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ANALYZING SERVICE PROCESS EFFICIENCY AND TECHNOLOGY USE IN PHOMO PHOTOBOOTH OPERATIONS

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ABSTRACT

This study aims to analyze the operational performance of PHOMO's photobooth service from an operations management perspective, focusing on queue management, capacity, and service quality aspects. The method used is a descriptive quantitative approach through direct observation of approximately 30 service transactions using time study and process observation techniques. The main variables analyzed include arrival rate, service rate, waiting time, utilization, system capacity, as well as quality indicators such as defect rate and reliability. The results indicate that the operational performance is relatively efficient but approaching its optimal capacity limit. The average total flow time was recorded at 25.5 minutes, with the main bottlenecks occurring during the photo session and assembly stages. Although the service quality is considered stable with a low operational defect rate, variability in customer behavior was found to affect process efficiency. The implications of this study highlight the importance of capacity optimization and process standardization to reduce variability and improve the overall customer experience.

Keywords: *Photobooth, Operations Management, Queue Analysis*

INTRODUCTION

Photobooth Service Industry Background

The photobooth service industry is part of the experience-based service sector, which has experienced significant growth in recent years. Changes in consumer behavior that increasingly prioritize visual experiences, personalization, and the need for social media content have become the main drivers of this industry's expansion. Modern photobooths no longer merely provide photography services; instead, they offer immersive, fast, and easily accessible experiences. The growth of this industry is also supported by advances in digital technology, such as high-resolution cameras, instant printing systems, and integration with digital platforms. These developments enable service processes to take place in real time, allowing customers to take photos, edit them, and print the results within a short period. Therefore, operational efficiency has become a crucial aspect in maintaining service quality and customer satisfaction.

From an operations management perspective, photobooth services can be categorized as high customer contact services. Customers are directly involved in the service production process, from selecting photo concepts and using the equipment to receiving the final output. This condition requires companies to establish effective operational systems, particularly in queue management, service capacity planning, and output quality standards. Furthermore, competition within the photobooth industry has intensified with the emergence of various brands offering different concepts and experiences. Each business strives to create differentiation through studio design, photo quality, service speed, and customer experience innovation. Therefore, analyzing operational and service systems becomes essential to understand how companies can achieve competitive advantage in an increasingly competitive market.

Operational Problem

In the photobooth service industry, various operational problems arise alongside high demand and the experience-based and real-time nature of the service. Several key issues commonly faced include waiting time, capacity mismatch, and service variability, all of which directly affect service quality and customer satisfaction. One of the main issues is waiting time. High customer interest, particularly during peak hours such as weekends or public holidays, often leads to long queues. Since the service process is sequential and cannot be significantly accelerated without compromising the quality of the experience, waiting time becomes a critical factor that may reduce customer satisfaction and potentially result in lost demand. Another issue is capacity mismatch, which refers to the imbalance between service capacity and customer demand. In the photobooth business, capacity is determined by the number of available booths, the duration of use per customer, and the efficiency of the operational flow. When demand exceeds capacity, queues accumulate. Conversely, during off-peak periods, available capacity is underutilized, which reduces operational efficiency and profitability.

In addition, there is service variability, which refers to variations in the service process. This variability may stem from differences in customer behavior (for example, varying booth usage times), staff skills, or the technical condition of the equipment. High variability can create uncertainty in service duration and output quality, making queue management and capacity planning more difficult. These three issues are interrelated and represent major challenges in photobooth service operations management. Therefore, appropriate operational strategies are required to manage queues, align capacity with demand, and minimize service variability in order to create an optimal and consistent customer experience.

Research Gap

Although the experience-based photobooth service industry has experienced rapid growth, academic studies that specifically examine operations management aspects within this service context remain relatively limited. Furthermore, existing research generally has not examined differences in service process design among photobooth businesses with varying levels of operational complexity, particularly in services that extend beyond the stages of photo taking and printing to include additional processes in producing the final product. In fact, these differences in process flow may significantly affect operational performance, such as waiting time, service capacity, and service quality consistency.

Moreover, there is still a lack of comparative studies that directly compare two experience-based photobooth service providers with similar positioning, such as PHOMO and Studioverse Gading Serpong. Both services offer customer experiences that go beyond conventional photobooth services; however, they differ in their operational process design, which has not been widely analyzed from an operations management perspective.

