# Internal and External Factor Analysis in Bottleneck Detection in Shop Sales: The Case of Grocery Shops in Lithuania

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Abstract: The optimization of supermarket processes as well as the increase in productivity and profitability of shop sales requires extensive knowledge of bottlenecks within the sales processes as bottlenecks limit the capacity of shop sales. Bottlenecks refer to bursty processes in analogy to the occurrence of bit-errors in data transmission systems. The aim of the paper is to analyse external and internal factors in shop sales underpinning the examination of external and internal factors in shop sales based on the collected data of two supermarkets in Lithuania. In this context, concentrated arrival of customers is identified as an external factor. By internal factors, the buyers' waiting time in the queue to the cash register as well as the payment processing time at the cash register are meant. In this work the internal factors of the payment process are modelled by gap processes where the obtained parameters such as the buyers' concentration and the buyers' probability allow a good comparison of the payment related processes. This work aims at achieving customer quality improvement through prevention of queuing. The obtained results show that the waiting time in the queue to the cash register is quite bursty whereas the payment processing time at the cash register is quite regularly distributed. Therefore, the conclusion can be drawn that at the cash register short periods of high activities are followed by longer periods of inactivity.

## 1 INTRODUCTION

The optimization of supermarket processes as well as the increase in productivity and profitability of shop sales requires extensive knowledge of bottlenecks within the sales processes. By bottlenecks, customers that arrive at a rate that exceeds the processing system rate are meant (Ahrens et al., 2019c). Bottlenecks can appear due to external and internal factors. A concentrated arrival of customers is defined as the external factor. Buyers' waiting time in the queue to the cash register and the payment processing time at the cash register are determined as the internal factors. Within the present work, by customers shop visitors and buyers are meant. A shop visitor is someone who visits the shop, but does not buy anything in this shop, and a buyer is defined as one who has purchased something in the shop.

Customer satisfaction is one of the key factors strongly influencing the success or failure of a business. It is important to track the customer satisfaction in order to make the customers more loyal (Miceviciene et al., 2018). Despite the efforts of scientists and researchers to investigate the customer characteristics (e.g. satisfaction, customer buying characteristic, repurchase behavior) (Mittal and Kamakura, 2001; Kumar et al., 2016), this work is aiming to achieving customer quality improvement through prevention of queuing as waiting lines or queues are still a common phenomenon in life, and long waiting times at the cash register are still an indicator of customer dissatisfaction.

When analyzing the customer flow through the shop, it should be pointed out that bottlenecks can emerge in any single process within the shop (e. g. at the butcher station, at the bakery station or at the cash register). Bottlenecks appear when the capacity of a shop's single process is less or equal than designed



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i. e. any single process, whose utilization is 100 % or more, within the buying process chain. By buying process chain, the customer arrival at the shop, the selection of goods, the payment process which includes both waiting in the queue to the cash register and the payment processing at the cash register as well as the customer departure is meant (see also Fig. 1).

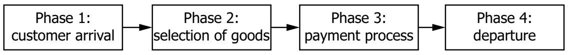


Figure 1: Phases of the buying process chain.

Therefore, any bottleneck will halt the continuous flow of customers throughout the shop. Fig. 2 demonstrates a bottleneck in shop sales created by internal and/or external factors whereas in this work the focus is put on studying and modelling internal factors only.

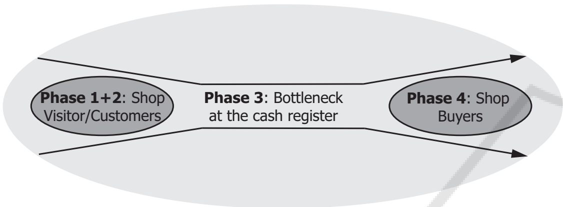


Figure 2: Bottleneck in shop sales when analysing the payment process according to Fig. 1.

