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ALTERNATIVE SOLUTION FOR CLIENT SERVICE MANAGEMENT

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Annotation. The purpose of the article is to introduce the framework of investigating quieting processes employing innovate technique – Big Data aiming to present effective solutions for burstiness control and ensure high quality customer flow management. This contribution is organized as follows: the first section introduces the main principles of Queuing theory, then the discussion of its empirical application follows and finally the theoretical grounding of proposed new model development that gives a realistic description of binary customer behavior based on gap processes is presented.

Keywords: queuing; time of service; bid data

INTRODUCTION

At present most firms are striving very hard to provide the best level of service for there are dozens of factors contributing to the success or failure of a business reflecting in the end line of profit loss statement. Customer satisfaction is one of the factors strongly influencing the former. It's important to track this factor and work on improving it in order to make your customers more loyal and eventually turn them into so called brand ambassadors. Despite the efforts of the scientists and customer behavior analytics investigate the moderating effects of customer characteristics (satisfaction, repurchase intent, and repurchase behaviors and etc.) (Mitta et al., 2001; Kumar, 2016), the authors of the manuscript focus on customer service quality improvement through prevention of queuing - formation of so called waiting lines or queues are still a common phenomenon in life but the service level must be high. However, paradoxically, investigating empirical data from the retail sector the authors of the manuscript emphasize some discrepancy and shortcomings of the application of queuing theory for the purposes of managing queues and improving service level. The scientific problem of the article was formulated by questions: how to prevent queuing employing data mining. Aiming to present solutions for this complex problem and the big data analysis technique as the novel approach and tool is presented. The research problem was realized fulfilling the following tasks: statistical analysis of the queuing system within the company sampling, processing, detection of and interpretation of customer behavior patterns, processing and analysis of the secondary data of the enterprise. In order to conceive the analyzed problem, general methods of scientific literature comparative structural analysis and synthesis as well as those of logic analysis were applied. Correlation - regression analysis allowed determining relationship between the variables: sold goods and service time. Data mining allowed to pattern in large scale of data in order to transform it into information – service patterns in a particular case.

Despite the fact queuing is investigating basing employing Big data from retail, the presented results regard to more universal problem solution and might serve for different purposes, it was developed for practical needs of a certain company. It is one of the reasons the literature on the topic is large. For queuing modeling techniques that are useful and applicable to the study of data networks and gives an in-depth insight into the underlying principles of isolated queuing systems as well as queuing networks. Although a great deal of effort is spent in discussing the models, their general applications are demonstrated through many worked examples (Davidson, 1998).

QUEUING SYSTEMS: THEORETICAL INSIGHTS

Most authors (Davidson, 1998; Smith et al., 2002; McManus et al., 2004) conclude the queuing theory is used widely in engineering and industry for analysis and modeling of processes that involve so called waiting lines. It is also emphasized that queuing theory is the formal study of waiting in line and is an entire discipline within the field of operations management. Notable, that queues are formed when customers (human or not) demanding service have to wait because their number exceeds the number of servers available; or the facility doesn't work efficiently or takes more than the time prescribed to service a customer. Some customers wait when the total number of customers requiring service exceeds the number of service facilities, some service facilities stand idle when the total number of service facilities exceeds the number of customers requiring service (Priyangika & Cooray, 2016). The theory utilizes mathematical models and performance measures to assess and hopefully improve the flow of customers through a queuing system (Nosek & Wilson, 2001). The analysis of related literature allow to conclude that queuing theory was applied in optimizing staff schedules, working environment, productivity, customer waiting time – the challenges that are met in most service plants (pharmacy, telecommunications, banking and etc.). They all maintain inventories, hire clerks, and stay open even when they have no customers (National Bureu of Economic Research, 1992). On the other side, of the exchange, customers may have to wait to be served. Someone or something is almost always waiting (Bakari et al., 2014). The following assumptions were made for queuing system which is in accordance with the queue theory. They are: arrivals follow a Poisson probability distribution at an average rate of λ customers per unit; service times are distributed exponentially, with an average of μ customers per unit of time; there is no limit to the number of the queue (infinite); the service providers are working at their full capacity; the average arrival rate is greater than average service rate; servers here represent employees of the supermarket; service rate is independent of line length; service providers do not go faster because the line is longer. However, testing the same assumptions in practice by employing other methods (for example – Big Data) and investigating queuing and burstiness processes allow to discuss the empirical value of the application of the theory for improvement of customer service.

