

# A New Queuing System with Different Classes of Customers

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**Abstract.** Flexibility is an essential concept for businesses to deal within the rapid change in the business environment. Currently, customers have a power to guide the companies and manufactures as they tell the companies their requirements and thus the companies must attract the best customers to join their services. In this paper, we propose a requirements engineering based approach for BPM to support businesses in order to maintain their performance in such environment. We propose a new numerical model to improve the customers' satisfaction in the area of the time to be serviced according to their priority group classes especially the customers within high priority groups.

**Keywords:** Priority Queue; Customer Differentiation; Manage Change; Numerical Model.

## 1. Introduction

Companies must carefully model their business processes as a good Business Process Model (BPM) style has many advantages, such as improving the business performance, directly involving the employees from the initiating of the business processes modifications in order to be sure that they understand and support the business processes redesigning, and identifying the erroneous models and thus easily makes the model into code transformations [5].

However, there are several challenges to create a good BPM. One of the major challenges of the BPM is that the business environment and the business processes can be changed rapidly [6]. Hummer and Champy found that the environments can be featured by several forces. Firstly, the consumers assume to be controlled instead of salesmen. Currently, the consumers tell the industries suppliers what kind of products they need, when they need them and how much they can pay and how. Secondly, the competitions between companies are increased and each company requires attracting the active customers [7].

It is very complicated to keep the business processes under control since the business processes change rapidly and thus flexibility is an important concept for businesses in order to deal within the rapid change in the business environment. The manufactures flexibility may be achieved throughout mix product; new produce; etc. Thus, some companies and manufactures may require dividing their customers into different priority queues classes to be served according to service times and price. For example, one of the customers class can get their items and services immediately while other customers' class may accept the delay to receive their items and services for a discount [3].

Literature shows that there is no any research done in dividing the companies' customers into different priority groups to be served according to their payment history and feedback in order to increase the companies' performance and profit and save the time of customers within high priority class which may lead to increase their satisfaction. However, it is very important to analyze how to manage these systems which is very hard because of servicing different customers within different customers' priority classes.

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Therefore, we will propose a requirements engineering based approach for BPM to support businesses in order to maintain their performance in such environment. We will propose a new numerical model to improve the customers' satisfaction in the area of the time to be serviced according to their priority group classes. The remainder of this paper is organized as follows: section 2 describes the related work of dividing the customers into different priority queues; section 3 presents our proposed numerical model; and the conclusion and future research directions are presented in section 4.

## 2. Related Work

Literature shows that some companies and manufactures may divide their customers into different priority queues classes to be served according to service and price. For example, one of the customers class can get their items and services immediately while other customers classes may accept the delay to receive their items and services for a discount. For example, most of the e-commerce companies and WebPages through the Internet, such as Amazon.com, ebay.com, etc can provide the services and ship items within different price and delivery time options where paying a higher price can give the customers immediate fulfillment whereas accepting delay to receive with the shipment discount can give the companies the opportunity for the delay fulfillment and this may provide great customers utility and flexibility in order to manage the production system.

However, it is very important to analyze how to manage these systems which is hard because of servicing different customers within different customers' priority classes. The tactical inventory method and the delay production strategy is used to manage these systems in [2] and [1].

In [10], the authors considered the single item inventory system to serve two different customer classes within different service requirements in the discrete time units by using the critical level, reorder point and order quantity (s, q, k) policy.

Moreover, the queuing inventory system proposed by (Schwarz et al. 2006) [8] where the customers arrival one by one at the service facility to be served and the served customer is deleted immediately from the system queues. It is different from the traditional queue system because the inventory can influence the services. When there is no any inventory attach to the system, the services can be interrupted. Furthermore, it is different from the traditional inventory management system as its inventory is used at the serving rate while the traditional inventory management system is used at the customers' arrival rate if there are some customers in queue to be served. However, this queuing inventory system is limited to one class of customers. In [11], the authors considered the queuing system within inventory management where there are two classes of customers arrival to the service facility according to the Poisson processes.

