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Measuring queuing system and time standards: A case study of student affairs in universities

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The objective of the study is to examine the behavior and patterns of arrival of students in a university through observation method. Student affairs department of different universities are investigated in this study. Queuing theory is adopted for waiting in lines/queues. The results show that more than 70% of the students in universities are unhappy and dissatisfied with the service of student affairs. The results conclude that waiting in line or queue causes inconvenience to the students and ultimately it results in economic costs to the universities. Students usually wait for minutes, hours, days or months to receive desired service for which they were waiting.

Key words: Waiting line, student affairs, arrival patterns, universities, Pakistan.

INTRODUCTION

Waiting is often an unavoidable experience in many business settings. At the hospital, petrol pumps, bus stop, or in the canteen, people wait for their turn so waiting in lines seems to be part of everyday life. People usually wait in line when the demand for a service exceeds its supply (Kandemir-Cavas and Cavas, 2007). Sometimes, customers wait for a few minutes, hours, days or months to receive the ordered service. People not only wait in a line in front of a service window or cash register, but waiting sometimes might occur at home as well while waiting for a package to be delivered. In modern world service sector dominates the economies, yet basic features of services mean that queues or waiting lines cannot be avoided. One of the basic features of services is that they cannot be stored or carried in inventory and that demand is not predictable (Zeithaml et al., 1985).

This is also a problem for manufacturing industries, because now-a-days manufacturing industry is also providing services to their customer, e.g.: with offers of after-sales service or toll-free help numbers, to differentiate themselves and to keep their customer retained. The media have reported queue rage and telephone rage with increasing frequency. Marketing department put its all efforts to communicate and create a favorable image of a service organization; the first impression by the consumer of the organization itself which opposed to all its advertising efforts may be a line of waiting, frustrated and possibly angry consumers. Evaluation of customer of many services is critically influenced by waiting time.

Even though the concept of waiting for the services or goods appears to come in many different forms, in general, but customers take waiting as a negative construct. The waiting in line for services can often have a negative effect and also creates a negative perception about the particular firm. Hence the way in which managers address the waiting line issue is critical to the long term success of their firms. People waiting in queue sometimes raise problems also like, while the norm in many retail banks is to serve customers on a first-come-first-served basis, some customers try to cut the line, usually by providing an excuse for their urgency. Therefore, service managers often try to offset the negative effects of waiting by implementing a number of solutions, like, shortening waiting times, informing

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customers about the length of the wait, and providing different kinds of entertainment like television etc during the wait. However, despite the wide variety in methods available to influence customer satisfaction, it is definitely not an easy practice to do. An organization may not be able to have full control over waiting process or queue. In addition reducing objective waiting time might not influence a customer's subjective interpretation of the waiting for the services (Pruyn and Smidts, 1998).

There are a number of studies stresses the importance of perception in queues and waiting situations (Davis and Heineke, 1998; Davis and Maggard, 1990; Jones and Peppiat, 1996). Queuing has become a symbol of inefficiency for organizations. Universities also face the same kind of problems. Despite the managing the length of the line few of the factors that are responsible for long waiting lines or delays in providing service are: lack of passion and commitment to work on the part of the staff (Belson, 1988) overloading of available staff, and insufficient staff etc. These put staff under stress and tension, hence tends to dispose off a customer/student without in-depth probing, which often leads to dissatisfaction (Babes and Sarma, 1991). This paper is based on the understanding that most of these difficulties can be managed by using queuing model to determine the waiting line performance.

The structure of the paper is as follows: Section 2 presents a brief literature review. Section 3 elaborates the methodological framework. Section 4 shows results and discussions. Final section concludes the study.

LITERATURE REVIEW

Literature available on waiting line management indicates that waiting in line or queue causes inconvenience to customers and economic costs to individuals and organizations. Hospitals, airline companies, banks, manufacturing firms etc., try to minimize the cost involved in waiting, and the cost of providing service to their customers. Therefore, speed of service is very important and increasingly becoming a competitive parameter (Katz et al., 1991). Many studies have shown the negative effect of queues on consumers (Katz et al., 1991; Taylor, 1994; Hui and Tse, 1996). It is very common for customers to overestimate the time which they spend for waiting (Hornik, 1984; Katz et al., 1991). As the perceived time of waiting increases, customers get dissatisfaction (Katz et al., 1991).

