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QUEUING THEORY FOR OPTIMIZING HUMAN RESOURCE CAPACITY IN ASIA CELL'S CALL CENTER IN IRAQ SULAYMANIYAH

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Abstract

Queuing delay occurs when a number of entities arrive for services at a workstation where a server has limited capacity so that the entities must wait until the server becomes available. Many organizations such as banks, airlines, telecommunications companies, and police departments, routinely use queuing models to determine the optimum level of server which help managers to allocate resources in order to respond to demands in a timely and cost-efficient way. This paper studies the application of queuing theory on a call center in Sulaymaniyah by using single server and multiple server models to determine the efficiency of the company and also determining the optimum level for their servers. And the results showed that number of servers varies based on different time of the day and night.

Keywords: Queuing theory, waiting lines, human resources management, capacity management, call center

INTRODUCTION

Nowadays human resources is one of the most valuable factors in production and service sectors and is one of the most important assets of any organization (Wernerfelt, 1984). Moreover, it is the main source of competitive advantage for generating an essential capability of the organization. They are important to an organization because they have skills and

experience which is necessary in order to use it for negotiating and training the employees within an organization. Overall it can be said that human resources is dealing with almost all of the functions within an organizations in order to determine the capacity of the organization.

Human resource capacity is a measure to ensure that an organization have sufficient number of qualified people in the right place at the right time to achieve its objectives. (Mazaheri et al., 2010) Human resources capacity is very important to be measured and focus on because a lack of capacity has a direct impact on an organization's ability to deliver services and perform its task that is why it is important to manage and calculate human resource capacity in order to know either organization employees are working efficiently or not.

Human resource capacity can be managed and calculated through different ways and tools like organizing training and development courses. For example if a manager wants to know the efficiency of a telecommunication company's call center they need to use some academic tools and theories like waiting line method which is also called queuing theory, (Tabari, M.,2012) by this the company can calculate the efficiency of their employees and manage it to better. From a business point of view a call center is an entity that combines voice and data communications technology, which allows an organization to implement critical business strategies that reduce cost and increase revenue.

Comparing to the traditional manufacturing operations, the service capacity of a call center mainly depends on the quantity and skills of human resources available, either through a direct employment, subcontracting, or through cooperation with other service firms. This heavy dependence on human resources implies that the Manpower Planning Problem is a key challenge for managers to manage a call center's queue.

In many life situations, there exist queues with different behaviors. These queues are prevalent in several areas. Anyone who ever waited in a stoplight, McDonalds or a register office experienced the dynamics of waiting line. A waiting line or queue is one or more customer waiting for a service. Not only, in the daily life in the administrative branches, or in the banks, but also in telephone networks. The sharing of resources via a server, or the management of telephone calls are all models for the queue. The analysis of queuing model is of concern to managers because it affects process design, capacity planning, process performance and ultimately value chain performance. And this analytical model is used in the call centers to determine how many agents must be available to serve calls over a given period.

Many companies and organizations, in public and private sector, use call centers to communicate with their customer and they have contact and relationships through the call centers. For some of the companies such as cellular operators, their call centers are the main station for building contact with their customers. In general, call centers are becoming a vital

part of the service driven society nowadays. As a result call centers have also become an object for academic research. That's why the purpose and object of this research is about call center's performance measuring and its queue management based on queuing theory principles.

In this paper data from one of the telecommunication centers in Sulaymaniyah have been used and the data is calculated by using queuing theory models which are single server and multiple servers M/M/1 and M/M/C. The importance of this research is that it can be used to measure the efficiency of the servers and can solve the problem that could happen due to the time and cost. It's also important because it help you to understand perceptions about service levels, service quality and the working environment.

LITERATURE REVIEW

The modern call center's continuing importance and complexity has led to an extensive and growing literature. Call centers have become more and more important for many large organizations. Brown et al. (2002) reported that in 2002 more than 70% of all customer business interactions were controlled by call centers. It's reported that more than 3.5 million people are hired in call centers of U.S which is 2.6% of the workforce. Due to the importance of this industry, significant literature has focused on the management of call centers.

