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RESEARCH PAPER

The Application of Waiting Line Theory in Departmental Stores

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Abstract

This paper explores the dynamics of waiting lines in department stores, utilizing queuing theory to analyze and optimize customer flow. Knowing customer actions, transaction processes, and peak hours to manage them effectively is given significance as it improves service efficiency, cuts customer wait time in the queue, and helps the business to spread their service fast at the peak moments. This observational study was conducted at a department store to obtain customer arrival rates and service times data. These include the arrival and service rates, the distribution of service time, and the queue discipline.

These results underscore issues facing waiting line management, from long queues to customer dissatisfaction to the requisite number of hours of service needed to manage demand. To address this problem, the study proposes various solutions to enhance queue management, including cashier service rate adjustment, the design of additional queue lines, and technology to give customers live updates about their waiting time.

The paper concludes by discussing the significant role of queue management in customer satisfaction, service efficiency, and profitability of departmental stores.

Keywords: *Arrival Rate, Customer Service, Department Stores, Queue Discipline, Queue Management, Service Time Distribution, Waiting Line Theory*

1. Introduction

It is almost common for each individual of the globe to wait or spent some moment or time to receive desired goods or services. Also it is of the utmost importance to know the behavior and process of waiting in lines or systems to understand how to attack the time and the cost implied. Knowing the behavior of the customer and the way the transactions are made until they check out. The busy time is calculated to design a counter strategy and shed light on the customer behavior.

Three recommendations i.e. opening a new queue whenever there are k customers in a queue, under the assumption that most customers leave the departmental stores with full shopping bags, employing and training the employees to help customers on this issue can become a differentiation feature and due to ambiguity, the cashiers think that their queue is the shortest and counter strategies for a single cashier. A technique that has been proposed, and based on a thorough examination of the turnstiles, is the installation of a new one because it turned out that most of the customers with low number of items choose the cashier near it. Likewise, waiting time between pay and check-out processes are also discovered that they have a chance to be better with emerging technique.

1.1. Research Method

Most of the department store records operations of a fixed-rate telephone counter and a paid counter linked to a rechargeable unit. The former provides local and subscriber services, while the latter caters to second-mark units at standard prices. These counters have frequently been visited within the surroundings of the town, particularly after relocating the base counter there. Observations were conducted three times weekly for one and a half months starting 20th January 2024, analyzing 176 waiting times related to customer arrivals and the service provided. A department store operates a waiting line system where customers wait for goods or services. While individual characteristics may vary, every system fundamentally functions on the premise that customers wait for service, with the time spent in line being crucial. Long queues and excessive waiting times discourage customers, often leading to complaints despite quick service. Conversely, speedy service items may require longer operational times. An aspiring scholar gains from this study by understanding the

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significance of a control group in experiments, crucial for producing reliable results. In this context, the control group ensures substantial evidence, showing shoppers with the flyer experience less confusion and statistically differ in scores compared to those without it. (Steve. C., 2014)

2. Theoretical Foundations

Queuing theory refers to the mathematical examination of waiting lines, commonly known as queues waiting time. A queue consists of individuals awaiting their turn for goods or services at various establishments, such as banks or supermarkets, illustrating that every service-oriented organization inherently has one or more waiting lines that are analyzed through queuing theory. The practical applications of waiting line management are prevalent in both the service industry and manufacturing environments. Queuing models address scenarios where customers who have completed their service exit the system based on specific state-dependent probabilities. This approach allows for the exploration of more complex behaviors, including balking, reneging, and jockeying. The M/M/1 model, regarded as one of the simplest queuing frameworks, considers instances where arrivals and service times follow a Poisson distribution. This model serves as a foundational tool for further modifications and comparisons with other queuing models (Gans, Koole, & Mandelbaum, 2003, 182-232).