First, in today's fast moving life time has become more precious and valuable commodity especially in developed countries where the standards of living are very high. So as a result people are less willing to wait for services. Second, this is a growing realization by organizations to make their customer satisfied and also to retain them to get business in today's competitive environment. Finally, advances in technology such as computers, internet etc., have provided firms with the ability to provide faster services. Addressing the problems of queuing involves a trade-off between the costs of customers waiting time and the cost of providing faster service.

Katz et al. (1991) argued that we can control service waits by two techniques: the first one is operations management and second one is perceptions management. The operation management deals with the management of how customers (students), queues and servers can be coordinated and cooperative towards the goal of providing effective service at the least cost. Most of the firms have tried the obvious approach to the problem, which is managing the actual wait time for the services through operations management, like, modifying service delivery systems (Shostack, 1985), conducting maintenance work at offices at night, or differential pricing to shift demand, (Maister, 1985; Taylor, 1994, 1995). However, the frequency of queues attests to the limits of operations management. Davis and Vollman (1990) say that the amount of time customers must spend waiting for services can significantly influence their satisfaction. Furthermore, Taylor, (1994) has demonstrated that customer satisfaction is not only affected by waiting time but also by customer expectations towards services or attribution of the causes for the waiting. As a result, one of the issues in queue management is not only the actual amount of time the customer has to wait for services, but also the perception of the customer's to wait (Davis and Heineke, 1994).

There are two ways to increase customers' satisfaction with regard to waiting time: by decreasing actual waiting time, and through enhancing customer's waiting experience. If the organizations cannot control the actual duration of the waiting, then it might consider how it manipulate the perceived wait time. As Taylor et al. (1994) have observed that the perceived waiting time is usually different from the actual waiting time. It means that understanding the factors that effect the perceptions of waiting, and their subsequent have effect on consumer behavior, provides valuable clues to strategies makers for marketing communications.

Apart from operations management, that is making changes to reduce the actual waiting time, studies conducted previously on waiting and its impacts on customer satisfaction have focused on customer perceptions of the waiting and how this will be affected by the factors like, filled wait time which is providing distractions or activities (Taylor, 1994), services provider control that is can the firm be blamed for the delay (Tom and Lucey,1995; Taylor,1994; Baker and Cameron 1996), the duration to wait or queuing information which is related to the providing feedback on how long the delay is expected (Hui and Tse, 1996), the impacts of lighting, color, music and temperature (Baker and Cameron, 1996) and finally attribution of the cause of waiting for services (Baker and Cameron, 1996; Taylor, 1994).

Queuing theory is basically a mathematical approach which is applied to the analysis of waiting lines within the field of operations management (Nosek and Wilson, 2001). Any system in which arrivals of customers place demand upon a finite capacity resource may be termed as a queuing system (Singh, 2007). Gorney (1981) and Bunday (1996) argue that queuing theory uses queuing or mathematical models as well as performance measures to assess and expectedly improves the flow of customers through a queuing system .A good flow of customers means that the customers queuing is minimized while a poor customers flow means customers suffer considerable queuing delays (Hall, 2006). Queuing theory can be diversely applied and has been used mainly by the service industries (Nosek and Wilson, 2001). A queuing system or waiting lines consists of six major components: the population, the arrival, queues itself queue discipline, service mechanism and departure or exit.

a) The *population source* serves as from where arrivals are generated. Arrivals of customers or students at the university may be drawn from either a finite or an infinite population. A finite population source usually refers to the limited size of the customer pool. Alternatively, an infinite source is unlimited.

b) The queue discipline is the sequence in which customers or students are processed or served. The most common and widely used discipline is first come, first served (FCFS). Other disciplines are last come, first served (LCFS) and service in random order (SIRO). Sometimes customers may also be selected from the queue based on some order of priority (Taha, 2005).

c) The service mechanism describes how the customer is served at source. Nosek and Wilson (2001) conclude that the number of servers and the duration of the service time-both of which may vary time to time and also in a random fashion. The choices of facility structure can be determined by the number of lines and servers. The common service facility structures are: single-channel, single – phase; single-channel, multiphase; multi-channel, single phase and multi-channel, multiphase.

d) The *departure* or *exit* occurs when a customer is served. There are two possible exit scenarios that are: (a) the customer may return to the source population and immediately become a competing candidate for service again; (b) there may be a low probability of re-service.

