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Using Waiting Queue Models to Study Reducing the Phenomenon of Delay in One of the Health Institutions in Baghdad

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Abstract:
The research presents a proposed model for the role of using waiting queue models in improving the performance of health institutions in Iraq, Baghdad. The proposed model relies on a set of numerical methods, the most important of which is the quantitative programming method (QM for Windows). The model analyzes the stability of the system and simulations are performed to evaluate its performance. The main goal of this paper is to improve the performance of these government medical institutions in Iraq in a scientifically sound manner, so that the proposed model is applied to reduce crowding and waiting in health centers. This study was applied in one of the health centers in Baghdad, Palestine Street (Al-Idrisi neighborhood) during the period extending from 1/3/2019 to 3/1/2019. The study concluded by presenting an alternative model to improve the current situation in the institution under study, as this contributed the alternative is to improve all performance indicators. Other models can be evaluated using artificial intelligence, which enables us to enhance the system and improve prediction accuracy in different health center scenarios.

Keywords: proration research models, queue models, access rate, service rate

استخدام نماذج صفوف الانتظار لدراسة تقليل ظاهرة التاخير في احدى المؤسسات الصحية في بغداد

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الخلاصة:
يقدم البحث نموذجًا مقترحًا الى دور استخدام نماذج صفوف الانتظار في تحسين أداء في المؤسسات الصحية العراق بغداد ويعتمد النموذج المقترح على مجموعة من الطرق العددية ومن اهمها طريقة البرمجية الكمية (QM for Windows). يقوم النموذج بتحليل استقرار النظام ويتم إجراء عمليات المحاكاة لتقييم أدائه. الهدف الرئيسي من هذه الورقة هو تحسين اداء هذه المؤسسات الحكومية الطبية في العراق بالشكل العلمي الرصين بحيث يتم تطبيق الانموذج المقترح لتقليل الزخم والانتظار في المراكز الصحية. حيث تم تطبيق هذه الدراسة في أحد المراكز الصحية في بغداد شارع فلسطين (حي الادريسي) خلال الفترة الممتدة من 2019/1/3 لغاية 2019/3/1 وتوصلت الدراسة إلى تقديم نموذج بديل لتحسين الوضع الحالي الموجود

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في المؤسسة محل الدارسة، حيث ساهم هذا البديل في تحسين جميع مؤشرات الأداء. يمكن تقييم النماذج الأخرى باستخدام الذكاء الاصطناعي الذي يمكننا من تعزيز النظام وتحسين دقة التنبؤ في سيناريوهات المراكز الصحية المختلفة.

1- Introduction

Process research is interested in taking scientific readings to design and develop equipment and manpower systems according to certain conditions that require the optimal allocation of limited resources [1], [2] and [3]. Our daily lives, especially in service institutions, date back to 1909, when the Danish scientist Erring experimented with the problem of congestion in receiving phone calls [3]. At this time, due to the increase in health awareness among the members of the community as well as the increase in chronic diseases and epidemics, this increase in the number of patients has accompanied. Through all of this is necessary for decision makers in Iraqi Public Health Institutions to find ways and to adopt various scientific methods that help improve the performance of institutions, such as applying the models of waiting classes. So based on the above study, which resulted that the health unit works the subject of study.

In al-Idrisi neighborhood, the child vaccination service is fully equipped. The distribution of children's access to the distribution of children is subject to the distribution of service times to the exponential distribution. Mothers of the children spend long hours in the queue before relying on the modeling method that can be adopted in the study of reality the emergence of several new manifestations and problems in the management of public health institutions resulting from the formation of long rows of patients. Based on virtual models in the form of mathematical formulation because it is the appropriate method, QM for Windows has been used and the Public Health Foundation has been selected.

2- Theoretical aspect

Kendall-Lu's symbols are credited with setting the six factors that define the characteristics of any queue system model to both the British sports scientist Kendall in 1953 and 1966, Kendall put the first three symbols in the form of (M/M/S) and was known in [4], [5] and [6].

Scientific references in the name of the symbols of Kendall, and in 1966 the scientist Lu added the two symbols and then the symbol was added to indicate the capacity of the source of the units. On the other hand, to make the shape of the symbols better and express all the first six factors that determine the characteristics of any [7] and [8].

Model, i.e., it became as: (M/M/S)

Where:

M- For potential distribution of arrivals.

S- The number of service providers in parallel (number of service centers).