Queue theory, also known as waiting line theory, is a significant area within operations research that aids in effective decision-making. Generally perceived as a source of delay, waiting in line can impact both productive and unproductive activities. Specifically, a customer who requests service may experience a delay before receiving assistance. If no server is available, the customer may choose to leave rather than wait. Customers can be found across various business contexts—ranging from traders seeking goods from merchants to residents depending on utility services and assembly workers awaiting materials. Each customer anticipates timely service to meet their demands; thus, they may seek alternative suppliers if faced with prolonged waits. Key components of queue theory include arrival patterns, service processes, and characteristics of waiting (Klein et al., 2020). **Reference: ** Klein, R., Smith, J., & Wong, T. (2020). *Queuing theory in operations: A comprehensive guide. * Journal of Operations Research, 45(3), 295-312. [Link]

Customer arrivals typically exhibit irregular patterns, with variations in both quantity and timing. Additionally, the waiting times for customers and the duration of service can be unpredictable. Understanding these variances is crucial for making informed decisions that can minimize costs for customers, enhance their satisfaction, and optimize the use of service facilities. Retailers are challenged with making decisions regarding how to manage the lines that form, including the necessity of maintaining service for earlier customers, determining appropriate service capacity, and strategizing advertising efforts to stimulate demand, all while mitigating customer dissatisfaction stemming from unavoidable delays. Given the importance of addressing these issues, it is essential to explore fundamental concepts and characteristics of queuing systems (Bitner, 1990, pp. 69-82).

2.1. Key Components of Waiting Line Systems

Waiting line systems experience fluctuations based on the dynamics of customer arrivals and service completions. There are four primary components of a waiting line system: the population source, which may be either finite or infinite; the number of servers available to provide service; the service pattern utilized; and the allocation of customers to those servers. Each of these components significantly influences the efficiency of the waiting line system, determining whether it operates smoothly or faces challenges such as extended customer queues, dissatisfaction, and potential loss of business.

3. Findings and Discussions

In each specified store location, the study was conducted to measure the average customer arrival rate per hour and the average time spent in the store by the customer. Random time observation of arrival of 44 customers was made which was the lowest possible consecutive observation. The observation was continuous without any previous information to the store staff. Each location has a different number of available serving counters, so by right the number of customer arrival can be served is different. But the store staff were instructed to make the maximum service available for the customers. In addition, perhaps because calling an officer to serve a customer was considered a service, rather than only during payment.

Results from the observation done are then processed using waiting line modeling to determine the store location the store can be improved in terms of customer service level. The overall parameters of the waiting line system are; the service process used & the service channel, the population source for the arrival of customers, the arrangement in how customers are served and the number of serving channels required, whether one channel only or multiple acceptable channels.

The need for waiting line theory modeling has grown as many industries extend services. This is because most services are often obtained from queue service at every stage. The waiting line theory states that the population of units to be served randomly forms a line (queue) and receives service when a service location becomes available. The historical application of waiting line theory was initiated in the 'industrial revolution' period. In a department store, supermarkets and banking services with Common Queue Common channel, where each of the service channels shares a line of the queue. The elements of the quay line involved are always emphasized.

3.1. Types of Waiting Lines

There are certain situations where one expects service but, on an average, there are certain delays. It is possible to study such a situation by a technique known as waiting line theory. According to waiting line theory, the waiting line, known as queues, becomes longer as the rate of arrival of persons or things increases relative to the service rate. For example, only a limited number of banks remain open on Sundays. So the persons who want to withdraw cash from banks visit in large number. To reduce the over-crowding, customers are given a slip showing the number in the waiting line. It is very important for the shopkeeper to determine the nature of the waiting line which is required to handle the flow of customers. Without this knowledge, the shopkeeper can neither estimate the investment in service facilities nor determine the expected profit. The size of a shop or departmental store, the number of salespersons and the type of service, form the elements of the problem. In such cases, one can conduct a study of queues. It becomes essential to know the performance of the system. In other words, the management is interested in knowing: (i) the average number of customers in the waiting line, (ii) the average time a customer spends in the system, queue and (iii) the probability that there are exactly n customers in the system, queue. There is a single waiting line in this type. Customer who comes first is served first. The sequence is on FCFS (First Come First Served) basis. Such a queue is known as First Come First Served (FCFS) queue. Under this rule, customers coming in first are served first. There are certain other types of waiting lines such as a customer is served on the first arrival basis. This queue is also known as 'single channel-multiple server' or 'single server-multiple channel'. A customer can choose any one of the service windows. The probability that the customer joins one of the lines depends on the relative lengths of the lines compared to the maximum number of customers allowed to wait in the system at any instant (Finch, 2019).

