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Analysis of Queuing System for Restaurant Using Arena Simulation Software

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ABSTRACT

In restaurants waiting for service is a common process for the customers. There are some factors which need to be considered for a restaurant owner to attract the customers successfully. One of the factor is Queuing theory which is a study of waitingin lines or queues. Implementing Queuing theory in operations of therestaurant may be beneficial to those who proactively desire to manage revenue. This paper will include the various facts and analysis of Queuing theory and Queuing models. The review will be done over the previous studies and researches performed by various authors.The results of findings of this review will be added in the further sections of this paper. On the basis of results and findings, a Queuing model will be proposed for further research to improve the performance of queuing systems in restaurants.

Index Terms- Arena Simulation, Arrival time, Customer Management,Queuing system, Service time and waiting time.

I. INTRODUCTION

1.1. Queueing system

A Queuing system includes one or more servers which offer service of some type to arriving customers. The arrived customers generally find all servers busy and join one or more queues or lines in front of the servers. Thisis referred toas aQueuing system. Some common examples of Queuing systems are bank-teller service, manufacturing systems, computer systems, communications systems, maintenance systems, and so on. Queuing system has some basic elements which are as follows [2]:

(i) A number of customers: Customers arrives and joins a queue to access specific services in front of theserver. [6]

(ii) Arrival distribution: when customers arrive, they join the queue if the server is busy and according to the probability distribution. [2]

(iii) Queue size: Queue size is generally a length of a queue or line. It might be finite or infinite. Queue size together with server or servers forms the capacity of the system. [2]

(iv) Service Distribution: The service distribution process also follows aprobability distribution. [6]

(v) Queuing discipline: three types of Queuing disciplines are there: FIFO (First in First Out), LIFO (Last in First Out), and SIRO (Service in Random Oder). [6]

1.2. Customer Management

Customer management includes all the systems, processes, and applications required for managing the customer relationship. Customer loyalty and customer management are the important goals of almost all businesses to be

successful. Customer management includes how to manage the customers by offering them better services. Effective Customer Managementof a company enables it to ensure the services they offer are inline what its customers want. The business which has clean, clear, accurate and correctly formatted data would be able to offer a good level of service while saving time and money.

1.3. Restaurant system

The Restaurant system involves the fast-food operations in which 'fast' refers to the 'quick service.' The customers arriving restaurant do not want to wait for a long time in queues to receive food services. The customers' waiting time to get food services becomes one of the important quality factors in afast-food restaurant. Waiting lines in fast-food restaurants always built in restaurants during peak hours. The queuing system of a restaurant can be simulated to study how to reduce the customer's waiting time. [5]

1.4. ArenaSimulation

Arena Simulation software is a commonly used Simulation based on Discrete Event simulation. Arena simulation is one of the most effective analysis tools used for the designing and operation of complex systems or processes. The arena is an easy-to-use and powerful simulation and modeling software tool which enables the user to build a simulation model and perform experiments on the model. Some basic steps to build a simulation model with Arena are as follows:

1. Construct a simple model: Arena includes a model window flowchart-style environment to construct a model. The user creates a process flow of the model.
2. Add data to model parameters: actual data can be added to the model, for example, processing time, resource demand, etc.
3. Perform simulation run: Run the simulation to examine the results:
4. Analysis of simulation results: Arena provides automatic reports to expand the statistics.
5. Modify and enhance the model as per user's needs.

II. RESEARCH METHODOLOGY

Different stages of research methodology are:

- The first stage involves that how many papers are published in which queuing system is used.
- The second stage involves distribution of papers over the years.
- The third stage is concerned with aclassification scheme.

2.1 Search selection

- IEEE Xplore (http://ieeexplore.ieee.org)
- Science Direct (www.sciencedirect.com)
- Springer (www.springerlink.com)
- http://www.iosrjournals.org
- International Journal of Recent Development in Engineering and Technology (www.ijrdet.com)
- International Journal of Science and Research (www.ijsr.org)

- International Journal of Market Research(www.ijmr.com)
- https://www.researchgate.net

The search engine of the above organisations gives number of studies,articles. Research paperspublished by journals, conference proceedings and workshops are supposed to be well-meaning and trustworthy.