RESEARCH METHODOLOGY

Before discussing the methodology of research, first it is better to understand the structure and working of student affairs in universities.

The student affair department for different universities is almost similar in nature; the study brings in to the consideration of different universities which are located in the Abbottabad, Khyber Pakhtoonkhawa (KPK) province of Pakistan namely, COMSATS Abbottabad campus, COMWAVE Abbottabad, Hazara University, Mansehra campus and UET Abbottabad campus. Student Affairs is facing a problem of queue management. A survey of the students of different universities showed that more than 70% of the students in universities are unhappy and dissatisfied with their services of student affairs. One of the big problems in the student affairs is the large waiting lines that build up just before exams when students have to collect their sessional or exam coupons. In order to collect them they need to clear their dues, fines, and any other such defaults. At time like this students have less time to stay in line because of the ongoing classes so they simply break lines and try to get to the server first which causes a kind of chaos in the student affairs. Another such phenomenon is seen during the new admission time. Students flock in students affairs to clear their queries, submit forms, documents, clear fee dues, enable installments, education fund, etc. once again the same thing happens. So in order to reduce these waiting lines and managing them the queue system of the student affairs need to be re-designed and improved.
Student affairs major work is to deal with the following three functions in the universities,

i) Information: Information area in student affairs provides the arrivals all kind of information that they require else than that information portion deals with all the queries related to academic and non academic issues of both students and faculty members and their other services are information providing facility to parents, notice board, online course registration, registered course status, attendance monitoring, fee status, marks, result card, overall progress, login history, changing password.

ii) **Student issues:** The student affairs section basically deals with the following matters that are admissions, student counseling for academic as well as non academic issues, provision of certificates, information / query center for students, liaison with the guardians / parents, student refunds.

iii) Admission: It deals with the admission for the new candidates. In this admission desk the students are provided by the student applications for academic as well as non academic issues. It also deals with the provision of certificates, student counseling and student refunds. These set of modules provide all the academic functions including admissions, academic activities, student fees, examination, head of department activities, faculty activities, user management, student transport, HRMS & payroll system, library access, ID-cards.

RESULTS AND DISCUSSION

The study used the observation method for research purpose. Direct investigation method is used to observe students and staff for seven days to find out the arrival pattern, arrival rate, service rate and the queue system in practice. The research findings are discussed as follows.

Customer arrivals / population: Arrivals at student affairs is infinite. As the admission process is in progress and it is unpredictable for the department to predict the arrivals for the admission.

Arrival rate: The customer arrivals for one hour that visit the student affairs are approximately ranges between 40-50. The study classified these arrivals according to the desk system that are to be used which are:

a) Into the student issues desk the total number of

arrivals observed in one hour are ranges from 15-20. The range may vary due to the size of the respective universities.
b) Into the accounts desk the total number of arrivals observed in one hour are ranges from 10-15.
c) Into the information desk the total number of arrivals observed in one hour are ranges from 15-20.

Distribution of arrivals

Since the arrival rate is random in nature so the study used exponential distribution of the arrival rate.
$F(t) = \lambda e^{-\lambda T}$

Since there are three desks or servers so the study calculated the probability of expected customers for the following three desks of student affairs. We present a specific case for one university for ready reference.

Students' desk

Data

λ= 17/hr
$F(t) = 17. e^{-17x1}$
F (t) = 0.0000000703

This means that there is a probability of 0.0% that 17 people would come in the next hour.

Normal time

At student disk number of arrivals = 17 students/h
Normal time = time per unit x performance rating
Normal time = 3.52 x 110%
Normal time = 3.88 min
So it means student disk deals with 1 student in 3.88 min.

Standard time

Standard time = Normal time (1+Allowance time)
Standard time = 3.88 (1+25%)
Standard time = 4.85 min

Accounts desk

Data

λ= 12/hr
$F(t) = 12. e^{-14x1}$
F (t) = 0.000000997
It means at the accounts desk there is 0.0% chance that there will be 12 students in the next hour.

Normal time

At accounts disk number of arrivals = 12 students/hours
Normal time = time per unit x performance rating
Normal time = 5 x 110%
Normal time = 5.5 min
So it means accounts disk deals with 1 student in 5.5 min.