Research Objective

This study aims to analyze and compare the service operation systems of PHOMO and Studioverse Gading Serpong as two experience-based photobooth service providers that share similar service characteristics but apply different operational approaches.

PHOMO offers a more complex and multi-stage service process, where customers not only take photos, but the photo results also go through several additional stages such as processing, printing, heating (oven) for shrink material, resin coating, and UV curing to produce the final product. On the other hand, Studioverse Gading Serpong also provides an experience-based photobooth service, but with a different process flow and operational design in delivering the final output to customers.

Based on these differences, this study specifically aims to:

1. Analyze the queue system (queue analysis) of PHOMO and Studioverse Gading Serpong, particularly how differences in process flow affect customer waiting time.
2. Analyze service capacity (capacity analysis) by considering the number of process stages, cycle time, and the capability of each service provider in handling customer demand.
3. Analyze the resulting service quality (service quality), particularly in relation to customer experience and the output value delivered by each service model.

Thus, this study is expected to provide a more comprehensive understanding of how differences in service process design between PHOMO and Studioverse Gading Serpong influence operational performance and customer experience in the experience-based photobooth industry.

LITERATURE REVIEW

Service Operations

Service operations is a branch of operations management that focuses on planning and managing capacity and facilities within service systems. According to Russell & Taylor, capacity is defined as the maximum ability of a system to produce output within a given period of time, and capacity-related decisions significantly affect service levels, waiting times, operational costs, and a company's ability to respond to customer demand. In the service context, capacity management becomes more complex due to demand fluctuations and the direct involvement of customers in the service process.

In service systems, capacity is not only determined by the number of physical facilities but also by process efficiency and the interaction between system elements. Russell & Taylor emphasize that capacity decisions must consider demand levels, uncertainty, and company strategy, including when and by how much capacity should be expanded. In addition, the concept of the best operating level refers to the optimal level of capacity utilization to minimize cost per unit, while a capacity cushion refers to the reserve capacity provided to anticipate demand fluctuations or operational disruptions.

In the context of instant photobooth or photoshoot services such as PHOMO, service capacity is determined by a combination of key resources such as the number of studios, printers, and workstations for the assembly process. This system is semi-parallel in nature, where some processes such as photo sessions and printing can be performed simultaneously, while other processes such as assembly have more limited capacity. This indicates that service capacity depends not only on the number of facilities but also on the distribution and coordination between processes within the system.

Furthermore, in service operations, facility layout design also plays an important role in determining service efficiency. The main objective of layout design is to minimize movement, reduce processing time, avoid bottlenecks, and improve overall service quality. In photobooth services, the layout must be able to accommodate a smooth customer flow, from the initial stage to the final product, without creating congestion at certain points such as the assembly area or waiting area.

Based on observations, the photobooth system shows a utilization rate of approximately 83%, which indicates that the system is operating quite efficiently but is approaching its optimal capacity limit. This condition suggests that although the current capacity is still able to meet demand, there is a potential risk of increased waiting time if there is a surge in demand or an increase in process variability. This is consistent with capacity management theory, which states that the higher the utilization rate, the more vulnerable the system becomes to delays and bottlenecks.

Overall, service operations in the photobooth business emphasize the importance of balancing capacity, demand, and process efficiency. An effective system not only has sufficient capacity but is also able to optimally manage service flow to maintain the quality of the customer experience. Therefore, capacity management and facility design become key factors in ensuring smooth operations and sustainable service performance.

Process Analysis

Process analysis is a systematic approach used to understand, measure, and evaluate the performance of service flows comprehensively. In the context of operations management, process analysis is defined as an effort to identify how inputs are transformed into outputs and how the overall process flow can be optimized to improve operational efficiency (Russell & Taylor, 2019). This approach is particularly relevant in experience-based services such as photobooths, where production and consumption occur simultaneously and involve direct customer participation (Fiveable, 2024).

Flow time refers to the total time required for one service unit to pass through all process stages, starting from customer arrival until the final product is received. At PHOMO, the flow time consists of a longer sequence of processes compared to conventional photobooths due to additional stages such as heating the shrinking paper using an oven for approximately 2–3 minutes until it shrinks and hardens into a keychain. Based on observations of the indirect competitor Studioverse, which has a somewhat similar process flow, the core process time is approximately 11 minutes and 30 seconds per customer, consisting of studio preparation (±1 minute), photo session (10 minutes), and printing (30 seconds). At PHOMO, the total actual flow time is estimated to be longer due to the additional heating and keychain assembly processes, which are variable and depend on the speed and skill of each worker. This aligns with process flow analysis concepts which state that additional process steps increase total flow time and may reduce throughput if not balanced with capacity adjustments (Capacity Planning Lecture Notes, 2020).