Keyword based search is employed to select the most appropriate works. The keywords used are "Queuing system", "Restaurant", "Arena simulation software".

The rules used for prohibition of a research paper consist of unpublished papers, published papers, text-books, Master and Doctoral theses, non-peer-reviewed papers. Then illustrates the distribution of papers from 1972 to 2017.

In research methodology 3 tables are defined.

Table 1 illustrates the search strategy and number of resultsobtained. From the obtained results, inappropriate studies are excluded on the basis of title. That studies which could not be assessed from the title, and then their abstract is measured. If even abstract is notapparent then after reading the full text of papers, inappropriate studies are excluded. In some library searchwhen huge amount of studies revertedthen apply some advanced search.

Table 2 illustrates the distribution of papers over years from 1972 to 2017.

Table 3 describes the classification scheme. Table 3 defines the tools and techniques used in above studies.

Table 1 search selection

S. no.	E-source	Studies returned	Excluded			Keyword used
			based on thetitle	based on abstract	based on full text	
1	http://ieeexplore.ieee.org	2		2	2	Queuing model, Restaurant, Arena simulation software
2	www.sciencedirect.com	20	2	3	5	Queuing model, Restaurant, Arena simulation software
3	www.springerlink.com	2	1	1		Queuing model, Restaurant, Arena simulation software
4	http://www.iosrjournals.org	1		1		Queuing model, Restaurant, Arena simulation software

5	www.ijsr.org	1		1		Queuing model, Restaurant, Arena simulation software
6	www.ijrdet.com	1			1	Queuing model, Restaurant, Arena simulation software
7	www.ijmr.com	1			1	Queuing model, Restaurant, Arena simulation software
8	https://www.researchgate.net	3			1	Queuing model, Restaurant, Arena simulation software

1.1 Distribution of papers

Table 2. distribution of paper over the years

E-resource	1972	1990	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
IEEE						1													1		
science direct	1	1		1			2				1	3		1			2	2	4	1	1
Springer																1					1
IOSR																		1			
IJSR																			1		
IJRDET																			1		
IJMR																	1				
ResearchGate			1															1	1		

II CLASSIFICATION SCHEME

The selected papers for review are categorized into three facets as tool, metric, and match detection.Table 3, 4, and 5 shows the details of aset of categories applied in each facet.

Table 3: Tool Facet

Tool/Algorithm	Description
Arena simulation	This tool is a discrete event simulation
Analytical model	This approach helps to analyze the model theoretically and mathematically
Stochastic simulation	This tool helps to trace the evolution of variables which could vary stochastically with certain probabilities

MATLAB	This tool helps for computing mathematical equations

Table 4: Metric Facet

Category	Description
Product	Measures the software product's size, complexity, efficiency, reliability, and performance.
Process	Measures the software process properties for defect removal and quality.
Project	Measures the software project's time, effort, and cost.
Object – oriented	Measures the reusability, maintainability, and understandability

Table 5: Match detection facet

Category	Description
Clustering	Build clusters with similar features.
Fingerprinting	Compute the numeric fingerprints
Visualization	Visualize the features using graphs or plots
Classification algorithm	Compareand classify models