As bottlenecks refer to bursty processes in analogy to the occurrence of bit-errors in data transmission systems or the arrival of TCP packets in communication networks (Kessler et al., 2003), the aim of the paper is to analyse external and internal factors in shop sales underpinning the examination of factors in shop sales based on the collected data of two supermarkets in Lithuania. Factors introducing burstiness as a means of bottlenecks in the shopping process are given in Tab. 1. The literature reveals three different approaches to factor analysis, namely, PEST (Political, Economic, Social and Technological) (Sammut-Bonnici and Galea, 2015), SWOT (Strengths, Weaknesses, Opportunities and Threats) (Gürel, 2017) as well as external and internal factors (Ahrens and Zaščerinska, 2014). Analysis of these three approaches allows concluding that external and internal factors are also part of PEST and SWOT. Consequently, the approach of external and internal factors is applied in the present work, whereas factor is defined as a reason of change of a phenomenon. It should be noted that external factors refer to external situations such as the concentrated arrival of customers at the shop. In turn, internal factors are conventionally regulated by a shop itself. It is worth noting that bottlenecks within the process chain of selling and buying are limiting the capacity of shop sales. Thus, a proper description of bottlenecks will help to increase the productivity of shop sales.

Table 1: External and internal factors that influence bottlenecks in shops.

| Classification | Description |
|---|---|
| external | concentrated arrival of customers or visitors at the shop |
| internal | waiting time in the queue to the cash register |
| internal | payment processing time at the cash register |

In this work only the internal factors such as the waiting time in the queue to the cash register and payment processing time at the cash register (further referred as buyers' service time) are studied and modelled as highlighted in Fig. 3. It should be pointed out that, while the payment processing time is usually determined by technological limits (scanning of the purchased goods, the paying process itself) and the experience of the sales staff, bottlenecks can be identified by analyzing the free time intervals between buyers at the cash register.

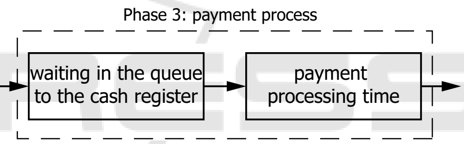


Figure 3: Elements of payment process (Phase 3).

Apart from that, the payment processing time gives a good insight into the buyers' behaviour, finding out if the buyers consistently buy few articles or many articles.

It should be pointed out that, in this work, the examination of the buyers' waiting time in the queue to the cash register is equivalent to the analysis of cashier free time intervals between two buyers. Here, it is expected that a high level of burstiness indicates that long free time intervals at the cash register are followed by many short free time intervals.

The question of the utilization of cash registers plays a central role when optimizing the productivity and profitability of shop sales. For example, buyers may appear in a very concentrated (bursty) manner at the checkout, which may result in short breaks (short free times at the cash register) between the individual payment processes followed by longer breaks (Fig. 4). On the other hand, it is important to know whether the buyers' service time differs under the assumption of bursty cashier free time intervals.

In this paper, gap-based models known from data transmission systems are used for bottleneck identification in grocery shops in Lithuania. The obtained

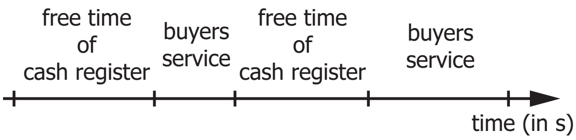


Figure 4: Interplay of buyer free time intervals and buyer service times at cash register.

parameters such as the buyers' concentration and the buyers' probability allow a good analysis of the flow of shop customers. The validation of the obtained results will be carried out using the data of two supermarkets of different sizes in Lithuania.

The novelty of this paper is given by the analysis of internal factors in bottleneck detection through a comparison of different approaches for measuring burstiness in real shop processes. Internal factors are investigated through the waiting time in the queue to the cash register as well as the payment processing time at the cash register. It is worth noting that this paper is dedicated to the payment process by jointly describing and modelling the waiting in the queue to the cash register as well as the payment processing time at the cash register by gap processes. Describing each process by gaps individually, the payment process can be modelled by two independent gap-processes with different parameters. Exemplary, gap parameters for modelling and simulation are found by analyzing the payment process of two supermarkets in Lithuania.

The remaining part of this paper is organized as follows: Section 2 introduces the theoretical basis for internal factors in bottleneck detection. The distribution of buyers within bursty environments for bottleneck analysis is given in Section 3 followed by approaches for measuring burstiness in bursty business processes in Section 4. The associated results of an empirical study of different grocery shops in Lithuania are discussed in Section 5. Finally, some concluding remarks are provided in Section 6.

## 2 BURSTY BUSINESS PROCESSES

In general, any process including the process of buying in which binary decisions are made can be described by gaps as illustrated in Fig. 5 (Ahrens et al., 2019b).