METHODOLOGICAL FRAMEWORK FOR INVESTIGATION OF QUEUING IS SERVICES: BIG DATA APPLICATION

One of the expected gains from studying queuing systems is to review the efficiency of the models in terms of utilization and waiting length, hence increasing the number of queues so customers will not have to wait longer when servers are too busy (Jhala & Bhathawala, 2017). Embedded Systems and Big Data Analytics with an aim to reduce the strain in services and industry by eliminating the drawbacks of the current scenario with the use of proximity technologies, interfaced over the embedded systems / SOCs and further augmenting this through data collection and predictive analytics (Chee-Hock & Boon-Hee, 2008). Since the solution aims to reduce human interaction in the whole so called purchasing process and also, in a way, provide the customer with a private experience. The whole process reduces the reliance of these businesses on manpower and provides and smooths automated flow to customer.

Big Data concerns large-volume, complex, growing data sets. The most fundamental challenge for the Big Data applications is to explore the large volumes of data and extract useful information or knowledge for future (Chee-Hock, N. & Boon-Hee, 2008). The application domains can also provide additional information to benefit or guide Big Data mining algorithm designs. For example, in market basket transactions data, each transaction is considered independent and the discovered knowledge is typically represented by finding highly correlated items, An appealing Big Data mining task is to design a Big Data mining system to predict the movement of the market in the next one or two minutes. Such systems, even if the prediction accuracy is just slightly better than random guess, will bring significant business values to the developers (Jhala & Bhathawala, 2017; Chee-Hock, N. & Boon-Hee, 2008; Ahrens et al., *2018*). The novel contribution of this paper is presented in the new model that allows a realistic description of binary customer behavior based on gap processes.

The remaining part of this contribution is organized as follows: the next section introduces the theoretical grounding proposed the new model development that allows a realistic description of binary customer behavior based on gap processes. The associated results of the model development will be presented in the following section. Finally, some concluding remarks are provided followed by a short outlook on interesting topics for further work.

RESULTS AND INTERPRETATION: EMPIRICAL EVIDENCE

We investigated duration of the service of the buyers at the cash register of the medium size grosery shop. The sample contained cash register data about the operation end time including seconds, the amount of goods purchased, their codes and prices of each buyer for all the June of the year 2018. During this time 2575 buyers were served.

In a shop the cash register busyness is quite irregular. After activity periods there may appear several gaps (free times) as is highlighted in Figure 1. The similar bursts appear in data transmission.

Analysis of bursty phenomena has been successfully implemented in telecommunications for optimizing data communication protocols and will be adopted in this work to analyze the buying process in a shop.

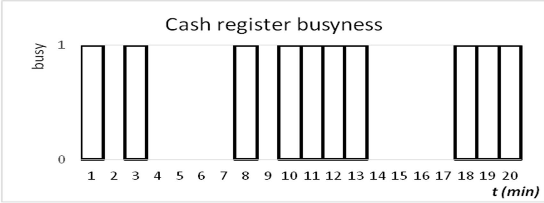

Figure 1. **Grocery shop: busyness of cash register**

Unfortunately, the cash registers do not record the start time of the operation. Therefore, the service duration time was not available from the database. To cope with this problem we observed buyers' service durations with different quantities of goods (see Table 1). It appeared, that the service duration t_s depends not only on the quantity of the goods, but also on the type of goods, individual characteristics of the buyer and other random factors, i.e. the dependence is statistical. The cash registers record only the end time of the service and number of goods but not the duration. To find the start time of the service observations of the service duration were carried out. Then a regression equation was found that connects the quantity of goods and the time of service. The calculated time of the regression equation enabled to find finding the free time (gaps) between serving adjacent customers. The analysis of these durations comprise calculations the burstiness parameters of free time and service time durations and investigations of the duration distribution.

Table 1

Duration of the service at the cash register

Amount of goods ***n***	**Service time t_s in sec.**
3	44
1	18
10	30
1	11
18	61
1	37

The correlation coefficient *r* between *n* and t_s equals 0.72 and the regression equation is $t_s = 1.9n + 22.8$. The equation yields that for one good it is required about 1.9 seconds and additionally about 22.8 seconds are required for the each buyer. Knowing the quantity of goods and using this equation was calculated at the service duration at a cash register and the service start time. Then having the start and end times of the each buyer was calculated the free time between two buyers service, if any. When it appeared that there was no free time interval between two or several buyers service then the sequential service times were merged into one continuous service time interval. Therefore, it was possible to investigate service duration times and time gaps between succesive buyers. It appeared that the average service continous duration *m*=37 seconds and the most frequent duration *mode*=32 seconds. The distribution of service is given in the Figure 2.