In [4] and [9], the authors considered the companies that provide the services and items to two different customers groups. The first group is customers within long term supply contracts while the second group is customers who request their items occasionally. As the order of the first group customers is known in advance, they must deliver to the customers without any delay and meet the schedule period. Also, this order may be modelled as deterministic order. However, as the order of the second group customers is unknown until it is received, it may be modelled as stochastic order.

Literature shows that there is no any research done in dividing the companies' customers into different priority groups to be served according to their payment history and feedback in order to increase the companies' performance and profit and save the time of customers within high priority class which may lead to increase their satisfaction. Therefore, we are going to propose a requirements engineering based approach for business process modelling to support businesses in order to maintain their performance in such environment. We will propose a new numerical model to improve the customers' satisfaction in the area of the time to be serviced according to their priority group classes.

## 3. Proposed Numerical Model

According to some selection criteria, such as the customers' history of payment and feedback, we have categorized the companies' customers into four different groups within different priority service classes: customers within high priority class (Ch), customers within second priority class (Cs), customers within low

priority class (C1) and new customers (Cn). Figure 1 shows the selection criteria that have been used in our proposed framework to divide the customers in different groups to be served.

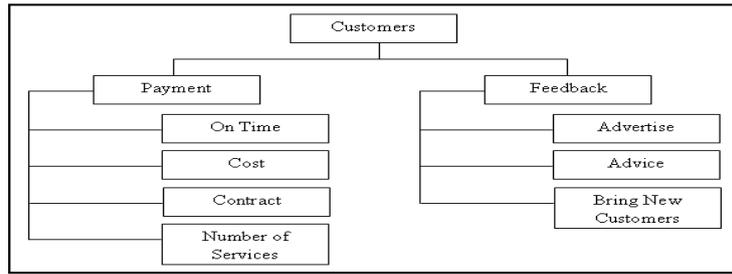


Fig 1: Selection Criteria for different Customer Priority Classes.

The customers’ payment history is an important criterion to distinguish between customers. We have categorized the payment history into four criterions. Firstly, the customers who pay their bills on time should be served before other customers who usually delay paying their bills. Secondly, the customers who pay much money monthly should be served before other customers who usually pay less money. In other words, the customers who increase the companies’ income monthly more than other customers should be served first. Thirdly, the customers who have contracted with the companies for long times should be served before other customers who are the new costumers or have contracted with the companies shortly. Fourthly, the customers who have applied or order more number of services and products from the companies than other customers should be served first.

The customers’ feedback history also is another important criterion to distinguish between customers. We have categorized the feedback history into three criterions. Firstly, the customers who assist the companies by advertising some of the companies’ services and products throughout their homepage, email, etc should have a high priority to be served. Secondly, the customers who provide a good advice and feedback to the companies to improve and develop their products and services should be considered as an active customer and this lead to serve them first. Thirdly, the active customers who help the companies by bring some new customers to join the companies should have a special bonus, such as giving them high priority class to be served first.

$$\int \begin{matrix} SC_i \geq X1; & 3 \text{ points} \\ X1 > SC_i \geq X2; & 2 \text{ points} \\ X2 > SC_i > 0; & 1 \text{ point} \\ SC_i = 0; & 0 \text{ point} \end{matrix} \tag{1}$$

After identifying the seven selection criteria to divide the customers into different groups within different priority queues to be served, equation (1) shows how these selection criterions (SC<sub>i</sub>) tested where i takes number from 1 – 7 referring to payment on time, cost, contract, and number of services, feedback advertise, advice and bring new customers selection creations respectively. In this equation, we have defined two variables: X1 refers to maximum amount that the customers require to reach to get higher points numbers whereas X2 refers to minimum amount used to distinguish between the customers who taking 2 or 1 points.

