Facilitate Decision Making by the Application of Queuing Theory for Replacing As Asset: A Study

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Abstract:
Waiting line or queuing theory has been applied to a variety of business situations. all situations where customers are involved such as restaurants, cafeterias, departmental store, cinema halls, banks, post offices, petrol pumps, airlines counters, patients in clinics etc are likely to have waiting lines. The replacement normally deals with substitution of man, machines, and equipments due to deterioration and descent efficiency. Queuing theory helps the owners, company and the managers in analyzing and aids them in taking their decision by boosting their knowledge and facilitating them by using the concept of queuing in deciding the benefits gain by replacing the machine or equipment related to the replacement. Large numbers of factors and circumstances are liable to replace the equipment before its expected useful life. Equipment replacement involves huge financial savings in terms of monetary benefits. An incorrect decision may cut the profit and the institute may undergo a great loss. The proposed work tries to formulate a relationship between replacement and queuing theory. The proposed work illuminate that queuing theory can be considered as a helpful decision making tool in the field of replacement. The empirical case is shown to evidence the strength of the proposed approach.

Key words: replacement, quantitative assessment, efficiency, queuing theory.

1. Introduction
Service is the necessity of every individual in today’s scenario as it affects the working culture of the system. The formulation of queues or waiting lines is a most widespread experience in our every day life. Queue often generates when the existing demands exceeds the existing capacity or when the demand is more than supply to make available that service. Queues also shaped even when the rate of providing service is higher than the rate of arriving due to random and unsymmetrical pattern of arrival of clients. The paper aims to improve and explain the intuitive and physical understanding of the theoretical concepts of queuing.

Some practical examples where the waiting lines may be shaped are barber shop, ration shop, cinema ticket window, bus stop, bank counters, railway reservations counters, telephone booth, doctors clinic, repair shop, automobiles service shop, cafeteria, restaurants, petrol pumps etc. Further these queue can also be formed in manufacturing industries in many situations where work in process goods waits for subsequent operations or waits for getting stimulated to another place, machine waiting for repair parts to processed or components waiting for assembly in assembly lines, many unused tools are waiting to be reprocessed, workers waiting at the store for the issuance of tools for working. This may increase production cycle duration which adds to the costs of the products and it may also delay the specified delivery period.
Queuing theory is a branch of mathematics and plays a very important role in decision making that studies and models the problem of waiting in lines. This paper will help in formulation of queuing theory model along with example of the models. If providing too much service to the employees and customers involve extreme and excessive costs and not providing enough service facilities to them causes the waiting line to become excessively long. The aim of studying queuing system is to apprise the readers about the concept of the queue in the area of replacement. There is always a layer of confusion that resists the decision makers in deciding and taking their decision regarding replacement that “when an asset that we possess must be replace now or later on”. This article helps the owners, manufacturer and the managers in analyzing and supports them in taking their decision on the area of replacement by exploding the concept of queue in taking replacement decision. The main intension of replacement is to decide the fruitful life of the existing working system. This paper suggested a methodology which helps the reader by boosting their knowledge to take replacing decision by queuing concepts. Below figure illustrates the queuing system.

![Queue system](image)

**Figure 1: Basic structure of single channel queuing model**

### 2. Assumptions

- The mean value of the arrival rate is \( \Omega \) with Poisson distribution.
- The service time distribution is approximated by an exponential distribution and the mean rate of the service is \( \zeta \).
- The rate of service is greater than the rate of arrival.
- The queue discipline is first come first served.
- The place of typing is only one i.e. only one service channel.
- The number of employees being served is infinite.
Table: 1 Term associated with queuing model

<table>
<thead>
<tr>
<th>S. No</th>
<th>Terminology</th>
<th>Definitions</th>
</tr>
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<tbody>
<tr>
<td>1.</td>
<td>Arrival rate</td>
<td>That rate at which customers arrived to be served. The number of customers arriving per unit time</td>
</tr>
<tr>
<td>2.</td>
<td>Service rate</td>
<td>The rate at which one service channel can perform the service. The number of customers served per unit of time.</td>
</tr>
<tr>
<td>3.</td>
<td>Service discipline</td>
<td>The order service is the rule by which customers are selected from the queue for services. The most common discipline is first come first served</td>
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<tr>
<td>4.</td>
<td>Service capacity</td>
<td>Maximum numbers of customers in the system can be either finite or infinite.</td>
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<td>5.</td>
<td>Queue length</td>
<td>The average number of customer in the queue waiting to get service. this excludes the customers being served.</td>
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<tr>
<td>6.</td>
<td>System length</td>
<td>The average number of customer in the system including those waiting as well as those being served.</td>
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<tr>
<td>7.</td>
<td>Waiting time in the queue</td>
<td>The average time that the customers have to wait in the queue before getting services.</td>
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<tr>
<td>8.</td>
<td>Waiting time in the system</td>
<td>The average total time spent by a customer in the system from the moment he arrives till he leaves the system</td>
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<tr>
<td>9.</td>
<td>Utilization parameter</td>
<td>It is the proportion of time a server actually spends with the customers.</td>
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3. **Problem Statement: An Empirical Case**