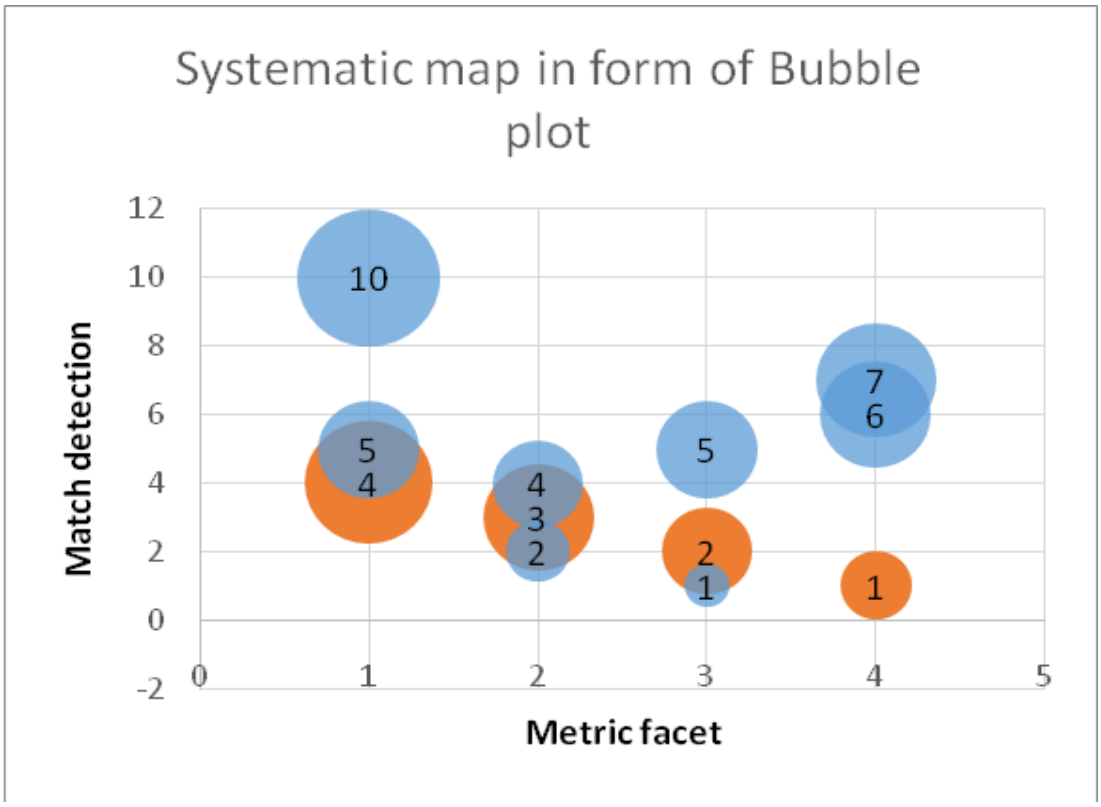

Fig.1

3.1 TOOLS AND TECHNIQUES USED

After reviewing the existed models of Queuing system, this section of the paper will describe the finding of each model.

Table 6: **Tools and techniques used in previous Queuing models**

Author and Year	Method	Input	Output
Hwang, J., Gao, L., & Jang, W. (2010)	Queueing based optimization model using quasi-birth-and-death process and state-dependent functions	Change in demand, system congestion, and	relative performance of the system in terms of improved service quality and reduced cost.
Arifin, M. Z., Probowati, B. D., &Hastuti, S. (2015)	PT XYZ path queuing system (Multi-Channel Model with four servers (M/M/4))	number of arrivals per unit of time, Waiting time, queue length,	minimal cost to the queuing system
Buijsrogge, A., De Boer, P., Rosen, K., &Scheinhardt, W. (2017)	Non-Markovian tandem queues model	Arrival process and service processes	Decay rates for N customers
Babicheva, T. (2015)	GI|G|∞ Queuing system	Service time, average waiting time, and the length of queues	minimized delays
Wang, K., & Tai, K. (2000)	M/M/3 queueing system with finite capacity	Number of customers, number of servers, queue length	Optimum value of number of customers and servers; and maximize net profit
Vass, H., &Szabo, Z. K. (2015)	M/M/n queuing model for Emergency Department	Number of servers, service time, arrival rate, system utilization	Probability of entering patient (patient flow)
Belciug, S., &Gorunescu, F. (2015)	M/PH/c queuing model for bed-occupancy in hospitals using	Number of patients, arrival time, average time spent	Optimize bed occupancy

