue systems, including the study conducted by (Bambang et al., 2021) on the queue system model in fast-food restaurant services, with a case study on KFC Gajah Mada in Kabupaten Jember. Another research by (Pratama et al., 2023) discusses the application of the Kano QFD method in developing services for customer satisfaction in a case study on McDonald Taman Geluran. Additionally, research by (Sintya et al., 2018) focuses on modeling and simulating consumer service queues at McD Solo Grand Mall using Arena. Furthermore, there is a study by (Tika, 2021) that analyzes the M/M/1 queue model to enhance cashier service at Toko Swalayan Omi Cempaka Indah in Central Jakarta. The last mentioned study by (Amelia, 2023) delves into the analysis of queue systems in both Go-Food services and offline services at Bakso Gepeng Pak Wanuri. The best service includes providing fast service so that customers are not left waiting for a long time by (Benediktus et al., 2020).

Arena software was used to simulate the current state of operation of the company's factory and a simulation of the future situation with the implementation of the suggested improvements, to streamline the process flow aiming to provide conditions for obtaining an increase in customer satisfaction by (Dias et al., 2022). DES is a form of computer-based modeling methodology that provides an intuitive and flexible method by (Zhang, 2018). Point Of Sales (POS) system is an application system that is applied to minimarket or shop businesses to handle data processing of purchase, sales, purchase returns and transaction reporting in general by (Putu et al., 2021). The difference between our research and the aforementioned studies lies in the methods employed and the expected outcomes. We have chosen to utilize a combination of Quality Function Deployment (QFD) and Discrete Event Simulation (DES) as an approach to provide recommendations for the queue system with some scenarios and considering the costs in the KFC fast-food restaurant in Pontianak. The results of our research will be simulated using the ARENA simulation software.

3. RESEARCH METHOD

This research employs a qualitative approach. Qualitative research is a method to discover findings through understanding the meaning of a study and can address occurring issues or comprehend a phenomenon with a case study concept aimed at creating a systematic and current portrayal of subject or object research facts (Fadli, 2021). The study is conducted at the Kentucky Fried Chicken (KFC) restaurant in Pontianak City. The sample used for the research consists of consumers who make direct purchases and consume products at KFC Pontianak. Data collection is performed using questionnaires distributed to KFC Pontianak consumers.

The questionnaire contains questions related to the assessment of importance and performance scores for 9 types of attributes using a 1-5 scale. This research utilizes data obtained from 70 respondents, comprising 48.6% females and 51.4% males aged 18-45 years. From the distributed questionnaires, 51.4% of the responses indicate dissatisfaction with the speed of service at KFC. The researcher employs a combination of the Quality Function Deployment (QFD) and Discrete Event Simulation (DES) methods, where the results of both methods will be applied using ARENA software. (Figure 1) is Research Framework and Workflow.