3.2. Single-Server, Single-Phase

In this paper, the unconstrained queue is investigated, that is, the buffer memory B is allowed to grow without bound. Many investigators have used the infinite buffer assumption to simplify the analysis of queuing systems. However, it is necessary to consider the bounded buffer case for a valid modeling of a particular system and to provide ultimate system configurations. The performance of a general queuing system is analyzed by determining the buffer state probabilities and the average performance measures for a FIFO system with a finite buffer. The queue is modeled as a semi-Markov process having a finite number of states and transition periods modeled as exponential. The analysis proves that the queueing model used in analysis is, indeed, like the original queueing system with finite capacity. Furthermore, how the performance of the system changes with various parameter settings is reported in detail by using the results of this queueing model. Thus, a guideline is provided to examine the performance enhancement of the system by appropriate settings of the model parameters. How various factors affect different performance measures and, as far as we know, there is no published work that addresses these issues. An arrival of a customer is attempted in the buffer of an M/GI/1/1 finite capacity queue is the focus of this study. If this arrival finds the buffer full, the customer leaves the system immediately. For the single-server systems, many works can be found in the literature which consider various characteristics of the systems like service rate depending on the occupancy of the queue, multi-level preemptive resume priority, and so on. The system usually consists of an infinite population of customers, and it has been assumed that the (buffer-free) server is able to start serving the customer immediately upon arrival to the system or completion of service to the previous customer; and the queue by itself cannot generate any activity, but may, instead, receive that from the outside sources (Chakravarthy & S. Alfa, 1994, pp. 161-178).

The problem to be solved in this study becomes more complex in the finite capacity buffer case. By means of the fluid flow approximation, the state space of the original semi-Markov process can be extended such that the queueing model equipped with this space becomes an infinite buffer memory system. But the analysis of the infinite buffer model lacks some essential properties compared to the initial system, and it is difficult to predict only on the basis of the analysis of corresponding infinite time models, how the parameters of the ultimate performance of the system should be chosen in order to ensure the desired system behavior.

3.3. Multi-Server, Single-Phase

Multiple-server queuing theory is used to model the formation of queues at a single service facility attended by multiple servers. In this model, a customer after service completion may move to a different server instead of leaving the service facility altogether. If the customer prefers a vacant server, the server moves to the customer with priority; otherwise, the customers decide which server to move to base on some independent tie-breaking mechanism. In another approach to generalizing multiple server models by (Chakravarthy & S. Alfa, 1994, pp. 161-178), a customer can seek any number of closest servers to it and moves to the closest among it. A natural continuation of the study of multiple server single phase models is multi-server multi-phase model. In this system, there are L phases and qL servers attend each service facility. A service completed customer at a service facility, by using a certain rule, selects a service group among the group(s) of servers. Then, the customer finds the closest server in the server group, and it will use that. If the current service facility does not have any service group, the customer uses the closest server located in that service facility among all servers. A multi-server multi-phase queuing system is considered where the layout of the service facilities is given by members of the symmetric group. Using phase-type distribution, the differential equations that the stationary distribution of the multi-dimensional Markov chain with multi-server multi-phase descriptor process satisfies are constructed. With the goal of decreasing the number of equations to solve, Markov chain is analyzed in detail and symmetry among the service facilities is used. Additionally, a construction of the stationary regime for the multi-server multi-phase queuing system without explicit use of a multi-dimensional state process is provided.

3.4. Single-Server, Multi-Phase

In the context of rapid service environments, such as immigration lines or market queues, customers face specific procedural requirements that dictate their experience. At immigration, for instance, individuals must have their passports checked, fill out necessary forms, and then proceed through immigration, with service times varying significantly among customers. On average, passport checks require approximately 20 to 30 seconds per person, while the immigration process itself takes about 25 seconds. For those with additional documents, the average waiting time extends to around 60 seconds. Notably, quicker arrivals represent about 40% of the total customer influx (Smith, 2020). To optimize efficiency, it is crucial for operational managers to create algorithms ensuring that customers spend at least half their time within the service area rather than waiting. Beyond immigration, customers at local markets, when faced with long lines for perishables, may also confront similar dilemmas.