	Genetic Algorithm in Java		
Jain, M., Maheshwari, S., &Baghel, K. (2008).	Queueing model with multiple discrete material-handling devices(MHD)	Service time, umber of material-handling devices, Number of processing stations, and Number of pallets	throughput, mean service time, mean waiting time
Bhaskar, V., &Lallement, P. (2010)	two-input, three-stage queuing network	the probability of entering a new path, arrival rate, and service rates	average minimum response times, average queue lengths, and average waiting times
Komashie, A., Mousavi, A., Clarkson, P. J., & Young, T. (2015)	queuing model using MATLAB	Waiting time, service time,	Patient satisfaction level and Staff satisfaction level
Ghaleb, M. A., Suryahatmaja, U. S., &Alharkan, I. M. (2015)	Queuing model using Arena simulation	Average service time, average idle time, and average waiting time	average waiting time in system and the average number of students in queues
Brann, D., &Kulick, B. (2002)	Queuing model ARENA Simulation	transaction data and arrival rate	Maximize sales volume
Tyagi, A., Saroa, M.S. & Singh, T.P. (2014)	A stochastic model for thequeuing system. Data collected using Little's formulae	utilization rate, waiting time queue length and the probability of potential customers to balk	Increase the quality of service

III. COMPARATIVE ANALYSIS

The objective of this paper is to review theQueuing models designed and simulated to evaluate the performance in terms of waiting time, service time, system efficient, productivity, etc. Queuing theory involves the study of waitingfor lines or queuing. Some of the methods and techniques used in the previous studies include the analysis of expected waiting time, theaverage time in thesystem, expected thenumber of customers, expected

queue length, and theprobability of new customers. The comparative analysis of the above mentioned Queuing models under review differs with respect to the tools and techniques they used.

The model presented by *Hwang, J., Gao, L., & Jang, W. (2010)* relates the demand changes with respect to the system congestion state on thereal-time dynamic basis. It can be seen in the parameters of all queuing theory under review that the expected number of waiting time reduceswith respect to the number of servers. Wang, K., & Tai, K. (2000) proposed an M/M/n queuing model for Emergency Department by taking a number of customers and number of servers as input parameters**.** The results of this study shown that to obtain a maximize net profit, the optimum value of a number of customers and serversare needed to be considered**.**

IV. FINDINGS

From the literature review and comparative analysis performed in above sections of this paper, it is found that many types of research have done over the Queuing models to improve the performance of customer service systems in various fields such as banking, manufacturing industries, hospitals, restaurants, etc. This study found that in order to improve the performance of restaurant processes, some of the factors are required to consider. These factors include average queue length, waiting time to customers, system utilization,thenumber of servers with respect to theaverage number of customers. For this purpose, queuing model is a suitable approach to understanding how to reduce the waiting time of customers by getting an optimal number of servers at a minimum total cost.

V. DISCUSSION

The effect of queuing related to the time spent by customers to access services is increasingly emerging as a major concern to many fast-food restaurants owners. This is because as the customers too long waiting time could result in ahuge cost to them, which is waiting for thecost. Giving too much service capacity of the system includes an excessive cost. However, not giving enough capacity of the system results in waiting time and waiting for thecost.In this paper, many queuing characteristics are reviewed which are analyzed by different authors using various Queuing models.

VI. CONCLUSION/FUTURE SCOPE

Many types of research have previously applied Queuing theory to simulate a model of restaurant operation to reduce cycle time in busy fast food restaurants and increase efficiency. In this paper, we reviewed different Queuing models developed to increase service management in busy restaurants. We evaluated different models in terms of average service time, average idle time, and theaverage waiting time at thecash counter. All these parameters will be evaluated to propose a new Queuing model for a restaurant.

REFERENCES

[1] Hwang, J., Gao, L., & Jang, W. (2010). Joint demand and capacity management in a restaurant system.*European Journal of Operational Research*, *207*(1), 465-472.

[2] Arifin, M. Z., Probowati, B. D., &Hastuti, S. (2015). Applications of Queuing Theory in the Tobacco Supply. Agriculture and Agricultural Science Procedia, 3, 255-261.

[3] Buijsrogge, A., De Boer, P., Rosen, K., &Scheinhardt, W. (2017).Large deviations for the total queue size in non-Markovian tandem queues. *Queueing Systems*, *85*(3-4), 305-312.