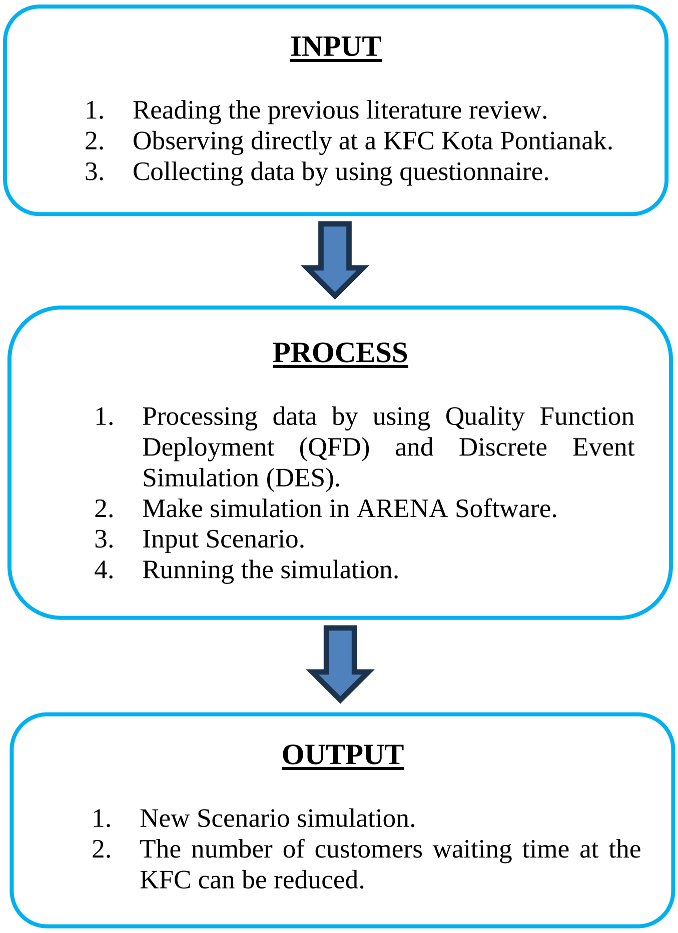

Figure 1. Research framework and workflow

4. RESULT AND DISCUSSION

Quality Function Deployment

In the context of implementing House of Quality (HOQ) or Quality Function Deployment (QFD) in the queuing system model in fast food restaurant services, the results of a questionnaire have been obtained which will then be discussed with an expert in the field of operational management or the head officer a fast food restaurant. The discussion covered various aspects, including internal restaurant operational processes such as stock management, service efficiency, and spatial planning to increase queue effectiveness.

The expert underscored the importance of understanding the dynamics between these factors and relationships in creating a satisfying customer experience. For example, although high food quality may be a priority for most customers, speed of service and queue convenience also play an important role in determining overall customer satisfaction. Additionally, the expert suggests that efficient payment integration can improve overall operational efficiency, speed up the checkout process, and ultimately, increase customer satisfaction.

Therefore, in developing an HOQ, it is important to consider not only the customer's directly expressed needs, but also the internal and external factors that influence the overall customer experience and restaurant operations. Based on the results of the discussion, the customer requirements obtained include: (a) Service speed, (b) Order accuracy, (c) Ease of use, (d) Customer satisfaction, (e) Queuing confort, (f) Food quality, and (g) Payment integration.

Analysis of Quality Function Deployment

In this section, we will elaborate on the analysis of the QFD results that have been developed.

Based on the customer requirements mentioned in the previous section, the results related to functional requirements and their relationships with customer requirements can be determined. This relationship can be seen in (Figure 2). From the figure, it can be concluded that the highest relative weights are for "Service Speed" and "Customer Satisfaction," each with a weight of 18%. This is followed by the other three relative weights, with the lowest being for "Ease of Use" and "Payment Integration," each with a weight of only 11%. The relationship between functional requirements and customer requirements has its respective analysis, including:

					Column #	1	2	3	4	5	6	7
					Direction of Improvement	▲	▲	◇	▼	◇	▲	◇
Row #	Weight Chart	Relative Weight	Customer Importance	Maximum Relationship	Functional Requirements / Customer Requirements (Explicit and Implicit)	Order via Application	Order Management	Menu Integration	Order Readiness Notification	Integrated Payments	Scalability	Ease of Use
1		18%	5	9	Speed of Service		●		○		●	○
2		14%	4	9	Order Accuracy			●				
3		11%	3	9	Ease of Use	●				○		●
4		18%	5	9	Customer Satisfaction		●	○	▽			○
5		14%	4	9	Queue Comfort						●	
6		14%	4	9	Food Quality		●	○				
7		11%	3	9	Integration with Payments	▽				●		○

Figure 2. Relationship between customer requirements and functional requirements

a. Service Speed with Order Management
Interrelated and mutually influential. A fast-food restaurant that can integrate these two aspects well tends to be more competitive, efficient, and better able to meet customer expectations.

b. Service Speed with Scalability
Scalability refers to the ability of a fast-food restaurant's service to expand or shrink its operations according to demand or changing needs. The combination of high service speed and good scalability can help the service become more competitive and responsive.

c. Order Accuracy with Menu Integration
Good menu integration is key to maintaining order accuracy and optimizing the operations of a fast-food restaurant. This helps maintain consistency and improve customer satisfaction.

d. Ease of Use with App Ordering
In maximizing the benefits of app ordering, it is important to design the application with a focus on ease of use. Good usability will enhance the app's attractiveness, maximize customer engagement, and help the fast-food restaurant grow sustainably.

e. Queue Comfort with Scalability
Queue comfort and scalability support each other in efforts to provide better service to customers. A fast-food restaurant that can integrate both well can enhance customer satisfaction, optimize resource utilization, and create a more positive customer experience.

f. Food Quality with Order Management

It is crucial to prioritize both the quality of the food served and efficient order management. Both aspects work together to provide an exceptional customer experience, which, in turn, can increase customer satisfaction, loyalty.

g. Payment Integration with Integrated Payments

They are different stages in the journey to improve the customer payment experience. Payment integration creates the foundation that allows a fast-food restaurant to accept various payment methods, while integrated payments take the payment experience to the next level by embedding the payment process into the application or website environment to enhance customer convenience.