In this section we are considering the case of office where the staff members of the office are generally found standing idle for their letter to be typed as the office is using single typist machine for facilitating their staff members in their work. It is found that the office receives on the average 20 letters per day for typing the typist works 8 hours a day and it takes on the average 20 minutes to type a letter. The company authority has observed that the staff persons are generally waiting with their letters to be typed and remains idle. The idle cost calculated was found as Rs.5 per hour/staff and affecting the working culture of the office. Now the authority of the office is planning to replace the typist machine with advance features to minimize the waiting time of their employees. In order to improve the typing efficiency the company has the choice to select one of the automatic machines out of two models available. The objective of the authority is to choose the best model which will minimize the total daily cost. The daily costs and the increase in efficiency of the typist are given below.

Table 2: Data Representation of the Proposed Systems

<table>
<thead>
<tr>
<th>Model</th>
<th>Additional Cost/Day</th>
<th>Increase in Typist Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rs.22</td>
<td>50%</td>
</tr>
<tr>
<td>2</td>
<td>Rs.27</td>
<td>65%</td>
</tr>
</tbody>
</table>
The proposed model discussed in this paper can facilitate the authority of the office in taking their decision. The implementation of the proposed model deals with arrival rate and service rate as their input. The model incorporates the following steps:

- **Step: 1** the quantitative data in terms of the arrival rate of the letters should be calculated by the authority during rush hours by survey.
- **Step: 2** the capability of the existing typist should be measured by the decision makers as represented by service rate in the proposed model.
- **Step: 3** the number of letters waiting or in queue should be calculated as per queuing decision theory.
- **Step: 4** the idle waiting letter number should be interrelated in terms of cost per day to take judgment.
- **Step: 5** the judgment should be on the criteria of the induced minimum cost per day.

Table: 3 Calculation by queuing model

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arrival rate</td>
<td>= 20 letters/day</td>
<td>Arrival rate</td>
</tr>
<tr>
<td></td>
<td>Service rate ( \Omega ) = 20</td>
<td>Service rate ( \Omega ) = 20</td>
</tr>
<tr>
<td></td>
<td>( \zeta ) = 24 + 12 = 36</td>
<td>( \zeta ) = 24 + 15.6 = 39.6</td>
</tr>
<tr>
<td></td>
<td>Increment of 12 in service rate because efficiency increases by 50% by the corresponding model</td>
<td>Increment of 15.6 in service rate because efficiency increases by 65% by the corresponding model</td>
</tr>
<tr>
<td></td>
<td>The numbers of letters waiting to be types as per queuing theory ( \frac{\Omega}{\zeta - \Omega} ) = \frac{20}{36 - 20} = \frac{20}{16} = 1.25</td>
<td>The numbers of letters waiting to be types as per queuing theory ( \frac{\Omega}{\zeta - \Omega} ) = \frac{20}{39.6 - 20} = \frac{20}{19.6} = 1.02</td>
</tr>
<tr>
<td>Cost spent by the office due to letter waiting to be typed</td>
<td>((1.25 \times Rs. 5 \times 8 + 22)) Hours /Day = Rs. 72/day</td>
<td>Cost spent by the office due to letter waiting to be typed</td>
</tr>
</tbody>
</table>

The calculated cost helps the authority in finalizing their decision as model 2.

Queuing theory provides large number of alternative mathematical models for describing and solving waiting line problems. The suggested model enable in finding a suitable equilibrium between the cost of service and the amount of waiting. The most important issue in waiting line problems is to decide the best level of service the organization should provide. Delays in service jobs beyond their due time may answer in losing future trade and business opportunities. Below Figure highlights the input data and the corresponding output in terms of costs per day.
4. Conclusions

Queues or waiting line are a part of everyday life. In today’s scenario there exist numerous cases where waiting lines are bound to occur. Queuing theory helps to sort out the problem of waiting line in various departments and offices which bring satisfaction to their customers and department employees. This paper stresses into the formulation of queuing theory along with example and applications. The purpose of the article is to supply the reader enough information to properly formulate a basic queuing system model into the field of replacement. The proposed work derives a relationship between replacement and queuing theory and has suggested the procedure of implementation of queuing model in the field of replacement. The empirical case presented in the paper shows the importance of queuing theory by suggesting feasible solution. The work presented depicts that the financial profit and efficiency of the system can be maximized by implementing queuing theory. Furthermore, the work explicates the reader in understanding the basic ideas of determining the helpful information such as average waiting times from a particular queuing system.

5. References