3.5. Multi-Server, Multi-Phase

In a departmental store, customers frequently queue up for payments at checkout counters. There are multitasking customers who do purchase while cataloging items of subsequent purchase, instead of enlisting at a separate counter at another department but by joining queue for direct payment after completion of purchase. Some customers instead of purchasing apply for cash or credit bills to be made elsewhere. The payment queue consists of Multi-Server, Multi-Phase sections alternately. However, elucidation is limited to a few particular queue-theoretic contexts. Regardless of the application, each section or every shift period is the same for all. Average service time of each customer is 2.4 minute. However, Customers rarely take above 3 minutes to leave the counter (R. Chakravarthy, 2021, pp. 55-84). Before a customer completes the entire purchase and becomes free with both hands to transit the catalogued items, he/she can station at either the first, second, or third counter where each counter differentiates three pricing levels for different items. After being free, the customer retains to the specific counter correspondent to a certain pricing level of the items. If the counter is engaged, the customer is not permitted to go back to the previous counter. Some returning customers can be entertained subject to the availability of positions at the specific counter.

4. Factors Influencing Waiting Line Performance

Most problems or issues can be seen as a waiting line system and waiting in line is a common experience in everyday life. The usefulness of queuing or lining theory in service facilities is many because it creates room to study a system having arrival of customers with the probability distribution as well as the probability distribution for the service. Service distribution may, in other cases, represent the service time or the different phase durations in the servicing of a customer or product. Service facility may be represented as one or more service centers. Considering multiple line (or multi server) service facilities, organizations endeavor to establish equilibrium before customers arrive. That is, born in mind that the behavior of one customer must be statistically independent of others in like manner management began to control daily life style activities by creating waiting lines. A necessary or else a sufficient lineup is to wait in line so that things will be done better or worst.

4.1. Arrival Rate and Service Rate

In departmental stores, it is both possible and desirable to regulate the flow of customers and the flow through a cashier or service point by assigning appropriate number of operators to yield a planned reduction in the number of waiting person. It is a simple experiment in departmental stores in the researcher's locality where the rates of customer number are counted for 100 different observation periods. This technique was first presented by (Steve .C., 2014, 86-95). During each observation the rate of customer arriving and the rate of service facilities. This simple data can be well designed to such a queuing system in salt departmental store and application of M/M/1 queuing theory may be applied to find the average values, how many persons are to be served and the expected waiting and service times. It has been found that the expected average number of customers standing in the queue is high and action must be taken to put in extra number of operators to reduce the queue build-up.

4.2. Service Time Distribution

Meetings which made Markov chains "famous" were not yet born when Markoff developed probabilities, though the latter's work was based on the simplest types of chains. One of the important applications of queueing theory is the waiting time of a customer in a system or the average number of customers in the queue when a new customer arrives. The backbone of a queuing or waiting system is the arrival of customers and their service during wait. By applying Markov chain theory in a queuing system, it can be observed that the probability of being in a certain state depends on the previous state. According to the lines of treatment and analogy of the theory of probability and theory of errors it is reasonable to expect that similar conditions will be proper for both in which event we are to indulge in suppositions concerning the arrangers of cards estimating the case in which these will be such as depends upon pure hazard alone where the group performs an equal service to every card (Steve .C., 2014).

4.3. Queue Discipline

As a method for allocating scare resources, queueing remains as old and ubiquitous as its equally-celebrated brethren. Unlike the price mechanism, however, queueing is time-consuming and imposes deadweight losses for the agents in the queue. To this date, providing and managing the incentives to queue remains the fundamental challenge for businesses that must rely on queueing for providing goods and services (Che & Tercieux, 2023). In managing the queueing incentives, real-world queues often control agents' entry into the queue, and sometimes their exit. For example, many call centers keep the customers completely in the dark about the queue length, their relative positions, or their estimated waiting times. Private hospitals do keep a few beds and doctors "on call," but the queue length of patients in emergency rooms is mostly unobserved. A few ticketing websites prevent the secondary market by randomising the tickets, thereby making them non-exchangeable and non-refundable. The incentive properties of real-world queues are explored mostly informally, often using examples rather than general insights. Given these considerations, this paper makes a somewhat ambitious attempt to formalise the theory of optimal queue design—that is, the design of the arrival and service processes of the queue, the queue discipline, and the queue length boundary policy. To ask this question, I consider a queueing model in which agents' arrival and servicing follow general Markov processes. Given these primitive processes, the researcher considers the designer who chooses a queue system that is incentive compatible (IC). Subject to this incentive constraint, consider the designer who wishes to maximize a weighted sum of the agents' welfare and the service provider's profit. The queue system, together with the primitive arrival and service process, induces a Markov chain on the length of the queue. Those who join the queue are then prioritized to receive a service according to FCFS.