In (Figure 3) below, one of the ways to meet the target functional requirements is presented. In the figure, it can be seen that the highest parameter related to the "HOW" column is "Order Management," with a technical importance rating of 107.1 and a relative weight of 30%, and "Scalability," with a technical importance rating of 289.3 and a relative weight of 19%. This aligns with the goal of our paper, which is to create a queue system model in fast-food restaurant services with a focus on these two aspects.

Target	Order via Application	Order Management	Menu Integration	Order Readiness Notification	Integrated Payments	Scalability	Ease of Use
Max Relationship	9	9	9	3	9	9	9
Technical Importance Rating	107.1	450	225	71.43	128.6	289.3	235.7
Relative Weight	7%	30%	15%	5%	9%	19%	16%
Weight Chart							

Figure 3. Functional requirements target

In (Figure 4), the results of the weighting between KFC and its competitors in the fast-food industry of a similar nature are presented. From the figure below, it is evident that KFC has advantages in terms of order management, order readiness notification, and scalability. However, areas such as app ordering, menu integration, and ease of use still need attention. Based on the ongoing research, it appears that there is no fast-food restaurant that has fully maximized the queue system in the service process.

Technical Competitive Assesment	Target	Order via Application	Order Management	Menu Integration	Order Readiness Notification	Integrated Payments	Scalability	Ease of Use
	KFC	4	5	4	5	3	5	4
	McD	4	4	3	4	4	4	5
	A&W	4	3	2	2	3	3	4
	Richeese	4	3	4	3	3	5	3
	Burger King	3	2	3	3	5	3	3

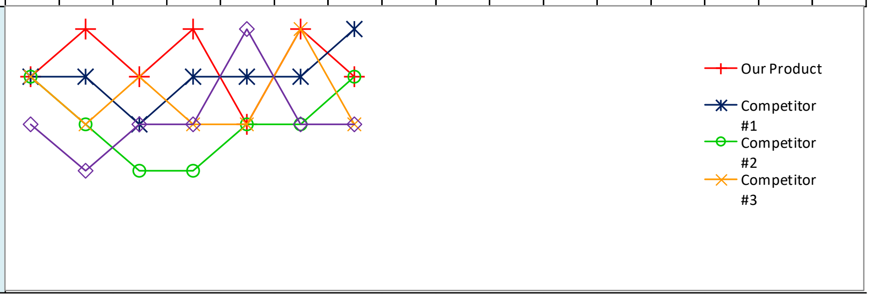

Figure 4. Comparison of KFC with competitors

In the graph below or (Figure 5), it represents the queue data for customers at KFC Pontianak during peak hours. In the initial scenario or scenario one, the total number of customers who arrived was 167. During this peak time, 59 customers were successfully served, and there were still 108 customers in the queue.