E- System Capacity (maximum number of service applicants who are allowed to be in the system) [4].

Service system (FIFO, LIFO) [9], [10] and [11].

The first basic symbols may also be replaced by the following:

GI- The probability distribution of arrivals is a general probability distribution.

G- Probability distribution of service time is a general probability distribution.

E Access distribution or service time follows Erlang distribution.

D- Probability distribution of access or service time specified or fixed.

H_k probability distribution of access or service time follows the distribution [12].

Access rate: The rate at which service applicants reach the service place during a certain period of time, and it often assumed that access cases are independent of each other, and they change randomly over time [13], [14] and [15].
Service delivery rate: The average number of applicants who can be served in a period limited time [5] and [16].

3- Field study: This study was conducted at the health unit in Baghdad in al-Idrisi neighborhood with the aim of improving performance measures. We have applied queue models, and a vaccination service center has been selected children because he suffers from the formation of long classes of children. Representation of the waiting phenomenon: The queue system at the chosen children's vaccination center consists of service-requesting units represented in infants arriving in the system from an unlimited source community and then organizing a queue to wait for their turn to receive the service. The priority of the service here according to the child who comes first provided with the service (FIFO) (by the service center and then the child comes out after receiving the vaccination service from the system. It should be noted that the queues in the service center is that the speed of children's access to the system is higher than the speed of service performance.
Statistical functioning of the waiting structure of the service center: in order to know the mathematical model. The probability distribution of service times and the rate of arrival of children must be determined and then we will measure a performance indicator. Determining the total viewing period: in order to determine the average of children arriving at the center. The duration of the study has been determined by 7502, the next table shows how to determine the period [17], [18] and [19].

Table 1: Determining the total and partial viewing periods during the study period

Sunday to Thursday	week days
Sunday to Wednesday	Days of the week approved by us
From eight in the morning to The Second in the evening	Official business hours
From eight in the morning to eleven in the morning	Our credit hours for the viewer
three hours	Watch duration in hours
180 minutes	Watch duration in minutes
10 minutes	One-time viewing period
Period / day18	The total number of watch periods per day
Period /week72	The total number of watch periods per week
Period 276 / 8 weeks	The total number of times watched in eight weeks

The statistical index of the phenomenon of the arrival of children is: the phenomenon of the arrival of children is considered of great importance in the theory of queues where their arrival is irregular and because it's an uneven time frame. To identify the probability distribution to which the arrival we selected a sample of 110 periods that randomly be taken from the number. The total drew a rat watch, and the following table shows this:

Table 2: Distribution of children's access during viewing period

Number Children Arrivals	1	10	9	8	7	6	5	4	3	2	1	0	Total
Duplicate (Viewed	1	2	3	7	5	15	16	13	14	13	10	1	100
Total	11	20	27	56	56	72	80	52	42	26	10	0	452

Through the table the arithmetic average for children's access can be calculated
α = 452/100, that is, 0,452 children/minute.
In order to ensure that the access distribution is subject to the Poisson distribution or not, we have used the Ch-Squared test being one of the most important statistical tests that allows us to know the distribution of a particular phenomenon. We will proceed from the following two assumptions:
H_0: The distribution of children's access is subject to the distribution of Poisson.
H_1: The distribution of children's access is not subject to the distribution of Poisson.

Table 3: Ch-Squared (K_2) of children's access during viewing period

Number of Arrivals	Replication of Observations0 αx/x!) (e^(xα/x))100(	Replication of Observations	Absolute frequency = (Relative frequency - OF **OBSERVATIONS**0) frequency) ^2	K=Absolut frequency /Relative frequency
0	1,088902367	1	0,007903785483	0,00725834666
1	4,921838698	10	25,78772221	5,239448871
2	11,12335546	9	3,52179473	0,316612621
3	16,75918889	11	7,613123331	0,316612621
4	18,93788345	12	35,25845987	1,861795166
5	17,11984663	12	1,254056486	0,073251619
6	12,89695113	11	0,804521332	0,062380738
7	8,327745588	13	0,10741717	0,012898709
8	4,705176257	12	5,266216011	1,119238839
9	2,363044076	3	0,405712849	0,171690766
10	1,068095922	3	0,86844521	0,813077919
11	0,438890324	4	0,314844068	0,717363885
Total	1,088902367	1	0,007903785483	10,8492831