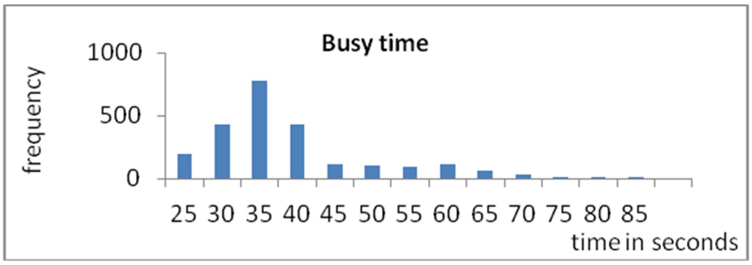

Figure 2. **Distribution of service duration times**

Similarly duration of free time intervals were processed. The average free time equals to 234 seconds, i.e. 4 minutes and the mode equals to 3 seconds. The fistogram is given in the Figure 4. It is different from the histogram of servise tiems. The frequencies of free times is constantly decreasing while it is not true for histogram of service times given in the Figure 3.

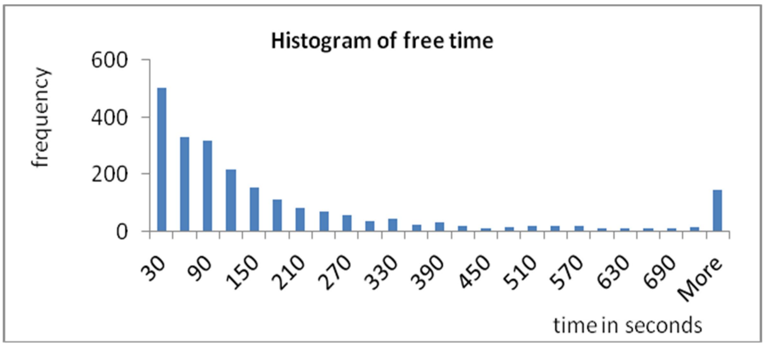

Figure. 3. **Distribution of free times of cash register**

The small mode of free time and the histogram of free times testifies that the time gaps between services usually are short. The histogram of free times up to 30 seconds, i.e. half minute, reveals that these durations are distributed quite similarly (see Figure 4).

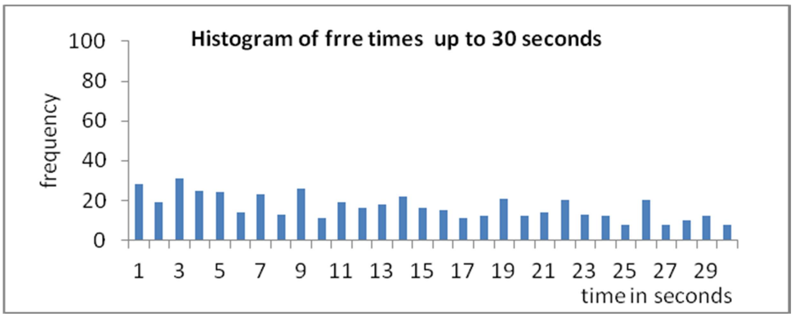

Figure. 4. **Distribution of free times up to 30 seconds**

One of the measures of burstiness is so called parameter *B*

$$B = \frac{\frac{s}{m} - 1}{\frac{s}{m} + 1} \tag{1}$$

defined by Goh & Barabasi (2008) in their research. It is evident that $B = \frac{s-m}{s+m}$.

From this formula follows that -1≤B≤1. Goh & Barabasi (2008) pointed out that B=1 corresponds to the most bursty signal, B = -1 corresponds to a completely regular (periodic) signal and B = 0 is referred to as neutral burstiness. Applying this formula to free times it yields that *B*=0.45. Therefore the free times between services is quite bursty. On the other hand, the burstiness of free times up to 30 seconds equals to *B*=-0.22, i.e. the burstiness is close to neutral. The high burstiness of free times during all the month were determined by the longer free time at the beginning and end of the shop open time. It appears that the burstiness of continuous busy times B= -0.55, i.e. between neutral and regular.

CONCLUSIONS

Progress in the service sector as such is frequently associated with innovations in business process management. High level customer or client service could be guaranteed under the cirscumces of effective allocation of endogenous productive and distributive functions or the provider. Understanging the customer bahaviour allows ensure the smooth automated flow. For the reason there is a compelling reason to argue for correct measure of the provider's performance – managemet of qeueing and burstiness in the particular case. In most cases the performance is investigated employing the Queuing theory, however the authors of teh manuscript are tended to dicuss the former and present insihts of Big Data for analysis of mentioned processes. The research was carried investigating a certain case of client service in a grocery shop applying Big Data. In particular case, one aspect – duration time of service – was investigated. The principal steps of the analysis included and the results obtained showed the average service in the shop (in seconds) was m=37 seconds and the most frequent duration mode=32 seconds. Similarly duration of free time intervals were processed. The average free time equals to 234 seconds, i.e. 4 minutes and the mode equals to 3 seconds.. Burstiness parameter B made -0.55, that means that busrtiness in teh shop warried between neutral and regular.

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