Standard time

Standard time = Normal time (1+Allowance time)
Standard time = 5.5 (1+25%)
Standard time = 6.8 min

Information desk

Data

λ= 20/hr
$F(t) = 20. e^{-20x1}$
F (t) = 0.00000000412
This also means that there is a chance of 0.0% that 20 people would come in the following hour.

Normal time

At information disk number of arrivals = 20 students/h
Normal time = time per unit x performance rating
Normal time = 3 x 110%
Normal time = 3.3 min
So it means information disk deals with 1 student in 3.3 min.

Standard time

Standard time = Normal time (1+Allowance time)
Standard time = 3.3 (1+25%)
Standard time = 4.12 min

Figure 1 shows the overview of the arrival pattern for the student affairs that from the portion at the very bottom of the picture the customers are going to be arriving to that unit. After that they take the necessary information according to their query from the information desk which is straight forward to the entrance and then if they want to take admission or any of the accounts or document issue then they further proceed towards it. While through the exit portion they exit by completing their work.
Services: The services according to the system designed in Figure 1 are categorized into the three desks

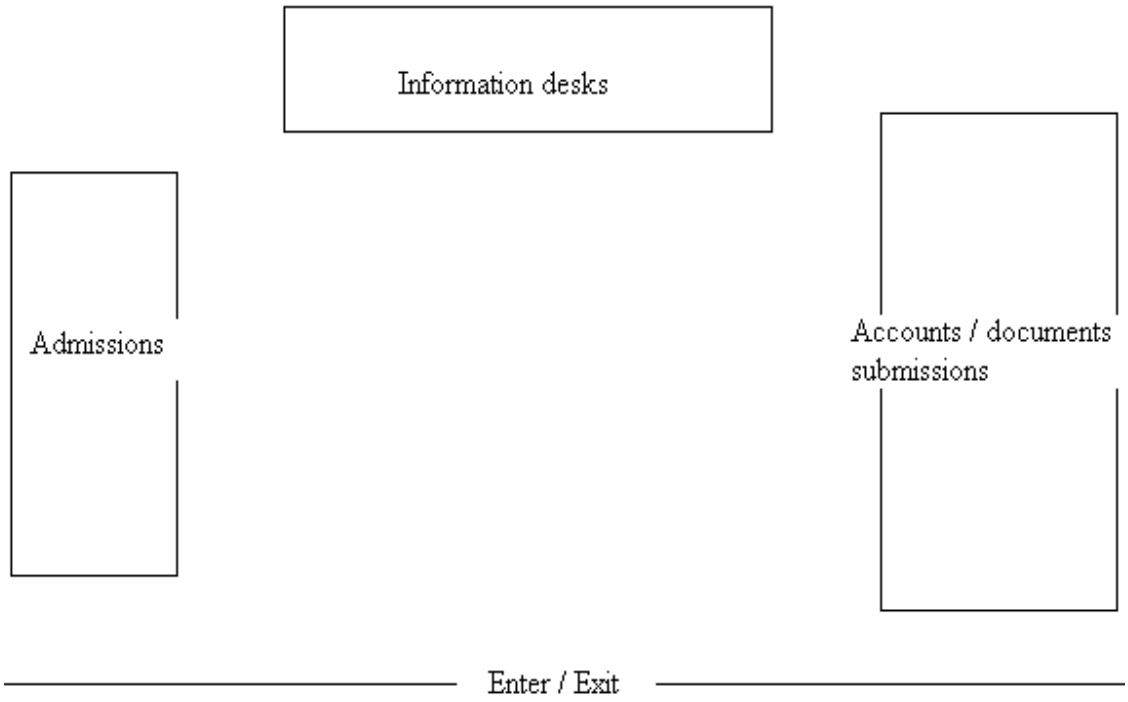

Figure 1. Arrival pattern.

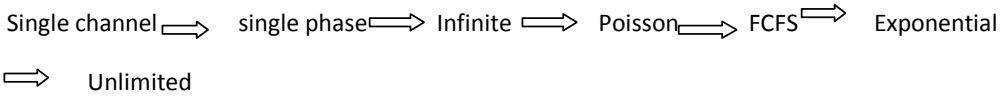

Figure 2. Line structure model for the student affairs.

which are admission, information, and the accounts / documents issuance and submission. These three desks basically act as servers which provide the service on the arrivals of the customers.