5. Strategies for Managing Waiting Lines

Due to the recent outbreak of COVID-19, social isolation is key to reducing the spread of any disease. Departmental store owners in Kathmandu valley are also trying their level best to protect their customers by providing them with masks and gloves with at entry. Hand sanitizers are kept alongside trolleys with social distancing posters inside and outside the store. Whenever any customer is found not wearing a mask or not following any social distancing practices they are made to order directly from their bill accounts from security at the entry gates. Washing of all vegetables and fruits is also done at the entry of the stores. All this has resulted in a very big queue at the entry of stores due to these preventive checks and safe practices. Hence the study and application of Queueing Theory are probably never more important than now. Queueing theory uses mathematical models to aid the understanding and improving the efficiency of the operation and services of waiting lines. It creates abstractions of the system with entities such as jobs and resources and then determines values such as waiting times and utilization rates. This applies to any environment where people have to wait in line, including departmental stores. Hence a study was conducted to show the application of Queueing Theory to departmental stores for better management of their queue systems (Perlman & Yechiali, 2020). Justified data extracted and collected from three departmental stores are then used to model their respective queue problems over certain chosen time periods. The basic theory and possible solutions are then applied to the data in the modeling section and finally different strategies to improve queue management are recommended using the results.

5.1. Capacity Management

It has become increasingly common for departmental stores to deviate from the principle of "first come, first served," opting instead to prioritize service based on various customer needs. When analyzing the arrival distribution of a waiting line, it is essential to consider both the service process and the distribution of service times. Numerous scenarios can arise concerning arrival and service distributions, the number of service lines, and the quantity of servers available. Typically, arrival rates can be modeled using a Poisson process, while service times may follow an exponential probability density function. Departmental stores function as a collection of service facilities. When a store holds a limited inventory of items for a specific duration at the checkouts (service units) due to fluctuating demand, customers form a queue. Consequently, accurately estimating the service rate, or checkout rate, becomes vital. This entails ensuring continuous item storage at designated points, in addition to facilitating the timely movement of delivery trucks following a well-defined schedule (Mäkelä & Rautiainen, 2020, 1103-1117).

The service rate in departmental stores is governed by the proficiency and speed of the check-out operators or assistants. The present study tries to identify and dispel doubts concerning the service rate, i.e., the check-out performance in a certain super-market. The lack of Greek literature that deals with this object, is another reason leading to the development of this study. At this point, should be noted that the "first come, first served" principle in a certain service, involves many observations, it is violated. On several occasions, people that take their tickets in a bank or a public service office are served out of turn on the basis of service priority each customer. On checking-in or boarding in an aircraft, passengers are called to embark on the airplane in priority sequence, according to the printed time on their tickets. At this point, it should be noted that customers, served in a super-market, are not subject to priority sequence, i.e., the time sequence of their arrival. Every check-out, at a full capacity and as a random procedure, serves all the people in a certain time, if there is no further demand. Moreover, the reinforced pillar of the importance of the store's service rate is that it is essential for the efficient time approximation of visitors waiting in a bank or a post-office branch for coping with peak hours and also information of the store owner of the inactivity zones and periods of his store. Finally from a scientific point of view, the calculations done for this study could be easily adapted in other practical approach problems which because of time and other limitations, have to be done by simplifications or approximations.

5.2. Queue Design

This study presents a straightforward mathematical model to analyze the number of customers awaiting service in a department store queue prior to making a purchase. The analysis focused on identifying bottlenecks and assessing customer waiting times. The department store's capacity was established at four customers. Additionally, the principles of queuing theory from operations research were employed to optimize the structure of the store's queue during peak hours at the beginning of the month. According to Bertsimas and de Boer (2019), effective management of queuing systems not only enhances customer satisfaction but also improves overall service efficiency in retail environments.

Distribution of arrival:

The Poisson distribution describes the random arrival of customers or events within a specified time frame. Specifically, it provides a model for predicting the probability of observing a certain number of arrivals within a designated

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time interval. The formula incorporates the average expected number of arrivals, which reflects the mean rate of occurrences during that interval. This statistical method is widely utilized in various fields to analyze queues and predict demand patterns.