If the customers’ selection creation is higher or equal to the X1, they won three points while if the their selection creation is less than X1 and higher or equal to X2, they won two points. However, if their selection creation is less than X2 and higher than zero, they won one point whereas if their selection creation is equal to zero, they will not won any point as they consider as the new customers. For example, in the cost selection creation (SC<sub>2</sub>), if we suppose that the X1 equals to \$500 a month and X2 equals to \$300 a month, the customers will only won three points if they spent \$500 or more a month. However, they will won two points if they spent any amount less than \$500 and equal or higher than \$300 a month while they will only won one point if they spent any amount less than \$300 a month.

$$TSC_{ci} = \sum_{i=0}^n SC_i \tag{2}$$

$$\begin{aligned}
& TSC_{ci} \geq TSC * 75\%; & C_h \\
& TSC * 75\% > TSC_{ci} \geq TSC * 50\%; & C_s \\
& TSC * 50\% > TSC_{ci} \geq TSC * 1\%; & C_l \\
& TSC_{ci} = 0; & C_n
\end{aligned} \tag{3}$$

After specifying the customers' points for each selection creation, we calculate the total point (TSCci) winning by each customer. TSCci is equal to the sum of every SCi winning points as shown in equation (2). We will use the total of these points for each customer to map them into the right priority group to be served in the right time according to equation 3. Regarding our creation points, the maximum number of TSCci is twenty-one points and as we divide the customers into four different groups, we suppose if the customers won about 75% (16 points) of TSC or more, they will map into Ch. Otherwise, if they won about 50% of TSC and more but less than 75% of TSC (10 – 15 points), they will map into Cs, whereas they will map into Cl if they won less than 50% of the TSC and not equal to zero (1 – 9). They map into Cn when they do not won any point.

$$TC_j = \sum_{i=0}^n C_{(j,i)} \tag{4}$$

$$CTC = \sum_{i=1}^4 TC_{(j,i)} \tag{5}$$

$$CTC = TC_h + TC_s + TC_l + TC_n \tag{6}$$

$$ATC_j = \frac{TC_j}{CTC} * 100 \tag{7}$$

After mapping the customers into different groups within different priority queue classes, we calculate the total number of customers in each different group according to equation (4) and then we calculate the total number of the customers joining the companies according to equation (5) in order to estimate the percentage for each customer group in the companies according to equation (7). In equation (4), TCj refers to the total customer number in the j class where j can take four different values to distinguish between customers groups: h for customer within high priority class, s for customer within second priority class, l for customer within low priority class and n for new customer. C(j,i) refers to customer in each priority group.

In equation (5), CTC refers to the total numbers of the companies' customers which equals to the sum of the total numbers of customer for each different priority classes (TC(j)). In other words, CTC is equal to sum of the total number of customer within high priority class (TCh), second priority class (TCs), low priority class (TCl) and new customers (TCn) (equation (6)). In equation (7), we calculate the average for each customer priority class (ATCj) which is equal to the percentage of total number of customer in j (TCj) to the total number of customers in the companies (CTC) where j can take four different values to distinguish between customers groups: h for customer within high priority class, s for customer within second priority class, l for customer within low priority class and n for new customer.

After computing the total number of customers joining the companies and the average of each priority classes, we have to estimate the total number of staffs (CTS) that the campiness should have to provide better services and products to the customers. As we categorize the customers into four different groups within different priority queues to be served, we also divide the companies' staffs into five different groups: staffs serving Ch (Sh), staffs serving Cs (Ss), staffs serving Cl (Sl), staffs serving Cn (Sn) and public staffs (Sp) where Sp refers to the staffs who are absent, under training and supporting other companies' staffs to serve different customers groups.

$$TS_j = \frac{CTS * ATS_j}{100} \tag{8}$$

$$CTS = \sum_{i=1}^5 TS_{(j,i)} \tag{9}$$

$$\begin{aligned}
& CTS \\
& = TS_h + TS_s + TS_l + TS_n \\
& + TS_p
\end{aligned} \tag{10}$$

$$\begin{aligned}
& ATS_j \\
& = ATC_j \\
& - 10
\end{aligned} \tag{11}$$

$$\begin{aligned}
& TS_j \\
& = \frac{\sum_{i=1}^5 TS_{(j,i)} * (ATS_j - 10)}{100}
\end{aligned} \tag{12}$$