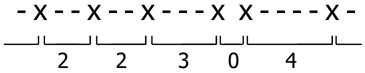


Figure 5: Modelling of the buying process by gaps (a buyer (represented by "x") within a sequence of non-buying visitors (represented by "-")).

When neglecting the payment processing times (also referred as buyers' service times), gap processes appear when describing the free time intervals between buyers at the cash register as highlighted in Fig. 5. The process of buying can be defined by buyer probability $p_\mathrm{e}$ as well as buyer concentration $(1-\alpha)$ (Wilhelm, 1976; Ahrens, 2000). A customer becomes with the probability $p_\mathrm{e}$ a buyer and remains with the probability $(1-p_\mathrm{e})$ a visitor. On the other hand, the payment processing time at the cash register can be modelled by gaps as well. Therefore the payment process can be modelled by two independent gap processes, namely the description of the waiting time in the queue to the cash register and the payment processing time at the cash register.

The distribution of the gaps (e. g. describing free time intervals between two buyers) can be described by a gap distribution function $u(k)$ defining the probability that a gap $Y$ between two buyers is greater than or at least equal to a given number $k$, i. e.

$$u(k) = P(Y \geq k) \quad . \tag{1}$$

A bursty behaviour could emerge, if $u(k)$ is different from the exponential distribution function (Kessler et al., 2003; Weisstein, 1999). Next to gap-distributions described by one parameter such as the beforehand mentioned exponential, distribution functions such as Weibull (Weisstein, 1999; Kessler et al., 2003) or Wilhelm (Wilhelm, 1976), which depend on two parameters, allow a greater precision when describing bursty business processes known from bit-errors in telecommunications (Ahrens, 2000) as well as the characteristic of transmission control protocol (TCP) connection arrivals (Feldmann, 2000; Kessler et al., 2003) or when analyzing the internet traffic (Zukerman et al., 2003; Kresch and Kulkarni, 2011).

The distribution function $u(k)$, published by Wilhelm (Wilhelm, 1976), is defined by the parameters, namely buyer probability $p_\mathrm{e}$ and buyer concentration $(1-\alpha)$, and results for bursty business processes (including shop sales) in

$$u(k) = [(k+1)^\alpha - k^\alpha] \cdot \mathrm{e}^{-\beta \cdot k} \quad . \tag{2}$$

with the parameter $\beta$ defined by

$$p_\mathrm{e} \approx \beta^\alpha \quad . \tag{3}$$

For independent buyers, the buyers' concentration results in $(1-\alpha) = 0$, whereas for practically relevant bursty buyers' processes, a buyer concentration in the range of $0 < (1-\alpha) \leq 0,5$ can be expected. The gap distribution function defined in (2) is of a high level of practical relevance as the function was found by analysing bit-errors in short-wave communication channels (Wilhelm, 1976) and confirmed by analyzing packet arrivals in TCP connections (Kessler et al., 2003).

## 3 DISTRIBUTION OF BUYERS WITHIN BURSTS

Bottlenecks as a capacity constraint can appear if more buyers, who require service, than expected are in the shop. Customers might have to wait because their number exceeds the number of expected ones. In this way the buyers appear in a bursty nature i. e. a high number of buyers appears within a given time interval and the flow of buyers throughout the shop is limited (Ahrens et al., 2019a). When modelling the payment process by gaps, a burst is based on the buyer-visitor relationship and is defined as a pattern which begins with a buyer and ends with a buyer, when at least $a$ visitors (who do not buy anything) follow. The parameter $a$ is also called the distance parameter (gap) between two buyers. If the gap after a buyer is greater or equal compared to the distance parameter (gap) $a$, the burst is considered as terminated. Fig. 6 highlights the burst definition with $a = 3$. The burst ends, when the gap after a buyer is greater than or equal to the distance parameter $a$ (here in the example $a = 3$), the proportion of these gaps is given by the parameter $u(a)$, i. e. the gap-distribution function $u(k)$.

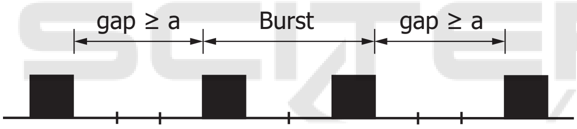


Figure 6: Burst definition the distance parameter $a = 3$.