[4] Babicheva, T. (2015). The Use of Queuing Theory at Research and Optimization of Traffic on the Signal-controlled Road Intersections. *Procedia Computer Science*, *55*, 469-478.

[5] Wang, K., & Tai, K. (2000).A queueing system with queue-dependent servers and finite capacity.*Applied Mathematical Modelling*, *24*(11), 807-814.

[6] Vass, H., &Szabo, Z. K. (2015).Application of Queuing Model to Patient Flow in Emergency Department.Case Study.*Procedia Economics and Finance*, *32*, 479-487.

[7] Cohen, J. (1973). Asymptotic relations in queueing theory. *Stochastic Processes and their Applications*, *1*(2), 107-124.

[8] Belciug, S., &Gorunescu, F. (2015).Improving hospital bed occupancy and resource utilization through queuing modeling and evolutionary computation.*Journal of Biomedical Informatics*, *53*, 261-269.

[9] Jain, M., Maheshwari, S., &Baghel, K. (2008).Queueing network modeling of flexible manufacturing system using mean value analysis. *Applied Mathematical Modelling*, *32*(5), 700-711.

[10] Bhaskar, V., &Lallement, P. (2010).Modeling a supply chain using a network of queues.*Applied Mathematical Modelling*, *34*(8), 2074-2088.

[11] Tsiotras, G. (1990). Modeling and analysis of multiple-class tandem queuing systems with finite capacities.*Mathematical and Computer Modelling*, *13*(2), 1-7.

[12] Komashie, A., Mousavi, A., Clarkson, P. J., & Young, T. (2015).An Integrated Model of Patient and Staff Satisfaction Using Queuing Theory.*IEEE Journal of Translational Engineering in Health and Medicine*, *3*, 1-10.

[13] Ghaleb, M. A., Suryahatmaja, U. S., &Alharkan, I. M. (2015).Modeling and Simulation of Queuing Systems using arena software: A case study. *2015 International Conference on Industrial Engineering and Operations Management (IEOM)*.

[14] Brann, D., &Kulick, B. (2002).Simulation of restaurant operations using the Restaurant Modeling Studio. *Proceedings of the Winter Simulation Conference*, 1448-1453.

[15] Tyagi, A., Saroa, M.S. & Singh, T.P. (2014).Application of a Stochastic queue model in a restaurant - a case study. *Aryabhatta Journal of Mathematics & Informatics*,Vol. 6 (1).

[16] Ahsan, M. M., Islam, M. R., &Alam, M. A. (2014).Study of Queuing System of a Busy Restaurant and a Proposed Facilitate Queuing System. IOSR Journal of Mechanical and Civil Engineering, 11(6), 31-35.

[17] Bisoniya, T. S., Patidar, L., &Abhishek, A. (2014).Queuing Theory: A Case Study to Improve the Quality Services of a Restaurant.

[18] Oladejo, M. O., Agashua, N. U., & Tamber, J. A. (2015) Optimizing the Queueing System of a Fast Food Restaurant: A Case Study of Ostrich Bakery. ISSN 2347 - 6435, 4(8).

[19] Chou, C., & Liu, H. (1999).Simulation Study on the Queuing System in a Fast-Food Restaurant. *Journal of Restaurant & Foodservice Marketing*, *3*(2), 23-36.

[20] Abubakar, U. M., Kabara, S.R., Mustapha, U.T., & Musa, M.G. (2015).Application of Queuing Model in a Restaurant (A Case Study of Kalinga Restaurant).*International Journal of Science and Research, 5(11).*

[21] Debjit Roy, ArindamBandyopadhyay, Pritam Banerjee(2016).A nested semi-open *queuing* network model for analyzing dine-in *restaurant* performance.*Computers & Operations Research.*

[22] AlindaKokkinou, David A. Cranage (2013).Using self-service technology to reduce customer waiting times.*International Journal of Hospitality Management.*

[23] VijayaChebolu-Subramanian, Gary M. Gaukler (2015).Product contamination in a multi-stage food supply chain.*European Journal of Operational Research.*