Service rate: The service rate is calculated on the overall services that are provided to the arrivals which are 72 per h and as the unit (student affairs) is categorized into the three servers so according to each server the observed service rate is:

- For the student issues desk the total service rate observed per hour are 24;
- For the accounts desk the total service rate observed per hour is 30 and
- For the information desk the total service rate observed per hour is 18.

Waiting line model

Line structure model for the student affairs is shown in Figure 2. The explanation of the model is given as follows. Single channel is to be adapted by the queue system. Single Phase is involved in process. The population on the arrival basis is observed is infinite. The arrivals calculations are on the base of the Poisson distribution. First come first serve is the queue system is being followed. The service rate is calculated on the base of the exponential distribution. As a whole the queue length is unlimited.

Exit system: The procedure is to be adopting by the arrivals after getting the service from the servers to exit from the system are on the two bases i.e., first is the arrival who directly exits from the system when they get the necessary information from the information desk. Other one is those who exit from the information desk and enter to the line for the admissions or accounts / documents issuance and submission. They do not directly exit from the system at once but they enter into another queue after one.

Figure 3 shows that flow chart for the existing system followed by student affairs of different universities. The study extracted all similarities of student affairs in the

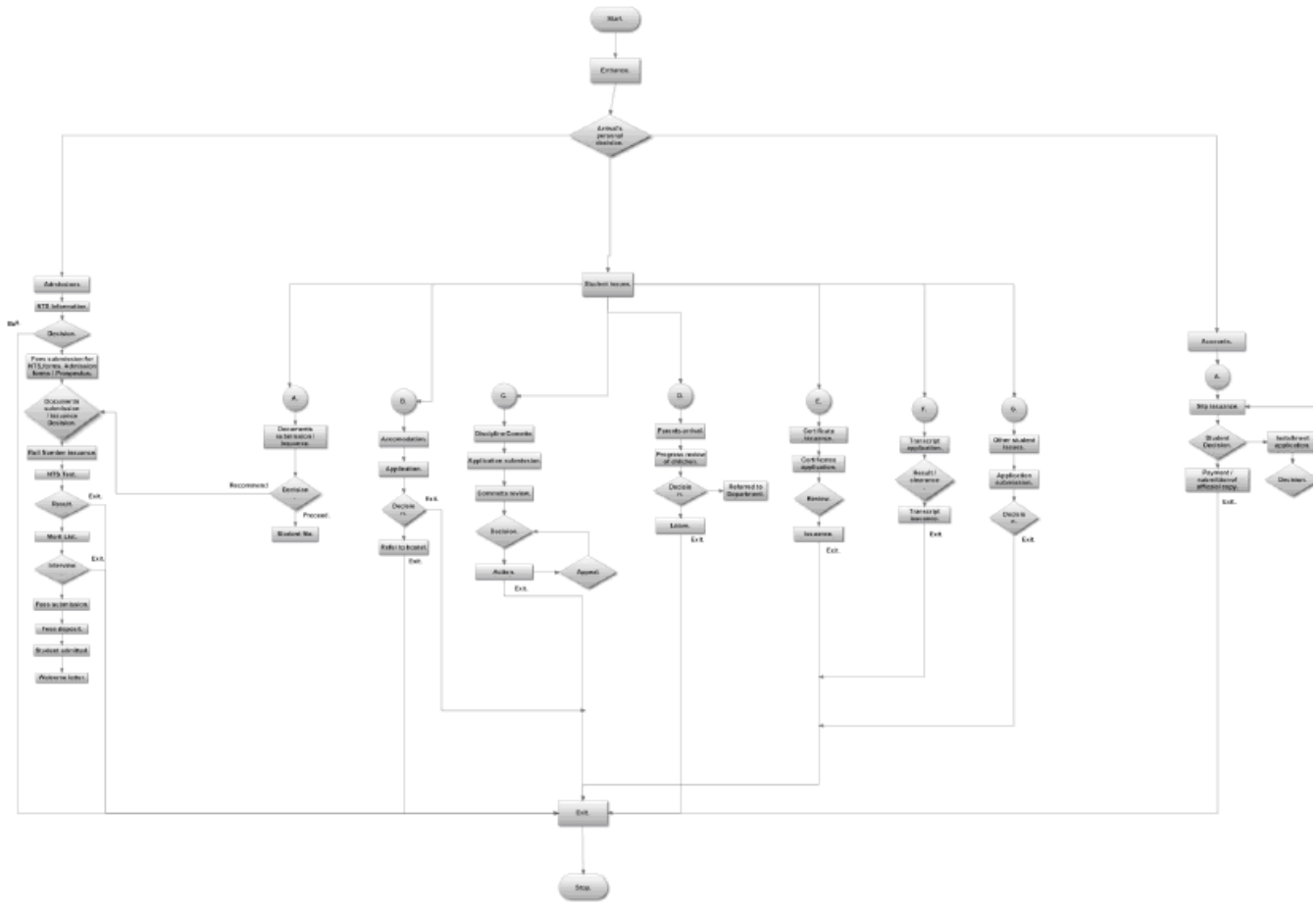

Figure 3. Existing flow chart of student affairs in universities.

different universities and makes a common flow chart.

The existing student affairs department of the universities has the process layout having the same entrance and exit point. Any new person arriving from the entrance points does not knows at which desk to go for the concerned purpose, as when he/she enters they see a number of help desks and they are not aware of the functions being handled on each desk. They themselves choose to go for any one of them to ask for the concerned to go for the solution of his problem work.

There are three help desks currently serving the activities of the student affairs which are:

i. Admissions: This desk is located on the extreme left corner of the hall with two officers responsible for handling different activities which are issuance of national testing services (NTS) registration numbers / conduction of tests, displaying merit lists, conducting interview with the help of concerned departments, displaying final merit lists, and final is to confirm the admission process and pass the data toward the student issues to manage a file for it while with this the student is finally admitted into the university.

ii. Student issues: Student issues desk is in front of the entrance and exit point of the hall. This desk has two officers as well who are responsible for the following functions; enrollment of newly admitted students, preparation of file of the student, arrangement of hostel facility to new students, address the parents with the progress of their children, discipline committee issues, certificates / achievements, and management of the major events for the campus like the convocation etc.