The number of bursts $z_B$ with the distance parameter $a$ in a sample with $z_f$-buyers results in

$$z_B = z_f \cdot u(a) \quad . \tag{4}$$

From (4) the average number of buyers $g$ within a burst is calculated as

$$E\{g\} = \frac{z_f}{z_B} = \frac{1}{u(a)} \quad . \tag{5}$$

Tab. 2 shows the obtained parameters for different values of $a$. The values obtained by simulations using (2) show a good agreement with the theory using (4). Assuming that the sample contains $z_f = 1000$ buyers, with the distance parameter $a = 5$ in total 957 bursts for the memoryless buyer scenario (defined solely by the buyers' probability), but only 560 bursts for a scenario with memory can be registered. This shows that the number of buyers per burst increased when the buyers' concentration raised.

Fig. 7 illustrates the calculation of the buyers within bursts. The Markov chain is started from state $B_i$ i. e. it is assumed that the burst is already started with a buyer. The Markov chain remains in state $B_i$ as long as the occurring buyers belong to the burst $i$, i. e. the gap to the previous buyer is shorter than $a$. When jumping to the next buyer, the burst can be finished when the gap $k \geq a$. The Markov chain is then in state $B_{i+1}$ i. e. in the next burst.

Table 2: Bursts $z_B$ at a buyers' probability $p_e = 10^{-2}$ for different parameters of the buyers' concentration $(1-\alpha)$ assuming $z_f = 1000$ buyers.

| $(1-\alpha)$ | $a$ | Simulation | Theory |
|---|---|---|---|
| 0,0 | 10 | 901 | 895 |
| 0,1 | 10 | 662 | 660 |
| 0,2 | 10 | 473 | 474 |
| 0,0 | 5 | 957 | 951 |
| 0,1 | 5 | 752 | 736 |
| 0,2 | 5 | 560 | 560 |

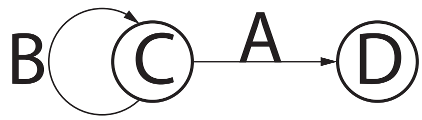


Figure 7: Buyers' distribution using Markov chain.

The number of buyers per burst can be calculated by the weight distribution $P(g)$ resulting in:

$$\begin{aligned} P(g=1) &= u(a) \\ P(g=2) &= u(a) \cdot [1-u(a)] \\ \vdots &= \vdots \\ P(g) &= u(a) \cdot [1-u(a)]^{g-1} \quad . \end{aligned}$$

The obtained results in Fig. 8 confirm that with the increasing buyers' concentration $(1-\alpha)$ more and more buyers per burst appear.

## 4 MEASUREMENT OF BURSTINESS

The optimization of underlying business processes such as the cashier free time intervals at the cash register as well as the payment processing time intervals require the estimation of the level of burstiness in order to find appropriate parameters for the simulation when using the gap-distribution function $u(k)$. With a known gap density function $v(k) = P(Y = k)$, denoting the probability that a gap $Y$ of length $k$ appears, the buyers' concentration $(1-\alpha)$ can be obtained, when analysing the probability that after a buyer, in the distance of zero another buyer appears, i. e.

$$v(0) = u(0) - u(1) \quad . \tag{6}$$

With $u(0) = 1$ we get

$$v(0) = 1 - u(1) = 1 - \left[(2^{\alpha}-1)\,e^{-\beta}\right] \quad . \tag{7}$$

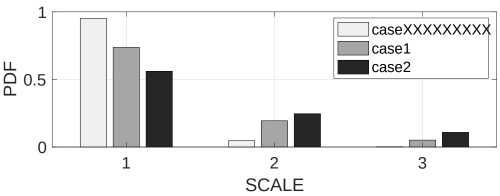


Figure 8: Buyers distribution $P(g)$ within the bursts for different parameters of the $(1-\alpha)$ at a buyer's probability of $p_e = 10^{-2}$ and a distance parameter of $a = 5$.