The literature mainly defines a call center in commercial terms (Mehrotra & Fama 2003, Omari & Al-Zubaidy 2005, and Gilmore 2001). The terms and descriptions that the definitions have in common are that they are based on telephone systems, they are staffed by dedicated people known as agents, there may be one or more queues and that there is a high inconsistency and uncertainty in the call arrival rate for received centers. The call center literature reviewed based on different research fields involving studies from marketing, human resource management to operations research and queuing. (Mandelbaum 2006)

Queuing theory is the study of queuing systems and originated from the work of AgnerKrarupErlang in 1909 to plan infrastructure requirements for the Danish telephone system (Thomopoulos 2012, pg 2).The literature that gives the best overview for empirical research into queuing systems is the paper by Brown,et. al. (2002). Numerous contributions in the literature prove that the queuing theory can be applied successfully to call centers performance optimization, e.g. Brown and Koole.

According to Bapat and Pruitte Jr. (1998), the premises adopted by the studies based on Queue Theory analytical models are extremely limited when based on call centers current context which have 3 causes, first is that incoming calls are all of the same kind, second from the moment a call enters a queue, it never leaves it, and this usually overestimates the labor

needed, increasing the personnel costs for the company, third the assistants handle the calls following the FIFO (“first in, first out”) discipline 4/ each operator handles all calls the sameway. Gans et. al.(2003) in their study reviewed literature of the call center as busy signals and abandonment, time varying arrival rates, staffing within the base example of identical customers and agents.

In a call center system, a queue occurs when there is no agent available to handle a client, which waits on a virtual line from which he/she will leave only when an operator is set to attend his/her or when he/she disconnects the call. There are many researches done due to this problem. As observed by Brown et al. (2002), in the case of call centers, the virtual queue is invisible among the clients and among the clients and the operators.

There are many more researches also about applications of queuing theory on call centers which have been done by: Jack et. al. (2006), (Betts et. al., 2002), (Gross & Harris, 1974), (Fomundam and Hermann, 2007). Feinberg et. al. (2007) Collings (1974) Kelly (1975) Stroher (2006) Ullah (2011) McGuire (2010) Caputo and Pelagagge (2011) Smith and Tan (2013 Papadopoulos et al. (2013) Buzacott and Shanthikumar (1993) and Narahari (1992).

Human resource is a very important function in each organization. In order to increase the level of efficiency and manage the workforce of an organization human resources must be managed properly Mohammadi et al. (2005). There are many important issues that human resource deals with them in an organization such as relationship with employees, safety of employees, offering motivation and incentives for the employees to work harder and achieve greater goals, and also training and development. That’s why it’s very important to focus on human resource department in each organization.

Service quality became one of the most important weapons to increase a market share (Aydinli and Demir, 2015) . From this point, efficiently managed queues can reduce service time and increase the quality. Thus, improve profitability of a service organization. There are two types of cost, one is related with customer waiting in line and the other is related with adding new counters to reduce service time (Dieter, 2001).

Efficient queue management can be done by having a good human resource in the organization which means that human resource management is very important in applying queuing theory in every sectors of every company in order to reduce cost and waiting time in the line, For this a very properly managed human resource is needed, because the staff strength plays a very important role in human resource management. Staff insufficiency leads to decreased service duties and makes the queue longer.

In the call centers scenario, Araujo, Araujo and Adissi (2004) say that the queues discipline, when well-managed and have a good human resource management it will be a strong ally for the call centers production planning and controlling area.

Much of the research around call centers is on finding the optimum way to staff their employees Erdem & Gedikoglu (2006). Queuing models are employed to forecast system performance of call centers so that the suitable staffing level can be established to obtain a desired performance metric like the Average Speed to Answer, or like the Abandonment rate. Staffing is an important factor to focus on in a call center management strategy. The most usual queuing model utilized for arriving call centers is the Erlang C model (Brown et al. 2005; Gans et al. 2003).

Some articles report staffing requirements when arrival rates are uncertain. Because when incoming calls are uncertain, staffing management will be challenging. (Harrison et al. 2005) developed a model that tries to minimize the cost of staffing plus a supposed cost for customer abandonment for a call center with numerous customer and server kinds when arrival rates are uncertain and variable.

Whitt (2006) permits arrival rate uncertainty and uncertain staffing, like absenteeism, also, when calculating staffing requirements. (Henderson et al. 2004) analyzes and measures the performance to utilize when staffing is under arrival rate uncertainty. (Harrison and Robbins 2010) develop a scheduling algorithm utilizing a stochastic programming model that is based on uncertain arrival rate predictions. And base on that decide on the staffing and agent numbers.

One of the major drivers for call center efficiency is cost. There are different types of costs including staff and telecommunications. These types divided into tangible and intangible costs. The tangible include staff and telecommunications and the intangible include political fallout, reputation and media reporting.