A bottleneck is defined as the stage with the lowest capacity that determines the overall system throughput rate. At PHOMO, the main bottlenecks are the oven capacity, which processes products per batch with a fixed processing time, and the keychain assembly stage, which is handled by the operations team and therefore limited by the number of available staff. Findings from Studioverse as an indirect competitor—where the assembly stage is designed as a self-service process with only four workstations serving seven studios—provide an important comparison showing that different process designs result in different bottleneck profiles. This is consistent with process bottleneck theory which states that system output is determined by the slowest stage of the process rather than the total number of resources (Kristen's Cookie Company Case, n.d.).

To measure how efficiently system capacity is utilized, the concept of utilization is introduced, formulated as:

$$\rho = \lambda / \mu$$

Where λ represents the arrival rate and μ represents the service rate. With the oven process as an additional stage, PHOMO's effective service rate is lower than that of conventional photobooths. This condition implies that at the same customer arrival rate, PHOMO operates at a higher utilization level, thereby increasing the risk of queue buildup, particularly during periods of increased demand such as weekends. This is consistent with operations management literature which explains that higher utilization levels increase the probability of waiting time growth and congestion (Russell & Taylor, 2019).

Another important dimension is process efficiency, defined as the ratio of value-added time to total flow time. At PHOMO, the stages that directly create value for customers include the photo session and the product transformation process through oven heating, which also serves as PHOMO's key differentiating feature compared to competitors. Therefore, the evaluation of PHOMO's process efficiency cannot be based solely on time minimization but must also consider the contribution of each stage to the value perceived by customers. This concept is aligned with service process design theory which emphasizes that customer value creation is as important as time efficiency in service systems (Fiveable, 2024).

Overall, in a high customer contact system, capacity should be designed to exceed average demand in order to anticipate fluctuations. The implication for PHOMO is the need to balance capacity across different stages, particularly between the number of studios, oven capacity, and the number of assembly staff, to ensure that flow time remains controlled and system utilization does not exceed optimal levels, which could otherwise result in long queues and a decline in the overall customer experience (ScienceDirect, 2010)

Queueing Theory

Queueing theory is a quantitative approach used to analyze the behavior of service systems in handling randomly arriving demand. In basic queueing models, customer arrivals typically follow a Poisson distribution, while service times follow a negative exponential distribution, with the fundamental stability condition being that the service rate must exceed the arrival rate ($\mu > \lambda$) (Russell & Taylor, 2019). Understanding this model provides an important foundation for PHOMO in designing its service capacity, particularly given its event-based operational nature with fluctuating and difficult-to-predict arrival rates.

The arrival rate (λ) is defined as the average frequency of customer arrivals into the system per unit of time. At PHOMO, λ is strongly influenced by the characteristics of the events in which it participates. Observations indicate approximately five customers per hour under normal conditions, increasing to around eight customers per hour during peak hours. This variability presents a challenge because, as an event-based business, spikes in customer arrivals are difficult to control and must be anticipated through adequate capacity readiness. Queueing literature explains that arrival variability is one of the main drivers of waiting time formation in service systems (ScienceDirect, 2010).

On the other hand, PHOMO's service rate (μ) is lower than that of conventional photobooths due to the additional oven heating process of approximately 2–3 minutes, which is not present in most competitors' operations. The lower the value of μ relative to λ, the more vulnerable the system becomes to queue buildup. This condition makes the optimization of staff numbers and equipment capacity a critical factor in maintaining the stability of PHOMO's overall queueing system (Capacity Planning Lecture Notes, 2020).

The direct consequence of the relationship between λ and μ is reflected in the waiting time, which can be formulated as:

$$\mathbf{W}q = \lambda / \mu(\mu - \lambda)$$

As utilization increases, waiting time rises exponentially rather than linearly. In the context of events, this implication is particularly critical for PHOMO, as customers who experience excessive waiting times are more likely to abandon the queue, directly resulting in lost sales opportunities. This phenomenon is consistent with queue management research showing that longer waiting times negatively affect customer retention in service environments (ScienceDirect, 2010).