And by going back chi square test statistic schedule at Degrees of Freedom 12
with parametric (1-1) =10 at the significance level 5%. We get K_2ar=10,8492831 and K0.05=18.307. And the distribution of access can be rounded to the distribution of Poisson the parameter is defined "α (0 .452Child / min) "statistical study of service times. The period of service is also considered to be fixed and random and its possibilities are known and subject to one of the known distributions. To know the type of distribution that you follow, a sample was selected randomly consisting of 100 service periods. The length of service has been calculated from the entry of the child to the vaccination office until his exit, where the term of service ends, where you must first know the number of categories and length, F=1+3.322log100=7.64=8 to calculate volume 5.8002=2.10/ (3200 6.5440-0). Statistics are collected in the following table:

Table 4: Summarizes the average service time calculations

Frequency Mid Interval	Mid Interval	Observations Frequency (Number of Children)	Service Time
6.43025	0.72735	30	1.1347-.3200
40.0933	1.54205	26	.9494- 1.1347
40.06475	2.35675	17	2.7641-1.9494
44.4003	3.17145	14	3.5788-2.7641
19.93075	3.98615	5	4.3935-3.5788
19.2034	4.80085	4	5.2082-4.3935
11.2311	5.61555	2	6.0229-5.2082
12.8605	6.43025	2	0.8376-6.0229
209.6046		100	total

From the table, the average service time can be calculated U=1/ 2.096046 = 0.477 in the same way, a test was applied chi square. In order to determine the theoretical distribution of the observations. Judging from the hypotheses.

H_0: The allocation of service times is subject to the exponential distribution

H_1: Not The allocation of service times is subject to the exponential distribution

Table 5: The sum of squared differences chi square (service times)

$K^2=2/\emptyset i(\emptyset i - Ni)$	$(\emptyset i - N_i)^2$	$\emptyset=(ue^{-ut}) * 100$	frequency (number of children Ni(	Mid Interval
0.409648526	13.81190013	33.71643648	30	0.72735
0.431405004	9.861769374	22.85965458	26	1.54205
0.1454079	2.253645816	15.49878522	17	2.35675
1.160350406	12.19311906	10.5081353	14	3.17145
0.633512029	4.513448777	7.124487886	5	3.98615
0.142750026	0.689537429	4.830383905	4	4.80085
0.496366198	0.689537429	3.274987486	2	5.61555
0.021883406	0.048590635	2.220432836	2	6.43025
3.441323495			100	total

$K2ar = 3.44132349, K20.05 = 12.5915, 120.052K$. Since the calculated value is less than the tabular. Therefore, the distribution of service times can be approximated to the exponential distribution. The parameter is defined U (0.477 service/ minute). Through studying the statistical distributions, the following results obtained the distribution of children's access follows the Poisson distribution. The distribution of service times follows the exponential distribution. The service rate is greater than the rate of arrival, so the requirement to apply queues is fulfilled. So that there is a state of equilibrium and that forms the queues. Therefore, the mathematical model is $(\infty/\infty/\backslash f_i f_0\ (M/M/1)$.

4- Study the performance measures of the studied model: In order to study these indicators, it requires studying and analyzing the expectations of mothers of children about the time that they can wait for it, and comparing the results with the final results by applying the queues.

Determining the expectations of mothers of children: In order to analyze expectations, a component sample was questioned of 100 of the mothers of children about the acceptable waiting time, the interview method was applied direct being the fastest methods of obtaining information and ensuring unbiased the answer is, and the results are reached in the following table below:

Table 6: Waiting period accepted by service applicants

The Ratio	Number	Acceptable Waiting Period
0.2	20	Only service time
0.5	50	10minutes
0.3	30	Maximum 20 minutes
1	100	total

Through the schedule, it becomes clear that some people never wish to wait in line. Another class accepts waiting in the system for a maximum of 20 minutes. Based on the results actual performance is compared to the results obtained from the interview.