Hughes (1995) notes that since “incoming call centers are often viewed as cost rather than profit centers, accurate staffing is a primary concern” and that staffing to meet service levels with tight cost constraints is a challenge. Consequently, much of the driving force associated with call center management and research is centered around improving efficiencies due to the high cost of labor (Bennington et al. 2000).

Chassioti & Worthington (2004) identify this as being in the order of 70% of a call center’s total running cost and there are significant management challenges in the areas of human resource management which are being recruitment, absenteeism, emotional support and burnout. Duder & Rosenwein (2001) identify that the cost to provide trained operators exceeds half of the operational costs of a call center. In addition, increased delays in servicing customers translate to increased system and telecommunications costs due to customers

abandoning and retrying or not retrying. And this will affect the efficiency level of the call center and also increase cost if not managed well.

Gans et al. (2003) conducted a wide survey of present knowledge, technology, and research prospects concerning call centers. They addressed a lot of matters that had not been sufficiently covered or determined in up-to-date literature. For example, they stated that there has been little investigation on call center networking, including quantitative effects based on queuing theory logics.

There are few studies applied on queuing theory in Kurdistan and especially on the waiting lines in call centers and how to determine the optimum level of servers that's why the limited literature which is reviewed about this topic is mentioned in the above sections and also There is a study in the name of "Optimizing Human Resources Capacity and Performance of Newroz Telecom Company by Proposing Queuing Theory" published by Demir (2015).

METHODOLOGY

Case study defined as a "detailed examination of an event which the analyst believes shows the operation of some recognized general theoretical principles" Mitchell (1983) (p. 192). As Yin said, one should use a case study strategy because he or she purposely wants to study appropriate conditions. In this research call center of Asia Cell Company was taken as a case study and the datathathavebeenusedintheresearchbelongtothecompany'scallcenter.The call center has been selected based on the convenience of sampling. There has been difficulty in confidentiality for providing information to the authors from other call centers. The call center of Asia Cell was the only call center that has provided the required information. Thus, the data used in this study has been collected from that call center. Data on arrival calls and service time were obtained for a period of one month and statistical analysis based on queuing theory was deployed to analyze the obtained data.

Arrival λ and departure μ are the main parameters of queuing theory, those two parameters have been extracted from 24 hour data of the call center. First λ have been calculated through taking the average of each specific hour in the day and μ also have been calculated by taking the call's average duration and the result is 28/ hour for each specific hour. The system used for analysis in this paper is queuing theory and contain single server and multiple servers; by these models the best number of agents at each specific time has been optimized. The parameters that are used in this research are mentioned below:

$Lq = P0 (\lambda \mu) c\rho / c! (1 - \rho) 2$

Lq Stands for average queue length which is number of people waiting in the queue.

Ls = Lq+ rho

Ls Stands for average number of people in the system

Wq= Lq/λ

Wq stands for average waiting time in queue which is a time that a customer waits in a queue to be served.

Ws= Ls/λ

Ws stands for average of time spent in the system which includes waiting time and service time.

These parameters are used in order to measure the length of waiting time in the system and in the queue also the waiting time in the queue until each customer will be served.

ANALYSIS AND DISCUSSION

This part of the research is about how analysis has been done by using queuing theory models and discussing the results that have been obtained from the analysis.

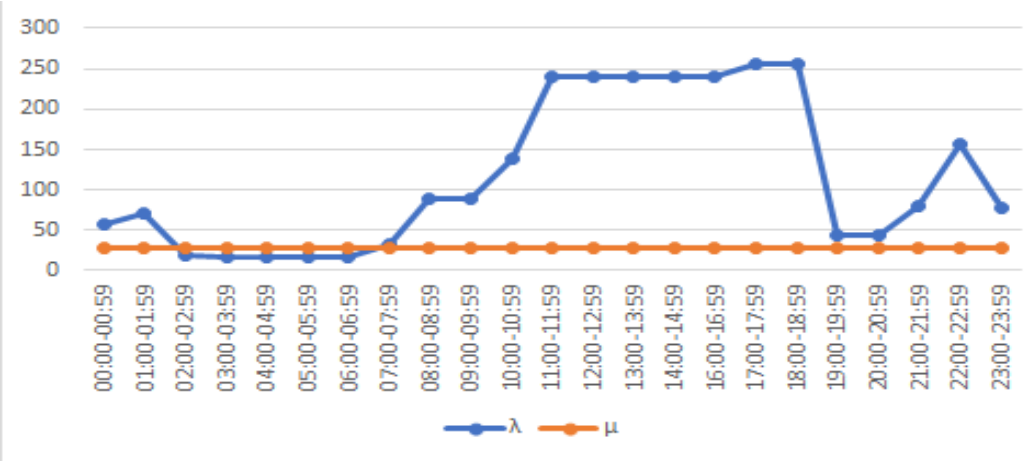
From the obtained data arrival and departure rates have been analyzed hourly as are mentioned in the table below