Utilization ($\rho = \lambda/\mu$) reflects how close the system operates to its capacity limit, and when ρ approaches 1, waiting times increase dramatically. With the oven process effectively reducing μ, PHOMO has the potential to operate at higher utilization levels than its competitors at the same arrival rate. This highlights the importance for PHOMO to design an adequate capacity cushion through optimizing oven capacity and staffing levels to ensure that the queueing system remains stable under various operational conditions (Russell & Taylor, 2019).

Capacity Management

Capacity is defined as the maximum output that a system can produce within a given period, and capacity decisions directly affect operational efficiency, costs, and a company's ability to respond to demand (Russell & Taylor, 2019). For PHOMO, service capacity is not determined solely by the number of photo studios but also by the oven capacity, which represents a unique stage that limits the number of products that can be processed at any given time.

In measuring system performance, the number of units successfully processed per unit of time is always constrained by the narrowest stage in the process flow. At PHOMO, this condition creates a gap between the theoretical capacity of the studios and the actual output produced, because the oven—processing products in batches with a fixed duration of approximately 2–3 minutes—becomes the primary determinant of how many products can be completed, especially during peak hours when demand increases. This is consistent with capacity planning theory which explains that effective capacity is determined by process constraints rather than design capacity alone (Capacity Planning Lecture Notes, 2020).

Every operational system has a critical point with the lowest capacity that directly limits overall output. PHOMO faces a layered constraint at this point: first, the fixed capacity of the oven, and second, the number of staff responsible for completing the final product assembly. The implication is that increasing capacity outside of these two constraint points will not significantly impact the overall system output. Therefore, PHOMO's optimization priorities should be directed toward these critical stages rather than toward adding more studio units. This finding is aligned with process optimization studies which emphasize focusing improvements on bottleneck stages to improve total system throughput (ScienceDirect, 2010).

Service Quality Operations

Service quality in operations management emphasizes that service quality is determined not only by the final outcome but also by the consistency of operational processes in meeting customer expectations. In service systems, particularly those with high customer contact, quality becomes more complex because it is influenced by process variability and customer involvement in service production. Therefore, service quality measurement focuses not only on output but also on the system's ability to minimize errors (defects), avoid process repetition (rework), and maintain service reliability.

In service quality operations, a defect is defined as any deviation from established service standards or customer expectations. In experience-based services such as photobooths, defects are not always technical in nature but may also include unsatisfactory customer experiences, poor photo results, or errors in the product completion process. Defects in this system may originate from two main sources: operational systems and customers. From an operational perspective, defects may include equipment failures such as camera or printer malfunctions; however, based on observations, the level of operational defects is relatively low, indicating that the technological system is functioning well. In contrast, more dominant defects tend to originate from customers, such as errors in the assembly process or improper use of facilities. This indicates that in service systems, quality control depends not only on the system itself but also on customer behavior.

Rework in the context of service quality refers to the repetition of processes due to defects. In service environments, rework has significant implications because it occurs directly within the service process and may affect the overall customer experience. In photobooth services, rework may occur in the form of repeated photo sessions, reprinting, or corrections in the assembly results. Although the level of operational rework is relatively low, the potential for rework still exists, particularly due to customer errors in the final stages of the process. Rework not only increases processing time but also reduces the effective system capacity, increases the waiting time for other customers, and may create imbalances in the service flow. Therefore, in service quality operations, reducing rework is essential to maintaining both efficiency and overall service quality.

Reliability in service quality operations refers to the system's ability to deliver services consistently, stably, and in accordance with established standards. Nelson emphasizes that reliability is a key indicator of service quality because it reflects the extent to which a system can repeatedly meet customer expectations without disruptions. In the context of photobooth services, reliability can be observed through the stability of service time, the consistency of photo quality, and the minimal occurrence of operational disruptions. Observations indicate that core processes such as photo sessions and printing have relatively consistent processing times, demonstrating a high level of reliability. However, there is notable variability in the assembly stage, which depends on customer behavior. This suggests that although the technological system demonstrates good reliability, the overall service quality is still influenced by human factors.

Overall, defect, rework, and reliability are three interrelated elements that determine service quality. A high defect rate increases the need for rework, which ultimately reduces system reliability. Conversely, systems with low defect rates and minimal rework tend to produce more consistent and reliable services. In the context of photobooth services, service quality is determined not only by technological sophistication but also by the system's ability to manage customer interactions and reduce process variability, thereby ensuring an optimal and consistent service experience.