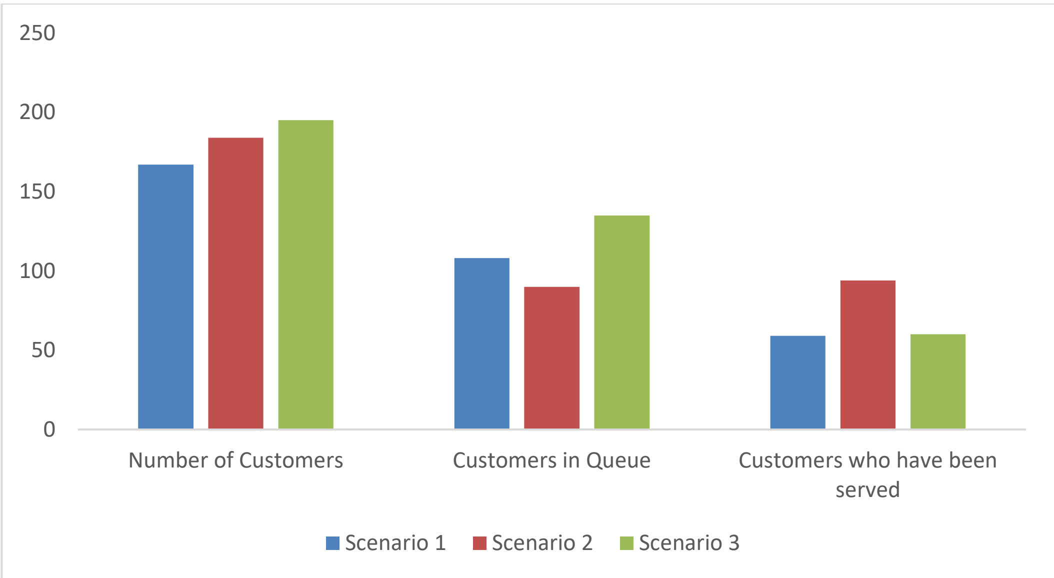

Figure 5. Customer queue data at KFC restaurants

Modeling using the ARENA Software

Modeling using the ARENA software involves three scenarios. The selected modules are as follows: "create" is used as the customer arrival activity, "decide" is used as the activity of choosing a cashier, "process" is used as the service activity by cashiers 1 and 2, and "dispose" is used as the activity of exiting the system. The queue model at KFC utilizes 2 cashiers, as seen in (Figure 6).

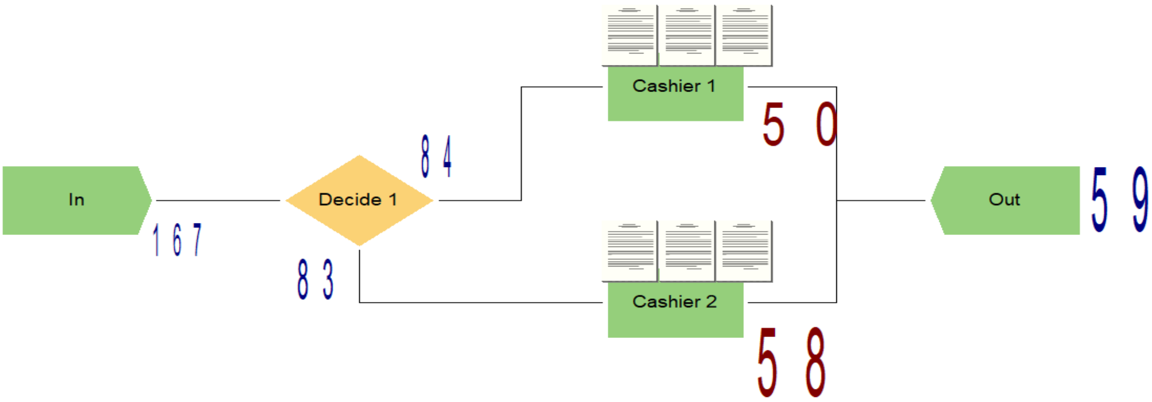

Figure 6. First scenario

In the process of creating this queue simulation model, the "create" module is utilized as the starting point for entities entering. Entities in this simulation model refer to customers conducting transactions, either for dine-in or take-away. The arrival type applied is "expression," following an exponential distribution with an average of 61 seconds. Subsequently, "max arrival" indicates that KFC does not limit the number of arriving customers, and "first creation" is set to (0) to initiate the system from the arrival of zero.

The next step involves the "decide" module, which is used for customer decision-making in choosing cashier 1 or cashier 2. This setting uses "2 way chance" with a probability of choosing cashier 1 at 51%. Next is the processing stage, where "process 1" represents cashier 1 and "process 2" represents cashier 2. Both have a "delay type" of normal, with time units in minutes, and an allocation of "value added" with a value of 3 and a standard deviation of 2.

The final step involves the "dispose" module, representing the activity of exiting the simulation. In the initial model reflecting the current queue conditions at KFC, a simulation is conducted for 3 hours, representing the peak time at KFC from 18:00 to 21:00. In this observation, there are 84 customers choosing cashier 1 and 83 customers choosing cashier 2. The number of customers successfully served during this period is 59, with a success rate of 35%.