Determine the performance measures of the service center [20]**,** [21] and [22]: after determining both the access rate and the average service, it is possible to calculate the rest of the other indicators that are related to class models, queues by applying **QM** for Windows as follows by the figures below:

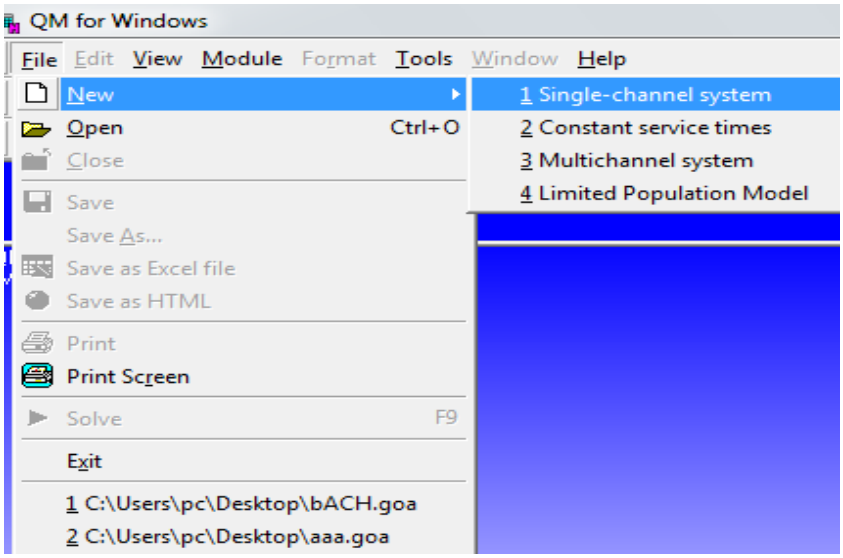

Figure 1: Quantitative programming method for windows

From the program we select M / M / 1, then we enter the value of each access average=5.007, Likewise average of service =5.002

Table 8: Introduction of access and service average and number of service centers

Parameter	Value
Single-channel system	
Arrival rate(lambda)	0,452
Service rate(mu)	0.477
Number of servers	1,

After her extraction measures of the performance is complete just as follows.

Table 9: Extraction Measure of the performance

(untitled) Solution					
Parameter	Value	Parameter	Value	Seconds	Seconds * 60
Single-channel system		Average server utilization	0,9476		
Arrival rate(lambda)	0,452	Average number in the queue(Lq)	17,1324		
Service rate(mu)	0,477	Average number in the system(Ls)	18,08		
Number of servers	1,	Average time in the queue(Wq)	37,9036	2 274,213	136 452,8
		Average time in the system(Ws)	40,	2 400,	144 000,

After extracting performance measures, the probabilities of the number of units in the system can be extracted in figure (2) as follows:

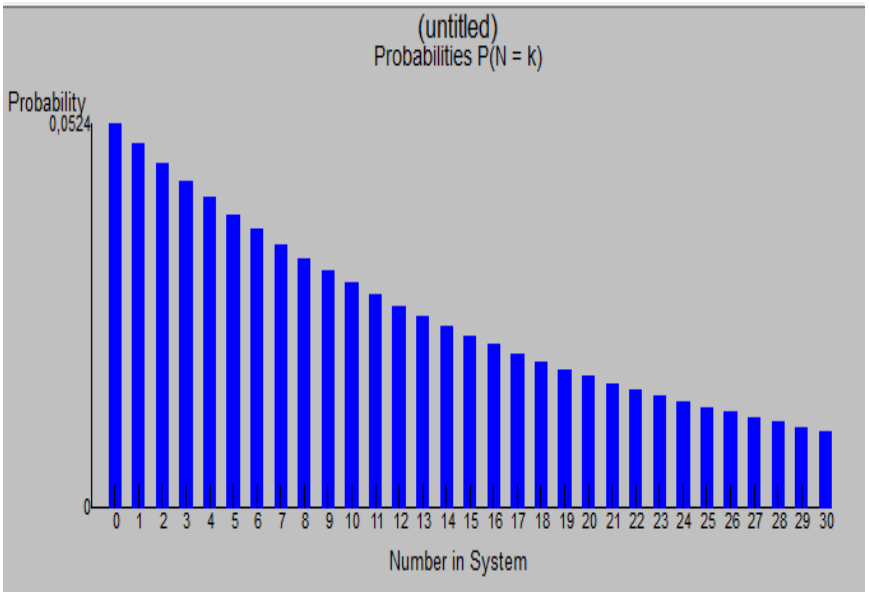

Figure 2: The probabilities of the number of units

Through different observation, the previous results in the table found that the average server utilization p=0.9476. This result means that possibility that office is Fertilization of the children busy 94.76 % from the time case of work is in and raved what gives a big sign clear about presence of congestion for the children and pressing of big on service center. This result indicates also provided that service center case is not comfortable to in a ratio of 5.24% of that time. The average children in queue the wait child be equal 17, and notices that he big number.