RESEARCH METHODOLOGY

Research Approach

This study employs a descriptive quantitative approach aimed at analyzing and describing the performance of the service operational system objectively based on numerical data obtained through direct observation. This approach was selected because the research focuses on measuring operational variables such as customer arrival rates, service times, and the efficiency of the queueing system without intervening in the observed processes.

Through this approach, the study not only describes the actual conditions of the service system but also identifies patterns, relationships, and potential operational issues, such as imbalances between capacity and demand, high waiting times, and the presence of bottlenecks at certain process stages. Therefore, the results of this analysis are expected to provide a comprehensive overview of the efficiency and effectiveness of the service system.

Furthermore, the descriptive quantitative approach enables the study to produce more measurable and objective findings, which can serve as a basis for formulating strategic recommendations to improve PHOMO’s operational performance and service quality.

Research Object

The object of this study is PHOMO, a photobooth business that offers an innovative service by producing photostrip keychain products. Unlike conventional photobooths that only produce photostrips on photo paper, PHOMO provides added value through an extended process in which the photostrips are printed on shrinking paper and then processed using a heating oven for approximately 3–5 minutes until they shrink and harden into keychains. This heating stage represents PHOMO’s main differentiating feature compared to typical photobooth processes.

As a comparison, this study also involves STUDIOVERSE as an indirect competitor. The selection of this competitor aims to conduct benchmarking of operational performance, particularly in terms of service speed, capacity, and service quality. This comparison is expected to provide insights into PHOMO’s current operational position as well as its potential areas for operational system improvement.

Data Collection Method

The data collection method in this study was conducted through direct observation of the service operational processes. The observation was carried out using two approaches:

- Time study: to measure the time required for each stage of the service process, starting from customer arrival until the service is completed.
- Process observation: to understand the overall service process flow and to identify potential constraints within the operational system.

Data were collected from approximately ±30 service transactions to obtain a representative overview of the observed operational conditions.

Sampling Method

The sampling method used in this study is time-based sampling, which is a data collection technique conducted based on specific time periods during operational hours. This approach was selected due to the dynamic nature of photobooth services, where customer arrival rates and service loads may vary depending on the time period.

Data collection was conducted by observing approximately ±30 service transactions at different operational times, both during relatively low-demand and high-demand periods. This was intended to obtain a more representative picture of the overall service system performance, including variations in waiting time, service duration, and queue density.

By using this method, the data obtained are expected to reflect actual operational conditions and reduce potential bias that might occur if sampling were conducted at only one specific time. Furthermore, this approach also enables more accurate analysis of queue patterns and service capacity under different operational conditions.

Research Variables

The variables in this study were designed to comprehensively analyze the operational performance of PHOMO's service, covering the aspects of queue management, capacity, and service quality. These three aspects are interrelated in determining the efficiency and effectiveness of the operational system.

1. **Queue**

   The variables in this aspect are used to understand the dynamics of queues that occur during the service process. The observed indicators include:

   - Arrival rate : the rate at which customers arrive within a certain period.
   - Service rate : the system's ability to serve customers within a given period.
   - Waiting time : the time required for customers from arrival until they receive the service.
   - Utilization : the efficiency of capacity or resources (machines, labor, and facilities) in use.

   The analysis of these variables aims to identify whether the queueing system operates efficiently or is experiencing overload conditions.

2. **Capacity (Service Capacity)**

   Capacity variables are used to evaluate the system's ability to handle customer demand. The indicators include:
   - Maximum capacity : the maximum number of services the system can handle under optimal conditions.
   - Actual output : the number of services actually completed within a certain period.
   - Process time : the time required for each stage of the service process.
   - Bottleneck : the constraint point in the process flow that may slow down the overall service.

These variables are important to determine whether the service capacity is already optimal or if there are still limitations that hinder operational performance.