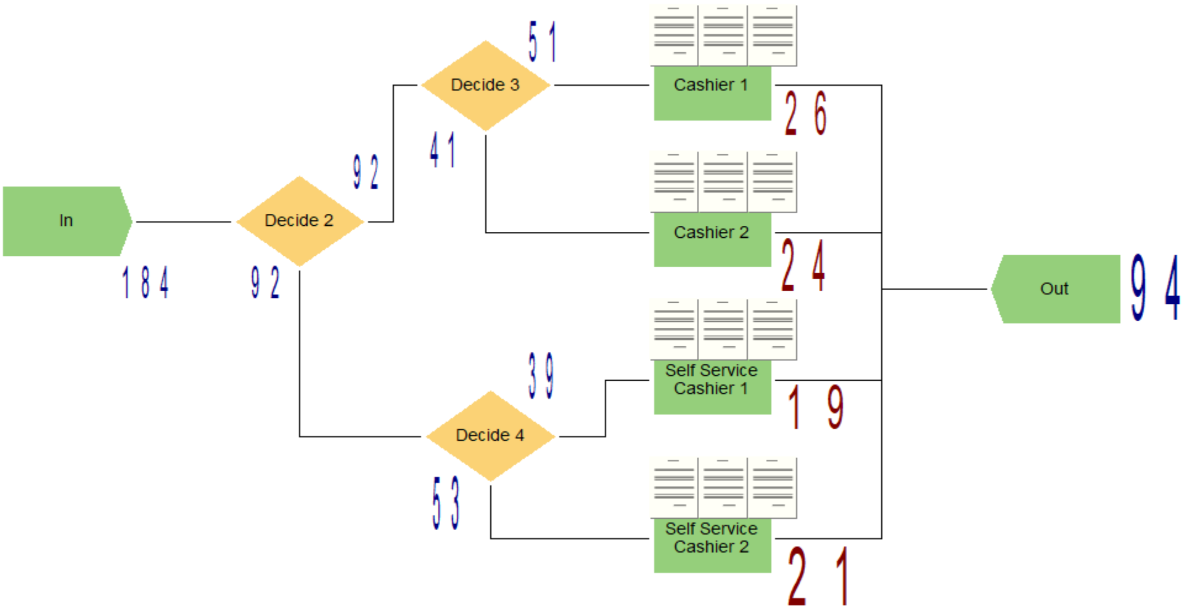

Figure 7. Second scenario

The improvement of the queue system is necessary to enhance an inefficient system. Scenario 2 introduces the utilization of 2 cashiers and 2 self-service cashiers, where self-service cashiers can take orders by scanning a QR code integrated with the service provider's application. The queue model for KFC cashiers is tested with 2 cashiers and 2 self-service cashiers in the simulation model presented in (Figure 7). The arrival type remains constant, using expression with an exponential distribution and average of 61 seconds, with unlimited max arrival, first creation set to 0.

The next step involves the "decide" module, where decide 2 uses a 2-way chance at 50%, then decide 3 employs a 2-way chance with 51% leading to cashier 1, and decide 4 uses a 2-way chance at 50%. This is followed by the process model, which includes 4 process stations divided into two types: cashier 1 and cashier 2, where customers are still served directly by KFC employees, and the second type is self-service cashier, where customers can directly order through the provided touchscreen. Cashiers 1 and 2 have a normal delay type, with units in minutes, and allocation as value added, with a value of 3 minutes and a standard deviation of 1 minutes. In contrast, for self-service, there is a difference in value 1 and a standard deviation of 0.2. The results show that 51 customers choose cashier 1, 41 customers choose cashier 2, 39 customers choose self-service cashier 1, and 53 choose self-service cashier 2. The total number of successfully served customers is 94, with a success rate of 51%.

Queue scenario 3 is depicted in (Figure 8). In this third scenario, the values of 1 and standard deviation of 0.2. The total number of successfully served customers is 158, with a success rate of 91%.