The expression can be simplified for small values of $\beta$ as

$$e^{-\beta} \approx 1 \quad \text{for} \quad \beta \ll 1 \tag{8}$$

and the parameter $v(0)$ can be expressed as

$$v(0) \approx 2 - 2^{\alpha} \ . \tag{9}$$

From this equation, the buyers' concentration $(1-\alpha)$ is estimated as

$$(1-\alpha) \approx 1 - \log_2 [2 - v(0)] \tag{10}$$

for the proposed gap model when analyzing exemplary the free time intervals between buyers at the cash register. Tab. 3 shows the obtained values when using (10) and (2) for estimating buyers' burstiness. As shown in (Ahrens and Zaščerinska, 2017) the probability $v(0)$ can be obtained as

$$v(0) = \frac{\mathbf{E}\{\text{number of neighbouring buyers}\}}{\mathbf{E}\{\text{number of buyers}\}} \ . \tag{11}$$

Therein, the parameter $\mathbf{E}\{\cdot\}$ denotes the expectation functional. The number of neighbouring buyers are counted when after a buyer immediately the next buyer appears, i. e. the distance $k$ between two buyers is $k = 0$ (also referred as neighbouring buyers).

Goh & Barabasi (Goh and Barabási, 2008) provided an alternative solution for estimating burstiness in business processes independent of the selected process by taking the mean value $m_1$ (average gap length or average length of free time intervals between two buyers at the cash register) as well as the standard deviation $\sigma$ of the length of time intervals or gaps into account and is defined as

$$B = \frac{\sigma - m_1}{\sigma + m_1} \ , \tag{12}$$

with $-1 \leq B \leq 1$. Whereas regular (deterministic) processes are described by negative parameters of $B$,

Table 3: Obtained values for the buyers' concentration $(1-\alpha)$ at a buyer's probability of $p_e = 10^{-2}$ using (10).

| Theory | 0,0 | 0,1 | 0,2 |
|---|---|---|---|
| Estimation | 0,0071 | 0,104 | 0,202 |

Table 4: Comparison of the estimated level of burstiness at a buyer's probability of $p_e = 10^{-2}$.

| $(1-\alpha)$ | 0,0 | 0,1 | 0,2 |
|---|---|---|---|
| $B$ (Theory) | 0,0025 | 0,18 | 0,34 |
| $B$ (Praxis) | 0,0018 | 0,17 | 0,33 |

bursty business processes are described by positive parameters of $B$.

Analysing (12), a value $B = -1$ can be obtained for any $m_1$ if $\sigma = 0$ and describes a completely regular (deterministic) process. In this case the density function degenerates to a discrete line at $m_1$, and the whole process becomes deterministic. On the other hand, $B = 0$ is considered as a neutral burstiness as here $\sigma = m_1$ holds. Bursty business processes appear for $0 \leq B < 1$, whereas the parameter $B = 1$ can be obtained for $m_1 = 0$ for any $\sigma$. However, in the case of non-negative random variables, the parameter $m_1 = 0$ appears just when all values are equal to zero. Therefore $B = 1$ cannot be obtained practically.

Next to $u(k)$ a gap density function $v(k)$ defining the probability that a gap $Y$ between two buyers is equal to a given number $k$, i. e.

$$v(k) = P(Y = k) \tag{13}$$

can be defined. Taking $v(k)$ into account, the gap distribution function $u(k)$ results in

$$u(k) = v(k) + v(k+1) + v(k+2) + \cdots \tag{14}$$

and the gap density function $v(k)$ can be defined as

$$v(k) = u(k) - u(k+1) \ . \tag{15}$$

By taking $v(k)$ into account, the mean value $m_1$ and the variance $\sigma^2$ result in

$$m_1 = \sum_{k=0}^{\infty} k\, v(k) \quad \text{and} \quad \sigma^2 = \sum_{k=0}^{\infty} k^2\, v(k) - m_1^2 \ . \tag{16}$$

Analysing a buying process with independent buyers, i. e. $(1-\alpha) = 0$, the parameter $B$ results as shown in (Ahrens et al., 2019a) in

$$B = \frac{\sigma - m}{\sigma + m} = \frac{e^{p_e/2} - 1}{e^{p_e/2} + 1} \ . \tag{17}$$

Tab. 4 shows the obtained parameters for the estimated level of burstines described by the parameter $B$ when using (2). When using the gap-distribution function $v(k)$ defined in (15), the obtained parameter $B$ follows the buyers' concentration $(1-\alpha)$ in theory as well as when analysing real visitor-buyer interconnections.

# 5 GROCERY SHOPS IN LITHUANIA

In order to analyse the level of burstiness, the duration of the service times of the buyers at the cash register as well as the free time intervals at the cash register of two different shops (grocery shop and supermarket) in Lithuania is studied in order to get appropriate parameters of the underlying gap distribution functions. The collected cash register data, obtained from a single cash register of each shop, contain the operation time, the amount of goods purchased, their codes and the prices paid by each buyer. The data collection was carried out in June 2018 and September 2018.