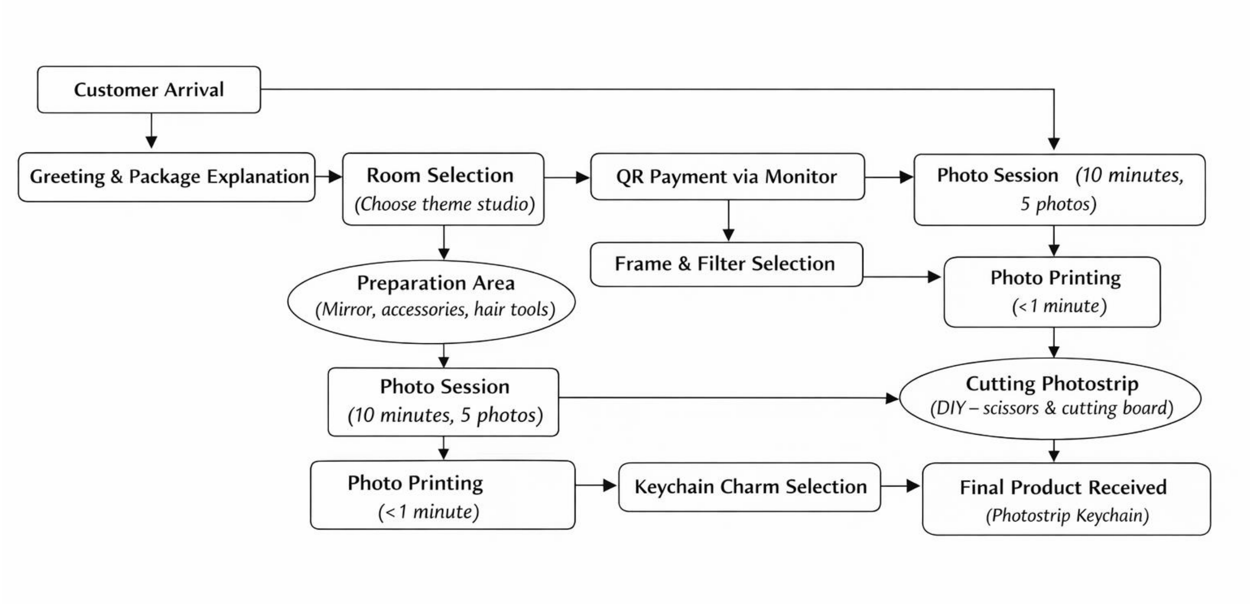
3. **Quality (Service Quality)**
Service quality variables are used to assess the extent to which the provided service meets established standards and customer expectations. The observed indicators include:
   - Defect rate : the rate of errors in service outcomes, such as products that do not meet quality standards.
   - Service reliability : the consistency of the service in producing outputs that meet established standards.

The analysis of these variables aims to ensure that improvements in operational efficiency are balanced with the maintenance of high service quality.

RESULTS

Process Flow Analysis

Flow diagram



Time Study Results

1. Observed Process Time

Process Step	Average Time
Greeting & package selection	1 min
Room selection	1 min
Preparation (mirror & accessories)	2–3 min
Photo session	10 min
Frame/filter selection	1 min

Printing	0.5 min
Cutting photostrip	5 min
Keychain assembly & charm selection	5 min

2. Total Flow Time
   Approximate total customer time in system:
   Total Flow Time = 25.5 minutes

   Breakdown:

Category	**Time**
Core service	10 min
Preparation	4–5 min
Processing (printing)	0.5 min
Customer assembly	10 min

The photo session represents the longest fixed process time, while assembly is variable depending on customer behavior.

Queue Analysis

From observation:
$\lambda = 5$ customers per hour

1. **Service Rate (μ)**
   Main service constraint = photo session (10 minutes).
   $\mu = 1/\text{service time}$
   $\mu = 1/(10 \text{ minutes})$
   Convert to hourly rate:
   $\mu = 6$ customers per hour

2. **Utilization (ρ)**
   $\rho = \lambda/\mu$
   $\rho = 5/6$
   $\rho = 0.83$
   Utilization = 83%
   This means the system operates close to capacity but is still stable.
3. **Waiting Time (Wq)**
   Formula:
   $Wq = \lambda / \mu(\mu - \lambda)$
   Substitute values:
   $Wq = 5 / 6(6 - 5) = 0.83$ hours

Convert to minutes:
$0.83 \times 60 = 50$ minutes

However, observed waiting time during observation was approximately 0 minutes, because demand was lower than capacity and no queue formed.

Indicator	**Value**
Arrival rate (λ)	5 customers/hour
Service rate (μ)	6 customers/hour
Utilization (ρ)	0.83
Theoretical waiting time	~50 min
Observed waiting time	~0 min

The difference occurs because queue models assume random arrivals, while the actual observation occurred during low demand conditions.