Table 1 Arrival and service rate of the call center

Morning Shift			Evening Shift		
Hour	**λ**	**μ**	**Hour**	**λ**	**μ**
00:00-00:59	57	28	16:00-16:59	240	28
01:00-01:59	72	28	17:00-17:59	255	28
02:00-02:59	20	28	18:00-18:59	255	28
03:00-03:59	16	28	19:00-19:59	44	28
04:00-04:59	16	28	20:00-20:59	44	28
05:00-05:59	16	28	21:00-21:59	81	28
06:00-06:59	16	28	22:00-22:59	156	28
07:00-07:59	32	28	23:00-23:59	77	28
08:00-08:59	89	28			
09:00-09:59	89	28			
10:00-10:59	138	28			
11:00-11:59	240	28			
12:00-12:59	240	28			
13:00-13:59	240	28			
14:00-14:59	240	28			

Table 1 above shows the results of λ and μ for each hour of the day and based on the result it's obvious that in the late midnight and morning the number of calls decreasing due to the time but its increasing rapidly during the mid of the day. And the result of such table has been drawn in such graph below;

Figure 1 Service arrival chart



It's clear that in the specific time of midnight to morning both of the arrival and service rate are very near to each other. But as the time is passing the arrival rate become more and in the evening shift during 19:00-21:00 the arrival rate decreases and then increase again which means that the number of calls varies based on different times during the day andnight.The analysis of the call center's efficiency level can be determined as follows;

Table 2 Efficiency level of the call center

Morning						
Hour	**Server**	**Efficiency**	**L_q**	**L_s**	**W_q**	**W_s**
00:00-00:59	C_3	0.67	0.97	3	0.017	0.052
	C_4	0.59	0.18	2.22	0.003	0.039
01:00-01:59	C_4	0.64	0.61	3.19	0.008	0.044
	C_5	0.51	0.15	2.17	0.002	0.03
02:00-02:59	C_1	0.80	1.78	2.50	0.089	0.125
03:00-03:59	C_1	0.50	0.76	1.33	0.047	0.083
04:00-04:59	C_1	0.50	0.76	1.33	0.047	0.083
05:00-05:59	C_1	0.50	0.76	1.33	0.047	0.083
06:00-06:59	C_1	0.50	0.76	1.33	0.047	0.083
07:00-07:59	C_2	0.57	0.66	1.69	0.017	0.053

08:00-08:59	C_4	0.79	2.27	5.44	0.025	0.061
	C_5	0.63	0.49	3.67	0.005	0.041
	C_6	0.52	0.13	3.31	0.001	0.037
09:00-09:59	C_4	0.79	2.27	5.44	0.025	0.061
	C_5	0.63	0.49	3.67	0.005	0.041
	C_6	0.52	0.13	3.31	0.001	0.037
10:00-10:59	C_6	0.82	2.58	7.51	0.018	0.054
	C_7	0.70	0.73	5.65	0.005	0.041
	C_8	0.61	0.25	5.18	0.001	0.037
	C_9	0.54	0.09	5.01	0.000	0.036
	C_{10}	0.49	0.03	4.96	0.000	0.035
11:00-11:59	C_{11}	0.77	1.21	9.78	0.005	0.040
	C_{12}	0.71	0.51	9.0	0.002	0.037
	C_{13}	0.65	0.22	8.79	0.000	0.036
	C_{14}	0.61	0.10	8.67	0.000	0.036
	C_{15}	0.57	0.04	8.61	0.000	0.035
	C_{16}	0.53	0.01	8.59	0.000	0.035
	C_{17}	0.50	0.00	8.57	0.000	0.035
	C_{18}	0.47	0.00	8.57	0.000	0.035
12:00-12:59	C_{10}	0.85	3.29	11.8	0.013	0.049
	C_{11}	0.77	1.21	9.78	0.005	0.040
	C_{12}	0.71	0.51	9.0	0.002	0.037
	C_{13}	0.65	0.22	8.79	0.000	0.036
	C_{14}	0.61	0.10	8.67	0.000	0.036
	C_{15}	0.57	0.04	8.61	0.000	0.035
	C_{16}	0.53	0.01	8.59	0.000	0.035
	C_{17}	0.50	0.00	8.57	0.000	0.035
	C_{18}	0.47	0.00	8.57	0.000	0.035
13:00-13:59	C_{10}	0.85	3.29	11.8	0.013	0.049
	C_{11}	0.77	1.21	9.78	0.005	0.040
	C_{12}	0.71	0.51	9.0	0.002	0.037
	C_{13}	0.65	0.22	8.79	0.000	0.036
	C_{14}	0.61	0.10	8.67	0.000	0.036
	C_{15}	0.57	0.04	8.61	0.000	0.035
	C_{16}	0.53	0.01	8.59	0.000	0.035
	C_{17}	0.50	0.00	8.57	0.000	0.035
	C_{18}	0.47	0.00	8.57	0.000	0.035
14:00-14:59	C_{10}	0.85	3.29	11.8	0.013	0.049
	C_{11}	0.77	1.21	9.78	0.005	0.040
	C_{12}	0.71	0.51	9.0	0.002	0.037
	C_{13}	0.65	0.22	8.79	0.000	0.036
	C_{14}	0.61	0.10	8.67	0.000	0.036
	C_{15}	0.57	0.04	8.61	0.000	0.035
	C_{16}	0.53	0.01	8.59	0.000	0.035
	C_{17}	0.50	0.00	8.57	0.000	0.035
	C_{18}	0.47	0.00	8.57	0.000	0.035