iii. Accounts, documents submission / issuance: Accounts desk is present at the extreme right side of the hall comprising three officers responsible for functions like issuance of Chelan slip / fee slip, management of student fees issues and along with it there is a document submission / issuance desk which is responsible for the issuance at the time of admissions and transcript at the time of the graduation and verification where necessary.

The above three mentioned desks are responsible for the functions allotted to them but are inefficient; for instance at the time of new admissions there is a huge rush of

people moving and going out, first draw back comes up at the entrance and exit point. Secondly when a person enters at that time the student issues desk appears just in front so that desk refers half of them to admissions desk and half towards accounts desk. Those referred to admissions desk are again sent back to the accounts desks which has the function of documents submission and issuance. The huge queue in front of student issues desk creates a hurdle in moment from admissions desk extreme left to accounts desks extreme right while getting through the large queue in the mid. When the arrivals are served from the accounts desk half of people are coming towards that desk this activity creates some mix up situation. As a result of which the extra burden comes upon the officers because there activities according to the desks are mixed up while the arrivals in the form of students and outsiders feel that they are ignored that also creates sometimes a huge problem as they think that they are misguided and may not be treated properly.
The model that can be used in this whole scenario of student affairs is the model1 which actually is;

$Lq = \lambda / \mu (\mu - \lambda)$ $Wq = Lq/ \lambda$

$Ls = \lambda/ \mu - \lambda$ $Ws = Ls/ \lambda$

To apply the model and find the utilization of the three desks we proceed as follows;

For students' issuance desk

Utilization

Utilization can be calculated with the following formula
$P = \lambda / \mu$
As λ = 17 students/hr and μ = 0.40 students/ min or 24 students/ h
Utilization can be calculated as:

$P = 17/24$
$=0.708$

So the utilization of student issues desk is 70%

Average number in waiting line

To find average number in waiting line we can use the following formula

$Lq = \lambda^2 / \mu (\mu - \lambda)$
$= 17^2 /24 (24-17)$
$= 1.72$ students

So approximately 2 students would be there in the waiting line.

Average number in system

Average waiting time can be calculated with the formula

$Ls = \lambda/ \mu - \lambda$
$= 17/24-17$
$=2.4$ students
So there will be 2.4 or 2 students in waiting.

Average waiting time in line

Average time in line is calculated as,

$Wq= Lq/ \lambda$
$=1.72/17$
$= 0.10$ hour or 6 min
So the average waiting time in line for a student is 6 min.

Average waiting time in system

This can be calculated as,

$Ws = Ls/ \lambda$
$= 2.4/17$
$= 0.14$ hour or 8.4 min
So the average waiting time of the system is 8.4 min.