As we divide the companies' staffs into five different groups, we suppose that the percentage of Sn and Sp to be 30% and then we calculate the total number of companies' staffs in the j class (TSj) where j can take three different values to distinguish between companies' staffs groups serving different customers groups: h for staffs serving Ch, s for staffs serving Cs and l for staffs serving Cl. As shown in equation (8), TSj is computed by the percentage of the total number of companies' staffs in all five different groups (CTS) and the average of total number of companies' staffs in j class (ATSj) where CTS is calculated in equation (9) and (10) and ATSj is calculated in equation (11).

CTS equals to the sum of total numbers of companies' staffs in all different five divided groups. In other words, CTS is equal to sum of TSh, TSs, TSl, TSn and TSp. In addition, ATSj is less than ATSj by 10% because we suppose that the average percentage of total companies' staff who serving Cn (ATSn) and Sp (ATSp) is 30% and equation (11) uses to calculate the average percentage of the total companies' staff in the other three different staffs groups. Thus, we calculate the total number of companies' staffs in the j class (TSj) where j can take three different values to distinguish between companies' staffs groups serving different customers groups: h for staffs serving Ch, s for staffs serving Cs and l for staffs serving Cl according to equation (12).

**Table 1 Serving Customer with High Priority Class (Ch)**

Algorithm 1: Serving Ch	
IF	$S_h \geq C_h$
	Serve Ch
Else IF	$(S_p + S_h) \geq C_h$
	Serve Ch
Else IF	$(S_n + S_p + S_h) \geq C_h$
	Serve Ch
Else IF	$(S_l + S_n + S_p + S_h) \geq C_h$
	Serve Ch
Else IF	$(S_s + S_l + S_n + S_p + S_h) \geq C_h$
	Serve Ch
Else	
	Serve Ch in FIFO queues

Before shown how to serve customers within different priority queues as categorized in our proposed math model, we have to identify equation (13) where there is two states for the staffs in i different companies' staffs groups: available or busy where i can take five different values to distinguish between different companies' staffs groups: h for staffs serving customer within high priority class, s for staffs serving customer within second priority class, l for staffs serving customer within low priority class, n for staffs serving new customer and p for public staffs. In equation (13), Si refers to companies' staffs for i class, Si\_aval refers to available companies' staffs for i class and Si\_busy refers to busy companies' staffs for i class.

$$S_{i\_aval} = S_i - S_{i\_busy} \tag{13}$$

The customers who considers as high priority customers have to be served before any other customers with second and low priority class and the new customers. In the first step, the Sh serve the Ch and if there is some Ch in queue who have not be served, the Sp can assist the Sh to serve these customers. In other words, if Ch is higher than the Sh, the Sp can work within the Sh to serve the Ch. After that, if there is still some Ch in queue have not been served, the Sn can help the Sh and Sp to serve these customers. Moreover, the Sl can help Sh, Sp and Sn to serve Ch who have not been served yet. Finally, the Ss will help all other companies' staffs to serve the non served Ch yet. Otherwise, the Ch will be served in first-in-first-serve (FIFO)

management queue (Algorithm 1) [PQ7]. We only explain the algorithm of serving Ch because of paper limitations.

## 4. Conclusion

It is very hard to manage the business processes since the business processes change rapidly and thus flexibility is an essential concept for businesses to deal within the rapid change in the business environment. Literature shows that the customers now have a power to guide the companies and manufactures as they tell the companies their requirements of the products and services types and the payments. Hence, the companies must attract the best customers to join their services.

In this paper, we propose a requirements engineering based approach for BPM to support businesses in order to maintain their performance in such environment. We divide the companies' customers to five different priority groups and we propose a new numerical model to improve the customers' satisfaction in the area of the time to be serviced according to their priority group classes especially the customers within high priority groups. However, the paper has some limitations; we have not tested our numerical model in the real business originations. This can be extended by calculating the customers waiting time in the queue to be served.

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