Capacity Analysis

Variable	**Value**
Studios	5
Assembly seats	4
Cutting tools	2
Staff	1
Arrival rate (λ)	3.5 sessions/hour
Service time	10 minutes
Service rate (μ)	6 sessions/hour
Observed sessions	30
Printing defect	0
Assembly defect	customer dependent

1. **System Capacity**

   The main service constraint is the photo session, which takes approximately 10 minutes per session. Therefore, the service rate for one studio can be calculated as:
   μ= 60/10 = 6 sessions/hour

   Since the studio has 5 photo rooms operating in parallel, the maximum theoretical capacity is:
   System Capacity = 5 × 6 = 30 sessions/hour

This means the system can theoretically handle up to 30 sessions per hour if all studios operate continuously.

2. **Actual Throughput**

From observation, the average number of customer groups arriving is approximately:

3–4 sessions/hour

Using the midpoint:
Actual Throughput = 3.5 sessions/hour

3. **Capacity Utilization**

Capacity utilization measures how much of the system capacity is actually used.
Utilization = System Capacity / Actual Throughput
Utilization = 3.5 / 30
Utilization = 0.12 (12%)

This indicates that the photobooth operates far below its maximum capacity during non-peak hours.

4. **Bottleneck Identification**

Even though studio capacity is high, potential bottlenecks occur in later stages of the process:

Process	Reason
Photo session	fixed 10 minute duration
Cutting station	only 2 scissors and cutting boards
Assembly seating	limited to 4 seats

Because the assembly process is self-service and variable, customers may spend different amounts of time completing their keychain, which can create delays if multiple groups reach the workstation simultaneously.

Service Quality Analysis

1. **Defect Rate**

Service defects refer to operational failures such as printing errors or system malfunction. Based on observation of approximately 30 sessions, no operational defects were recorded during the printing process.

Defect Rate = Number of Defects / Total Observations
Defect Rate = 300
Defect Rate = 0

This indicates perfect operational reliability during the observation period.

2. **Service Consistency**

   The core service processes such as photo session and printing show high consistency because their duration is standardized:

   Photo session: 10 minutes
   Printing: < 1 minute

   However, variability appears in the assembly stage, which depends on customer behavior and skill when cutting and assembling the keychain.

3. **Reliability**

   Overall service reliability is considered high, because:
   - No machine failures were observed
   - Printing results were consistent
   - The system operates through automated equipment

   The only variability in the system comes from customer-driven processes, particularly during the DIY assembly stage.

DISCUSSION

Queue Performance Discussion

Based on the observation results, the customer arrival rate averages around five customers per hour, while the system's service capacity ranges from approximately 6 to 34 sessions per hour. This indicates that the service system is still capable of handling the existing demand without causing significant queue accumulation. The identified waiting time within the system is relatively short, at approximately one minute during the studio preparation stage, which can be categorized as an acceptable waiting time within the context of experience-based services.

However, there is potential for increased waiting time if the number of customers rises during certain periods, considering that the system utilization rate has already reached approximately 83%. In queueing theory, a high utilization level indicates that the system is operating efficiently but carries a risk of increased waiting time if there is variability in customer arrivals or an increase in service time (Mwangi & Ombuni, 2015). Therefore, although there are currently no significant queueing issues, the service system still faces potential waiting time risks if demand increases without a corresponding increase in service capacity. This finding is also consistent with research showing that small improvements in service efficiency can significantly reduce waiting time without requiring additional facilities (Feng, 2023).

Capacity Performance Discussion

From the capacity analysis, it is found that the system's service capacity is slightly above the actual demand level. With a service capacity of approximately six customers per hour and an arrival rate of five customers per hour, the system still has buffer capacity that allows services to operate without overload. These findings indicate that the current service capacity is sufficient to meet existing demand.

However, system capacity is not determined solely by the number of facilities, such as the number of studios, but also by the efficiency of the service process flow and the time required by customers at each stage of the service. Time variations during the customer preparation stage before the photo session, as well as during the product assembly process by customers, are factors that may influence the system's actual capacity. This finding is consistent with process analysis theory which states that capacity is strongly influenced by flow efficiency and process coordination rather than only the number of resources (Russell & Taylor, 2019).

