## Sources of data
| Unnamed: 0 | Checkout preferences |  |
| --- | --- | --- |
| NaN | Number of items > 20 | Self-checkouts are only available for those, who have 20 items or less, therefore, their preference is in 100% of cases regular checkouts (checkout preferece = 1) (Tesco Vodňany, 2024) |
| NaN | 21 < Number of items > 10 | 27 % of customers definitely or rather prefer self checkouts, 39 % of customers definitely or rather prefer regular checkouts and for 34 % of customers the decision depends on situation (STEM/MARK, 2024). One of the decision factors for the "depends on situation" group is number of items (STEM/MARK, 2024). Let's suppose that with this amount of items, half of the group (17 %) prefers regular checkouts and the another half prefers self checkouts. In total, 44 % of customers should prefer self checkout and 56 % should prefer regular checkouts. This result can be reached by calculating the checkout preference with formula "=EXP(NORM.INV(NÁHČÍSLO(); 3,8; 0,9))" - the value Checkout preference (1-100) has then lognormal distribution with mean 3,8 and standard deviation 0,9. |
| NaN | 11 < Number of items > 0 | 27 % of customers definitely or rather prefer self checkouts, 39 % of customers definitely or rather prefer regular checkouts and for 34 % of customers the decision depends on situation (STEM/MARK, 2024). One of the decision factors for the "depends on situation" group is number of items (STEM/MARK, 2024). Let's suppose that with this amount of items, third of the group (11 %) prefers regular checkouts and the rest (23 %) prefers self checkouts. In total, 50 % of customers should prefer self checkout and 50 % should prefer regular checkouts. This result can be reached by calculating the checkout preference with formula "=EXP(NORM.INV(NÁHČÍSLO(); 3,9; 0,9))" - the value Checkout preference (1-100) has then lognormal distribution with mean 3,9 and standard deviation 0,9. |
| NaN | NaN | NaN |
| NaN | Number of items (basket size) | NaN |
| NaN | NaN | According to research, the basket size has mean of 14 items and standard deviation 15 (Martin et al., 2019). The number of items per basket has poisson lognormal distribution (Martin et al., 2019). |
| NaN | NaN | NaN |
| NaN | Customer satisfaction | NaN |
| NaN | Initial satisfaction | Customer satisfaction can be influenced by many factors not covered in this simulation, such as ambiance, atmospherics, location of the store etc. (Rajic & Dado, 2013). To reflect those factors in the simulation, an initial value of satisfaction is generated as a value with normal distribution with mean 80 and standard deviation 5. The mean and standard deviation values were set based on assumptions that people with lower level of initial satisfaction (not influenced directly by the current experience with service in the store, but rather with long-term experience) would decide to go to a competitor located in the same town. There is a competitor located righ next to the simulated supermarket, so the customers naturally choose a store they are relatively satisfied with. |
| NaN | Satisfaction change as a result of waiting | According to research, waiting time poses one of the most significant sources of discomfort for the customers (Pallikkara et al., 2024). The acceptable wait time without satisfaction penalty was set for 3 minutes. This value has been derived from the fact, that several czech supermarkets offer discount if the customer waits for longer time than 5 minutes. Based on this information, it is possible to suppose that 5 minutes of waiting can already lower customer's satisfaction. The original idea was to take half of that time as threshold for lowering customer satisfaction, but since the simulation is discrete, a whole number was needed - the threshold was rounded. If the customers wait for longer time, their satisfaction will drop based on the length of the waiting time. The longer the waiting time, the greater the satisfaction penalty - the growth of the penalty is more aggressive than the growth od the waiting time (Pallikkara et al., 2024) - therefore, the penalty has superlinear growth (10+n\*ln(n)). |
| NaN | Satisfaction penalty for switching checkouts | Customer can switch checkout is he calculates, that the new satisfaction will bring him better benefits than the current one. However, switching checkout is inconvenient - to some customers more than to others (which is defined by the value willingness to switch). The customers who decide to switch checkouts get a satisfaction penalty based on their propensity to switch checkout - the lower willingness to switch, the higher penalty for actually switching (random uniform distribution in within predefined range). There is also mechanism in the simulation, that prevents people with low willingness to switch from switching. Before a customer decides to switch checkout, there is a probability check - if willingness to switch checkouts is low, there's also low probability that the customer will swich even if it was beneficial for them. |