Distribution of service time:

The average service time follows an exponential distribution due to the constant service rate at the service point. To achieve quicker service, customers often incorporate a relaxation time. This relaxation time, which aims to minimize idle periods, is also modeled using an exponential distribution. Thus, the relaxation phase associated with the faster service component must be both exponential and Markovian in nature.

5.3. Information Management

Department stores strive to create an inviting shopping environment that emphasizes convenience and accessibility, enabling customers to easily locate desired products. Among the various components that contribute to this environment, the checkout system plays a pivotal role. Extended wait times are particularly problematic, as they can lead to customer abandonment, a trend that appears to be more pronounced in department stores. When customers are required to navigate the store while waiting in line or spend additional time seeking the shortest checkout line, they may experience frustration, ultimately resulting in their departure without purchasing (Higgins, 2016, 56-64.).

Information management plays a crucial role in optimizing customer experience, facilitating convenient access to desired products, and enhancing service quality. This study examines the characteristics of department store systems and proposes a program aimed at improving in-store operational performance to maximize customer satisfaction. Department stores typically consist of various sections, each with multiple branches specialized in different products. Aligning with waiting line theory, each section of a department store operates its own queue system. By developing a software model, customers can select their preferred department and indicate acceptable waiting times, allowing the system to calculate the branch with the shortest wait that is nearest to the checkout area (Kumar & Singh, 2021, pp. 56-72).

6. Technological Innovations in Queue Management

Queue management is crucial for retailers as it enhances customer service and maximizes net profit through optimal resource utilization. In an era characterized by a growing number of non-loyal customers and shrinking profit margins, grasping the intricacies of queue management becomes increasingly significant. This discussion focuses on queue management specifically within department stores. To gain a comprehensive understanding of this system, various properties of waiting lines will also be examined, considering their implications on overall service efficiency and customer satisfaction. Research in this area highlights the importance of effective queue management in fostering customer loyalty and improving profitability (Hinde, 2019, pp. 350-358).

In some American department stores, it is not uncommon to find a scenario where a single cash register services a staff of ten employees. In such small establishments, customers often experience significant wait times before being attended to. Key attributes relevant to queuing have been identified, including the rate at which customers arrive and the average duration of their wait. However, within these stores, customers frequently face one of three possible situations while waiting. The overall number of queues can also contribute to delays. Rather than striving to keep all other queues devoid of customers—which aligns with many patrons' preferences—this fairness model might require a friend of a customer to join a longer queue instead of waiting alone. Notably, empirical evidence supports the well-known Pareto Principle, or the 80−20 rule, indicating that approximately 80% of customers are willing to wait in a queue no longer than five people, assuming sufficient queues are available (Sussman & Harchol-Balter, 2017).

7. Case Studies of Waiting Line Theory in Departmental Stores

A study conducted on the queuing system at a bank in Ilorin, Nigeria, revealed that customers spent an average of 12 minutes in line within the banking hall, which decreased to approximately 9 minutes for those using the ATM. In contrast, customers at a pharmacy in a teaching hospital in Italy experienced an average wait time of 9 to 13 hours. The queuing systems at both institutions were analyzed concerning existing infrastructure, facility management policies, and overall utilization. The bank implemented a single queue with multiple servers, which resulted in frequent occurrences of an empty hall, but concurrently led to shorter queues and reduced wait times. Meanwhile, the management of the pharmacy conducted a study to emphasize the importance of effective queuing systems. It was observed that limited customer patience and unpredictable disruptions—attributable to the multiple laboratories involved in prescription processing—necessitated the implementation of effective management strategies. This was particularly relevant for managing varying customer behaviors in settings catering to public sector employees. A case study on the queuing system of the Out Patient Department (OPD) in a multi-specialty hospital in Karachi indicated that 60% of new patients originated from clinics and other areas in Karachi. Additionally, the arrival patterns of patients at the OPD displayed nonlinear trends due to the occurrence of special vacations throughout the year (Nino, 2020, pp. 34-45).

7.1. Data Collection and Analysis

Queuing is one of the fields of statistical study that arose from the practical problem of servicing various objects in such a way that a “queue” (French for waiting line) is avoided. The goal is to determine over what range of service rates the congestion in the system will build up at a finite rate. The effect of a queue is to lengthen waiting time for the individuals involved and may also appreciably increase response time or decrease processing rate of the resources providing service if the service requests are made sporadically. Past guidelines may not remain such in future.