15:00-15:59	C_{10}	0.85	3.29	11.8	0.013	0.049
	C_{11}	0.77	1.21	9.78	0.005	0.040
	C_{12}	0.71	0.51	9.0	0.002	0.037
	C_{13}	0.65	0.22	8.79	0.000	0.036
	C_{14}	0.61	0.10	8.67	0.000	0.036
	C_{15}	0.57	0.04	8.61	0.000	0.035
	C_{16}	0.53	0.01	8.59	0.000	0.035
	C_{17}	0.50	0.00	8.57	0.000	0.035
	C_{18}	0.47	0.00	8.57	0.000	0.035

Evening

Hour	Server	Efficiency	L_q	L_s	W_q	W_s
16:00-16:59	C_{10}	0.85	3.29	11.8	0.013	0.049
	C_{11}	0.77	1.21	9.78	0.005	0.04
	C_{12}	0.71	0.51	9.0	0.002	0.03
	C_{13}	0.65	0.22	8.79	0.00	0.03
	C_{14}	0.61	0.10	8.67	0.00	0.03
	C_{15}	0.57	0.04	8.61	0.00	0.03
	C_{16}	0.53	0.01	8.59	0.00	0.03
	C_{17}	0.50	0.00	8.57	0.00	0.03
	C_{18}	0.47	0.00	8.57	0.00	0.03
17:00-17:59	C_{10}	0.85	7.14	16.2	0.02	0.06
	C_{11}	0.82	2.18	11.2	0.00	0.04
	C_{12}	0.75	0.89	9.99	0.00	0.03
	C_{13}	0.70	0.39	9.50	0.00	0.03
	C_{14}	0.65	0.1795	9.28	0.00	0.03
	C_{15}	0.60	0.0814	9.18	0.00	0.03
	C_{16}	0.56	0.036	9.14	0.00	0.03
	C_{17}	0.53	0.0158	9.12	0.00	0.03
	C_{18}	0.50	0.0067	9.11	0.00	0.03
18:00-18:59	C_{10}	0.85	7.14	16.2	0.02	0.06
	C_{11}	0.82	2.18	11.2	0.00	0.04
	C_{12}	0.75	0.89	9.99	0.00	0.03
	C_{13}	0.70	0.39	9.50	0.00	0.03
	C_{14}	0.65	0.1795	9.28	0.00	0.03
	C_{15}	0.60	0.0814	9.18	0.00	0.03
	C_{16}	0.56	0.036	9.14	0.00	0.03
	C_{17}	0.53	0.015	9.12	0.00	0.03
	C_{18}	0.50	0.006	9.11	0.00	0.03
19:00-19:59	C_2	0.78	2.53	4.10	0.05	0.09
	C_3	0.52	0.289	1.86	0.00	0.04
20:00-20:59	C_2	0.78	2.53	4.10	0.05	0.09
	C_3	0.52	0.289	1.86	0.00	0.04