For information desk

Utilization

Utilization can be calculated with the following formula,

$P = \lambda / \mu$
As λ = 20 students/hr and μ = 0.50 students/ min or 30 students/ h

Utilization can be calculated as:
$P = 20/30$
$=0.66$
So the utilization of information desk is 66%.

Average number in waiting line

To find average number in waiting line we can use the following formula,

$Lq = \lambda^2 / \mu (\mu - \lambda)$
$= 20^2 /30 (30-20)$
$= 1.33$ students
So there will be 1.33 or 1 student waiting in line.

Average number in system

Average waiting time can be calculated with the formula,

Ls = λ/ μ- λ
= 20/30-20
= 2 students
The average number of students waiting in the system is 2 students.

Average waiting time in line

Average time in line is calculated as,

Wq= Lq/ λ
=1.33/20
= 0.06 hour or 3.99 min
So a student waiting in line will for approximately 4 min for his/her turn.

Average waiting time in system

This can be calculated as
Ws = Ls/ λ
= 2/20
= 0.1 h or 6 min.
The average time to wait in the whole system is 6 min.

For account desk

Utilization

Utilization can be calculated with the following formula,

P = λ / μ
As λ = 12 students/hr and μ = 0.30 students/ min or 18 students/ h
Utilization can be calculated as:,
P = 12/18
=0.66
So the utilization of information desk is 66%

Average number in waiting line

To find average number in waiting line we can use the following formula,

Lq = λ^2 / μ (μ- λ)
= 12^2 /18 (18-12)
= 1.33 students
There will be 1.33 or 1 student waiting in line.

Average number in system

Average waiting time can be calculated with the formula,

Ls = λ/ μ- λ
= 12/18-12
= 2 students
So in the whole system, there will be 2 students.

Average waiting time in line

Average time in line is calculated as,

Wq= Lq/ λ
=1.33/12
= 0.11 h or 6.65 min.
The average waiting time of a student is 6.65 or 7 min approximately.

Average waiting time in system

This can be calculated as,

Ws = Ls/ λ
= 2/12
= 0.16 h or 9.6 min
The average waiting time in the system for a student is 9.6 or 10 minutes approximately.

CONCLUSION AND RECOMMENDATIONS

Queuing models have found widespread use in the analysis of service facilities, production and many other situations where congestion or competition for scarce re-sources may occur. This paper has introduced the basic concepts of queuing models, and their implication to student affairs because queuing is a problem of student affairs like other service sector. Student affairs face queuing problems especially during admissions opening and before internal exams. So both, students and staff of student affairs, face problems.

There are a few suggestions that maybe useful if implemented:

1. Student affairs can hire two people per desk. This can be useful during the new admissions and examination time. This will increase the service rate and reduce the work load and stress making the communication between staff and students pleasant and easy.
2. The staff should be provided some kind of on the job training as well as re briefing about their job tasks and duties. Apart from that the whole system of the student affairs is needed to be explained since some of the staff members doesn't know about the system on which the student affairs is actually running.
3. There should be a proper arrangement of the desks so that when a person enters he or she may understand right away where exactly to go i.e. the information desk.
4. Systematic processes which ensure minimum time

consumption should be introduced. This will be highly appropriate for the new admissions e.g. the process that involves repetition of the desks should be made in such a way that the students are able to visit one desk only once and move on to the other, and their problems may be solved as they move on.

5. In order to make the staff more dedicated towards their respective tasks and jobs irrelevant tasks that only cause burden should be removed and for such “miscellaneous” activities a separate desk should be created. E.g. asking the information personnel to take care of hostels, couriers, parcels, transportation etc only adds burden and diversion of attention.

If these recommendations are taken under consideration then researcher is quite sure that the service at student affairs will improve to a great degree.

Limitations of the study

Despite its contributions, this study also has its own limitations. Most particularly, the study recognizes that the data was gathered during seven days, so this may limit the generalization of findings. As a result, a further study is recommended to cover some other aspects for a longer period of time. Moreover, only a student affair of the different universities was considered in this study. The related aspects or departments should also be considered, which indirectly affects student affairs efficiency and also creates hurdles in smooth operations of student affairs. Additionally, this study takes into consideration the actual waiting time but ignores the effect of perception of waiting time on students’ satisfaction.

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