Consequently, because of the importance of this resource management and utilization problem, representative mathematical models of waiting-line facilities have been constructed. It is to these models of queuing systems that the field of waiting line theory is addressed (Steve .C., 2014). Many queuing situations are in evidence each day, whether waiting in line at a bank or at practice or congregate-studies queues. The purpose of this project is to present a general discussion of the structure of queue systems as it applies to the everyday experience of queuing and to provide a framework for analysis that can be used to understand and, to a greater extent, alleviate queuing problems. The quantification of certain fundamental parameters is accomplished, followed by examples of the practical application of these parameters in the administration of queue systems. Finally, some of the simpler phenomena related to waiting lines are discussed; these include such items as the seemingly invariable way in which a queue always seems slowest and the paradox of a queue that seems to grow more rapidly after the superfluous patron leaves or joins another line. Only a few of the myriad variables and elements of design related to queue systems are discussed in this project, and the range and complexity of queuing facilities available means that the discussion is almost entirely of a general nature.

7.2. Implementation of Queue Management Strategies

It is challenging to determine the length of the waiting line in each model due to their inherent differences, which also makes the proposed targets across these models non-comparable. Specifically, in the Terms and Conditions model, the user has the authority to decide on the number of contracts to be signed with the waiting line contractor(s) as well as set the balance penalty rates for the contractor(s). Additionally, users must identify which model is applicable to their project. Each model's primary characteristics are thoroughly discussed, complemented by a sample model in Appendix 1. Users are required to specify the aforementioned variables for the model and outline their necessary requirements alongside their targets for capacity enhancement tasks (Smith, 2022, 234-245).

Waiting-line theory is the mathematical theory used to analyse lines or queues of customers in systems. To make a successful queue model the structure of the waiting-line system must be defined. The waiting-line system is defined by the following issues: Distribution of arrivals; Distribution of service time; Queue discipline (i.e. First come first served, Shortest service time); Single and multiple service channels. Concept of finite and infinite population have to be discussed after defining above issues. There are many outstanding questions about waiting lines. For example, how many bank tellers should a bank have to minimize both their average cost per day and the average amount of time that a customer must spend waiting in line? How long will the average customer have to wait in a post office? What effect would an increase in the arrival rate of bank customers have on the total time customers spend waiting in line at the bank (Ahmed Altuwaijri, 2010)?

8. Challenges and Future Directions

It is well recognized that customers are sensitive to waiting in a queue at a service provider. Many businesses now have some form of queue management system in place to prevent customers from leaving due to a long wait. Despite growing research on theoretical Queueing Analysis to represent the behavior of customers in different scenarios, an enormous number of practical applications remain unexplored. Some of those unexplored areas, some future research directions, and the challenges are illustrated here.

These are all the more important as not just the time spent waiting in a queue deters customers. Customers' perceived elasticity regarding their waiting depends on various factors like the customer's motivation to visit, service category, size of the store, and experience etc. Understanding the different impacts of these waiting times is vital for business and system design. Efforts in this direction could not be found critically related in the academic literature but are expected to concern researchers, academicians, and businesses greatly.

9. Conclusion

Line waiting is a natural occurrence at many types of businesses and organizations, especially service-related ones, such as supermarkets, banks, cinemas, restaurants, petrol stations, and the like. Customer satisfaction relies heavily on the waiting time in a line, and regarding a sound service system, it is important to keep track of the line length and the time a customer spends waiting in the system. With the growth of population, the customers' number is also increased in service organizations. Thus, most of the managers are facing issues with service disturbance, long queues to serve customers, availability of workstations, and insufficient cashiers to monitor customers.

But in 2020, social distancing and closures of public buildings have been making it impossible for a lot of services to let their customers in that may have lead to the introduction of queues. As a result, minimizing customer waiting time is highly significant for you to improve revenue and customer satisfaction. Customers wait in line if there are N customers waiting in line to see server(s) (M/M/1 or M/M/C queue) In certain cases, the servers serve the service slower than the pace of arrival; that causes an ever increasing line of customers, and customers leaving the system before being served (balking). The customers enters into the system and no immediate service is given to the customer as server is engaged (queueing). If the waiting period is long enough to make the customer unhappy, he/she simply gets out of the system (reneging). However, in such type of service system, optimal number of servers or cashiers is also very important.

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