21:00-21:59	C_4	0.72	1.216	4.10	0.01	0.05
	C_5	0.57	0.2889	3.1818	0.0036	0.0393
	C_6	0.48	0.0800	2.97	0.001	0.036
22:00-22:59	C_7	0.79	1.861	7.43	0.01	0.04
	C_8	0.69	0.6079	6.17	0.00	0.03
	C_9	0.61	0.2245	5.79	0.00	0.03
	C_{10}	0.55	0.0849	5.65	0.00	0.03
23:00-23:59	C_4	0.68	0.9008	3.65	0.01	0.04
	C_5	0.55	0.2185	2.96	0.00	0.03

Table 2 shows the efficiency, Lq, Ls, and Wq and Ws levels of the call center. The utilization level should not exceed 85% because in that case waiting time will increase and customer satisfaction will decrease since it will not be desirable for a customer to wait for a long time in a queue to be served. Within this information, capacity can be optimized by using queuing theory. The utilization and efficiency of the call center is measured by the formula below;

Efficiency= λ / server * μ

Based on the results that have been analyzed in the table above, at 00:00-00:59 the optimum level of server is 4 because the lengths of waiting in the queue is lower when there is 4 servers but its higher when there is 3. And between 1:00-1:59 it's better to have 5 servers in order to be at optimum level and serve the customer as fast as possible with least waiting time. When it's about late midnight to early morning from 2:00-6:59 only 1 server is enough due to the time and the arrival rate at that time is less.

In the morning from 7:00-7:59 for reaching optimum level only 2 servers is required. When the time is passing and become 8:00-8:59 to be at the optimum level the company needs to have 6 servers. At 10:00-10:59 the lowest time to wait in the queue is 0.03 but that time the efficiency will decrease, that's why we need to decrease the number of server to 8 or 9 in order to serve the customer efficiently. From 11:00-16:59 if there are 18 server the customer will not have to wait in the queue and will be directly served, but this cause them to decrease their efficiency and also cost them a lot of time, money and resources that's why the optimum level between those hours can be 14 or 15 servers since the arrival rate between these hours are high since it's during the midday.

From 17:00-18:59 number of servers can be 15 or 16 because during that time the arrival rate λ is very high and this needs to be managed in order not to make the customers wait for a long time to be served and also decrease the number of abandonment calls. At 19:00-20:59 it's better to have 3 servers which is the optimum level at 21:00-21:59 the optimum level is to have 4 servers and at 22:00-22:59 8 or 9 servers could be the optimum level since during

that time λ have been increased. At 23:00-23:59 the optimum level is to have 5 servers at least to serve the customer.

CONCLUSION

The purpose for conducting the applied study was to measure the efficiency of the servers in the call center during the 24 hour time. The study has shown that queuing theory is able to analyze such number of customer in system (Ls), lengths of waiting time in queue (Lq), expected time spend in queue (Wq), and expected time spent in system (Ws). By the results obtained from the analysis it showed that it's important to focus on specific time of the day and night while deciding on the number of servers to serve the customer in order to reduce cost, manage time, increase efficiency and also satisfy the customer with an optimum level of service time.

The results shows that during specific times of the day the number of servers must be optimized in order to manage cost and time and for this purpose the managers in the call centers must be aware of how they decide in which time how many servers to use. The optimum level is that when the efficiency of the company must not be less than 45% and not exceeds 85% that's why also if the waiting time is very low for the customer to wait in a queue it must be at an optimum level. For that the role of a human resource manager is very crucial to employ the right staff or server in the right place in order to increase customer satisfaction and reach an optimum level efficiently.

Such analyses that have been done could be very helpful for either human resource manager and also for the sake of the company in order to serve customers efficiently with less time and cost. And also, to increase customer satisfaction, loyalty and decrease the probability that a customer switches to another company.

Research questions have been answered by using queuing theory analysis and also a good human resource management and capable agents with good skills because by employing a very well trained agents and good staffing process this could be achieved and the call center could reach the optimum level also customers will be served in a very short time that does not need to wait in long queues. Well trained staff by an efficient queue management will be able to serve the customer better and quicker than another staff that does not have any information about the process and have not been trained well. That's why human resource management has an enormous role in each organization especially in call centers because well trained staff can respond quicker than others.

As every other researches it can be obvious that this research also have limitation, and the limitation about such study was difficulty in obtaining data, because we couldn't have a complete data to use in this study instead of that only 24-hour data have been obtained and

analyzed to measure the efficiency of the call center and also determine the optimum level. This was because of the complicated data base that the call center has and not everyone is allowed to obtain such data for a long period of time.

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