This suggests that increasing service capacity does not always require adding more facilities but can also be achieved by improving service process efficiency, for example through service flow standardization or by reducing process time variability. Previous research also supports this finding by showing that improving process efficiency can be more effective than increasing the number of service providers due to cost considerations (Kharel et al., 2020).

Bottleneck Analysis

Based on the observation results, the process stages that have the potential to become bottlenecks in the service system are the photo session stage and the keychain assembly process. The photo session stage has a fixed duration of approximately 10 minutes, and customers often require additional time to prepare poses and photo concepts, which increases the actual duration of the service process. This finding aligns with bottleneck analysis concepts which state that stages with the longest processing time tend to limit overall system throughput (Serazzi, 2008).

In addition to the photo session, the keychain assembly process also has the potential to become a bottleneck because the completion time is highly dependent on the customers' ability and speed. Since this process is self-service, there is no fixed time standard, resulting in high process time variability. The limited number of seats at the assembly workstation, with only four available stations, may also become a constraint in the process flow if the number of customers increases. Similar findings were also identified in service queue studies showing that customer activity variability can create operational bottlenecks even when equipment capacity is adequate (Feng, 2023).

These findings indicate that bottlenecks in service systems do not always originate from technological or equipment limitations but may also result from variability in customer behavior and service process designs that involve customer participation.

Service Quality Discussion

From the operational service quality perspective, the observation results indicate that the quality of service outcomes is relatively stable, particularly in the photo printing process, which did not show any production defects. This suggests that the technology system used demonstrates good reliability in maintaining product consistency. Service reliability is an important dimension of perceived service quality, especially in experience-based services where consistency of outcomes influences customer satisfaction (Parasuraman, Zeithaml, & Berry, 1988).

Potential errors were more frequently found during the keychain assembly stage; however, these errors originated from customer activities during the self-assembly process and therefore cannot be categorized as operational system failures. This indicates that while a self-service design can improve labor efficiency, it may also increase output variability due to its dependence on customer skills.

Overall, the operational service quality can be considered stable, as the core service processes operate according to established standards and no defects originating from the main operational system were identified. This demonstrates that the service system has good process reliability in producing outputs that meet the defined quality standards.

Comparison With Theory

The findings of this study are consistent with the concept of process analysis in *Operations and Supply Chain Management* (Russell & Taylor, 2019), which states that operational system performance is influenced by the relationship between process capacity, flow time, and utilization levels. The utilization level of 83% indicates that the system is operating at a good efficiency level; however, it must be carefully managed to avoid approaching maximum capacity, which could lead to increased waiting times.

Furthermore, the results are also consistent with the concept of waiting line models, which explain that higher utilization levels increase the risk of queue formation if not balanced with proper capacity management. The finding that the number of facilities does not directly determine system capacity is also aligned with process design theory, which states that actual system capacity is more strongly influenced by process flow and activity coordination than by the number of resources alone.

From a service operations perspective, customer involvement in the service process is also consistent with the characteristics of high customer contact service systems, in which customers become part of the service production process. This demonstrates that the instant photobooth service design represents a service system that combines technology and customer participation, both of which influence overall operational performance.

CONCLUSION

The operational system at Studioverse Gading Serpong is currently in a highly stable condition with a utilization rate of 83%. With an infrastructure consisting of seven studio units and seven parallel printers, the system is technically capable of handling an average arrival rate of five to eight sessions per hour with an operational defect rate of 0%. This indicates that the technological integration between the self-service software and printing machines has been well standardized, ensuring that the core service process runs consistently with an average duration of approximately 11.5 minutes per customer.

However, process analysis reveals a shift in the bottleneck from technical aspects to behavioral constraints. Although the studio capacity is relatively high, the overall system efficiency is significantly influenced by time variability in the acrylic assembly stage, which is performed independently by customers. The irregular duration at this stage, combined with the physical limitation of assembly workstations that only provide four seats compared to the seven available studios, creates a potential risk of queue buildup (backlog), particularly when the assembly process takes longer than the photo session itself.

The key insight from these findings suggests that machine reliability is not the primary challenge; rather, human process variability represents the main constraint. Future optimization strategies may therefore not require the addition of more machines but should instead focus on simplifying assembly instructions to reduce customer sojourn time at the workstation area. By balancing the assembly seating capacity with the number of available studios, Studioverse could maximize throughput and mitigate the risk of customer handling errors, which currently represent the only potential source of defects within the system.

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