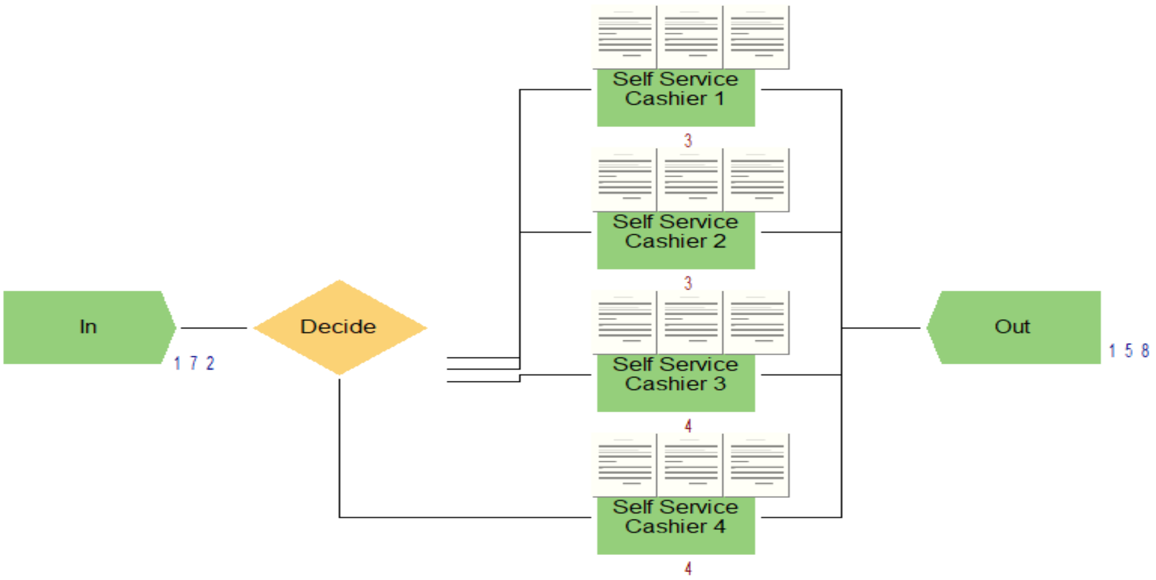

Figure 8. Third scenario

Calculation of Queue Costs Based on Scenarios

The calculation of queuing costs is based on several parameters, namely queuing time, system time, queue length, system length and server utilization (Murti et al., 2018). In the below Table 1, there are details of Service Facility Requirements Costs (General), while in Table 2, details of Service Facility Costs per Hour are presented for each existing scenario.

Total costs are formulated as follows: **Ct = Cs (s) + Cw (Ls)**

Information :

Ct = total cost per hour
Cs = cost of officer services per hour
s = number of officers serving
Cw = cost of waiting for customers in queue per hour
Ls = average number of customers in the system

Table 1. Costs of service facility requirements (general)

No	Cost Component	Cost Per Unit (IDR)	Period (Year)
1	Self Service Cashier Device	17.500.000	10
2	Computer Hardware	5.000.000	7
3	Cashier Device	3.000.000	7

Source: Processed data (2024)

Table 2. Service facility costs per hour based on scenarios

Scenario	Cost component	Amount	Cost per unit (IDR)	Total cost (IDR)	Total cost per hour (IDR)
1	Computer Hardware	1	5.000.000	5.000.000	83
	Cashier Device	2	3.000.000	6.000.000	100
		Total			**183**
2	Self Service Cashier Device	2	17.500.000	35.000.000	405
	Cashier Device	2	3.000.000	6.000.000	100
	Computer Hardware	1	5.000.000	5.000.000	83
		Total			**588**
3	Self Service Cashier Device	4	17.500.000	70.000.000	810
	Computer Hardware	1	5.000.000	5.000.000	83
		Total			**893**

Source: Processed data (2024)

5. CONCLUSION

By considering more service facilities, the number of customers that can be served increases, resulting in significant waiting time savings. This condition reflects the effectiveness and optimality of the service. In this case, the decrease in the average number of customers in the system has a positive impact on the total waiting time, creating a more efficient customer experience. Adding cashier facilities becomes a strategic choice, considering the minimal waiting time impact it can generate. The evaluation results indicate that Scenario 3 emerges as the preferred option to address the queue problem at KFC Pontianak. Therefore, it can be concluded that investing in additional facilities, especially cashier facilities, can provide the best solution to improve service quality and minimize customer waiting time. However, scenario 3 in terms of costs shows the highest costs. If you have a limited budget, then scenario 2 could be the best choice to improve the existing queuing system.

Additional Suggestions

In fast-food restaurants, the development of a dedicated ordering application or self-service becomes a significant expectation. Thus, the scenario simulated by the researcher can be implemented directly. The use of this application not only provides convenience in queue management but also brings various other advantages. With the ordering application, customers can easily view various attractive promotions, explore the complete menu, and place orders according to their preferences. This not only provides a more personalized shopping experience but also speeds up the transaction process, improves efficiency, and reduces waiting time in the restaurant.

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