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 Tab. 5). 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 correlation coefficient between $n_g$ and $t_s$ equals $0,72$, and the regression equation is given by

$$t_s = 1{,}9\,n_g + 22{,}8 \quad . \tag{18}$$

The equation yields that for one good about 1,9 seconds and additionally about 22,8 seconds for each buyer are required. The data were collected in the grocery shop, and it is assumed that all grocery shops as well as supermarkets have similar performance as they are working with similar equipment of cash registers and salespeople who are working at a similar intensity. Knowing the quantity of goods and (18), the start and end times of each buyer can be calculated. This allows us to analyse the free time intervals between two buyers' service.

In this work the payment process is jointly described and modelled by independent gap processes taking the waiting time in the queue to the cash register as well as the payment processing time at the cash register into account. By describing each process by gaps individually, the payment process can be modelled by two independent gap processes with different parameters as highlighted in Fig. 9.

Table 5: Duration of the service at the cash register.

| Amount of Goods $n_g$ | Service Time $t_s$ (in $s$) |
|---|---|
| 3 | 44 |
| 1 | 18 |
| 10 | 30 |
| 1 | 11 |
| 18 | 61 |
| 1 | 37 |

## 5.1 Free Times of Cash Register

The histograms of the free time intervals at the cash register for the grocery shop are given in Fig. 10 and for the supermarket in Fig. 11. Comparing both figures it turns out that the free times of cash register are more bursty in the supermarket. Here, either short free time intervals or significantly longer free times intervals are recognized. Tab. 6 highlights the calculated buyers' burstiness for the two investigated shops, described the burstiness parameter $B$. The obtained data confirm a higher level of burstiness in the supermarket compared with the grocery shop when analysing the free time intervals between two buyers.

The probability of free times' durations up to 30 seconds, i. e. half a minute, are shown in Fig. 12 for the grocery shop and in Fig. 13 for the supermarket. Whereas these durations are quite similarly distributed in the case of the grocery shop, the durations tend to be slightly exponentially distributed in case of the supermarket. The obtained data of the buyer probability and buyer concentration confirm a higher level of burstiness in the supermarket compared with the grocery shop.

## 5.2 Buyers' Service Time

Next to the free time intervals, the service times of the buyers at the cash register are analysed. The corresponding service times are depicted in Fig. 14 for the grocery shop and in Fig. 15 for the supermarket. Tab. 7 highlights the levels of burstiness obtained by analyzing the buyers' service times for the two investigated shops.

It comes out that negative burstiness factor $B$ of the time $t$ spent at the cash register shows a rather predominantly neutral (deterministic) behaviour than a burst-like behaviour. The burstiness parameters are very similar comparing the two shops assuming that the parameter depends on the consumer behaviour, performance of cash register and of salesperson. It confirms our initial assumption that all shops show a similar performance as they work with similar equip-

Table 6: Buyer's Burstiness when analyzing the free-time intervals.

| Shop | $m_1$ | $\sigma$ | $B$ |
|---|---|---|---|
| Grocery Shop | $234,1$ s | $620,1$ s | $0,45$ |
| Supermarket | $96,9$ s | $408,7$ s | $0,62$ |

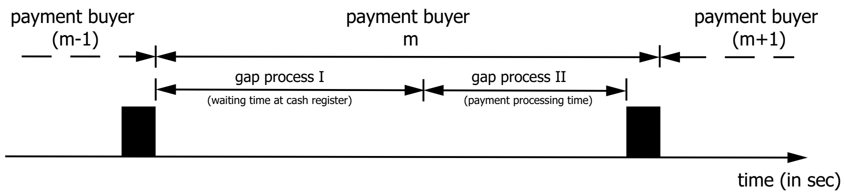


Figure 9: Modelling the payment process by two independent gap processes.

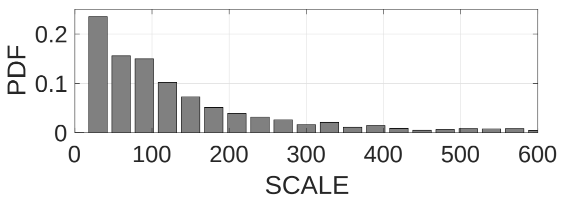


Figure 10: Distribution of free times of cash register (grouped) at grocery shop.