Especially and that expected their children of nursing. The average number of children in the system, i.e., the number of children in the queue, in addition to the number of children provided with service is equal to 18 children. The average time in queue is about 38 minutes. Where considers raved the indicator having big importance and on upright on the organizations healthy dearest the time raved his contraction as much as possible and that for that 38-minute time of extra-long in the ratio for the children considers Expected in the row. Where in comparison of this result with the obtained result on her from Expectations in the interview plateau that all mothers the children do not admire them the status quo. Since the

medium time immersed in the regime minute be equal 40, and this period considers extra-long.

Raved delay reviewed for who accomplishes him the child and he in row of the wait, and raved what indicates. Also provided that the arrival of the children is big very and average presentation of the service surpasses. From during results pointing, Ws Wq Last and in the opposite comparison with results plateau that time of the wait who accomplishes him the child extra-long in the row or in the regime as a whole and from period change of the status quo and general improvement of measures the performance in the organization Healthy on decision-makers.

The suitable thought in reduction the chronically ill wait and undertaking of the measures evident blessing these measures or the strategies is addition center for new service of nurse. New measures of the performance in addition of center, feel new service. In addition the thought be necessary new service center and that from Postponed Interview expectations of mothers of the children and contraction times of the wait and lightening pressing of the work on office fertilization of the children, and therefore the example becomes $(\infty/\infty\ f_i f_o)\ (M/M/2)$.

From the program and after choice M/M/S, then value enters all from arrival rate and the service so produces table. After her extraction measures of the performance is complete just as follows:

Table 10: Extraction parameter of the performance

Parameter	Value
M/M/s	
Arrival rate(lambda)	0,452
Service rate(mu)	0,477
Number of servers	2

From table (11) the entering averages of the arrival and the service and number centers of the substitute service.

Table 11: Extraction measures of substitute performance the example

Waiting Lines Results

(untitled) Solution					
Parameter	Value	Parameter	Value	Minutes	Seconds
M/M/s		Average server utilization	0,4738		
Arrival rate(lambda)	0,452	Average number in the queue(Lq)	0,2743		
Service rate(mu)	0,477	Average number in the system(Ls)	1,2219		
Number of servers	2,	Average time in the queue(Wq)	0,6068	36,41	2 184,6
		Average time in the system(Ws)	2,7033	162,1962	9 731,771

Through observation results of the schedule notices that:
Average server utilization p=0.4738
Average number in the queue (Lq)=0.2743
Average number in the system (Ls)=1.2219
Average number in the queue (Wq)=0.60668
Average time in the system (Ws)=2.7033
Raised in the article raved to Study Ways researches of the operations restrict where clarification of extension was complete.
Contribution examples of queue of the wait in improvement measures of performance of the Iraqi organizations.
Summarizing the important results which the achievement was complete her while follows:
Lack abundance of the specialized persons in ways researches of the operations in the one healthy in street Palestine - Baghdad the model contributed to the proposal in showing model queue of the wait in improvement turned different.
Measures of the performance in to unified healthy, where containers of the example
The proposal the next results:
The probability that the system is occupied at a specific time unit or the utilization factor has decreased, Because of increase center of new service from 0.9476 to 0.4738 any that the ratio also which Is in her service center Fertilization of the children is busy decreases also from 94.76 % to 47.38%
From the time of the work, and raved what indicates also on increase time of void of all center service. This result indicates provided that the big congestion who concentrated case of presence was in service only case of addition decreased in new center. Just as that addition center of new service helps in reduction chronically ill who accomplishes him. The child from Postponed the occurrence on the service, and improving of noticeable in all indicators Performance.
So, the average number of the children expected in row the wait decreased mn17 child to lack Presence of row for the wait, and raved what average drop afflicted to number of the children in the regime from 18 child to one service of the fertilization receives. Moreover, the previous results they were for impact on the time who accomplishes him the child in the regime is losing decreased also from 40 Minute to Minute to 7. Minute any about time of the service decreased too only. Dependency on results.

5- Conclusion and Recommendation

Study presentation of some recommendations be possible which already improvement of performance contributes in the organization in place of study. And representing in the coming the model adopted the proposal who different improvement contributed in measures of the performance Necessity of the assistance in examples of rows from improvement of performance founded Necessity of origination section for researches the many operations for the uses which accustoms in her the section raved on all organization is adequate different field.

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