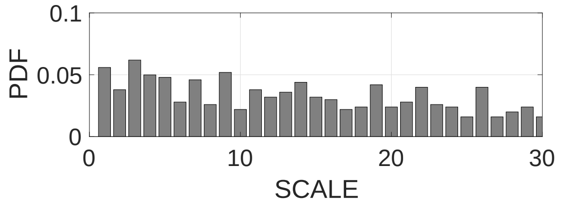


Figure 12: Distribution of free time duration up to 30 seconds (grocery shop).

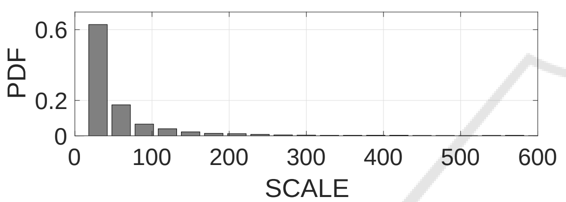


Figure 11: Distribution of free times of cash register (grouped) at the supermarket.

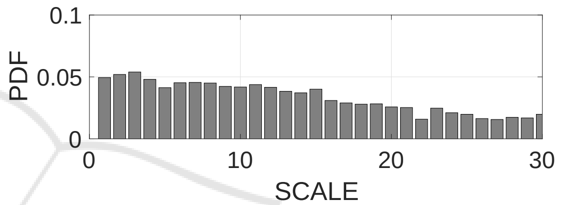


Figure 13: Distribution of free time duration up to 30 seconds (supermarket).

ment as well as staff who received a standardized training.

## 6 CONCLUSION

The work carried out within the present research allows establishing the inter-connections between bottleneck and burstiness. The theoretical analysis facilitated the creation of the model of shop sales process in 4 phases. In this work the waiting times in the queue to the cash register as well as the payment processing times at the cash register were studied and jointly modelled. The obtained results show that the payment processing times at the cash register are quite regular. However, analysis of the free time intervals at the cash register allow drawing the conclusion on its bursty behaviour. The bursty behaviour of the cashier free time intervals implies long breaks that alternate with many short breaks. The obtained parameters for bottleneck description within the defined internal factors were verified by the empirical data collected in grocery shops in Lithuania. The analysis of the collected data resulted in the conclusion that the level of burstiness depends on such factors as the consumer behaviour, the waiting times in the queue to the cash register, the payment processing time at the cash register and the performance of salesperson or cashier.

Table 7: Burstiness analyzing the buyers' service times.

| Shop | $m_1$ | $\sigma$ | $B$ |
|---|---|---|---|
| Grocery Shop | $32,1$ s | $5,1$ s | $-0,73$ |
| Supermarket | $30,8$ s | $7,1$ s | $-0,62$ |

The investigation carried out in this work results in differentiation between external and internal factors in shop sales. The theoretical analysis highlights three factors that influence shop sales, namely external factor such as a concentrated arrival of customers or shop visitors to the shop and internal factors such as waiting times in the queue to the cash register and payment processing time at the cash register.

The empirical study carried out in grocery shops in Lithuania allowed concluding that the burstiness parameter depends on consumer behaviour, performance of cash register and performance of salesperson or cashier. Further research will focus on widening the dataset for empirical studies.

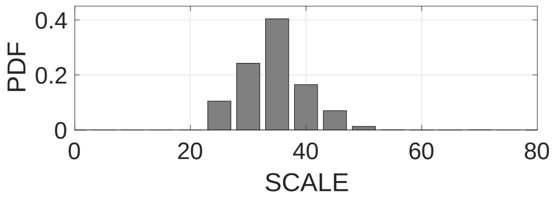


Figure 14: Buyers service time (grocery shop).

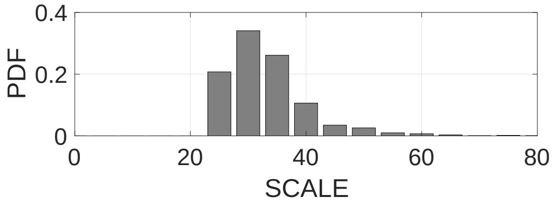


Figure 15: Buyers service time (supermarket).

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