| NaN | Satisfaction change for type of checkouts | Most of the customers have a prefered checkout, however, for many of them, the preference is not strict (STEM/MARK, 2024). Therefore, the preference of a certain checkout is not represented by a boolean value, but rather by a scale from 1 to 100, where 1 represents a strict preference for regular checkouts and 100 a strict preference for self checkouts. A customer can decide to use a checkout of unpreferred type, if the queue at preferred checkouts is too long, however, there is a satisfaction penalty for this decision to consider. The penalty for choosing unpreferred checkout depends on how strongly the another type of checkout is preferred. If the customer is served at checkout of his preferred type, his satisfaction will increase (depending on how strongly he prefers the current type of checkout). |
| NaN | NaN | NaN |
| NaN | Checkout speed | NaN |
| NaN | Speed of self checkouts | Every customer has to pay, therefore, for each customer, there is a time dedicated to payment process in place. It takes longer time to pay on self checkout - usually, the process involves marking a loyalty card (in Tesco, most of the customers use it (Bachárová, 2023)), choosing payment type, actually paying and packing the purchased items. In some cases, there is an age control needed. The payment time also depends on ability of the customer to use the self checkout - therefore, the variance of the payment times is greater than at regular checkouts. By observation, it was determined that the payment process takes on average about 1,2 minute, with standard deviation of 0,3 minute. Marking the items takes some time as well and depends mainly on the number of the items in cart and on the type of goods. Generally, marking the items at self checkout takes longer time due to slow operation of the self checkout system. By observation, it was estimated that about 80 % of purchased goods is EAN coded and their marking takes shorter time. Marking those items takes on average about 4 seconds - 0,07 minute with mean 0,02 minute. Marking the items without EAN takes longer time, on average about 5 seconds - 0,08 minute, with mean 0,02 minute. About half of customers agee with the statement "self checkouts sometimes stops working and assistance is needed" - there is a certain probability that an error will occur when marking an item (STEM/MARK, 2024). For self checkouts, this probability is signicifantly higher than for regular checkouts, since there are unreliable ani-theft mechanism implemented. The probability of an error when marking an item was set for 0,1 %. If an error occurs, it takes some time to resolve it - usually about 30 seconds to solve (mean 0,5 minute, standard deviation 0,1 minute). |
| NaN | Speed of regular checkouts | Every customer has to pay, therefore, for each customer, there is a time dedicated to payment process in place. At regular checkouts, the payment time is usually shorter since the cashier is experienced, the age-control is not needed in most cases (cashier is able to select whose age needs to be checked and whose not), scanning the loyalty card takes shorter time and packing the purchased items can be packed while marking the items (which is not possible at the self checkouts). On the other hand, the payment time takes on average longer time due to payments in cash which are not possible at self checkouts and which significantly prolong the payment time. Based on observation and considering all the facts, the average payment time was set for 1 minute with standard deviation of 0,2 minute. By observation, it was estimated that about 80 % of purchased goods is EAN coded and their marking takes shorter time. Marking those items takes on average over 3 seconds - 0,06 minute with mean 0,01 minute. Marking the items without EAN takes longer time, on average about 4 seconds - 0,07 minute, with mean 0,01 minute. At regular checkouts, the probability of error is significantly lower than for self checkouts, however, an error can still occur. The probability of an error when marking an item was set for 0,01 %. If an error occurs, it takes some time to resolve it - usually about 30 seconds to solve (mean 0,5 minute, standard deviation 0,1 minute). |
| NaN | NaN | NaN |
| NaN | Operating hours | NaN |
| NaN | NaN | The operating hours of the simulated supermarket are based on real opening hours of Tesco Vodňany (7:00 - 20:00) (Tesco Vodňany, 2024) |
| NaN | NaN | NaN |
| NaN | Customer arrivals | NaN |
| NaN | Peak hours | The peak hours were derived from the real peak hours of the simulated store. The first peak hours (7:00 - 10:00) are caused by people who are going to work and buy breakfast and snacks, pensioners who prefer to go shopping in the morning and parents who prefer shopping before lunch. The second peak hours (16:00-18:00) are caused by people returning from work and stopping by to buy groceries on their way home. The number of customers coming to checkouts during the peak hours was set based on observation for mean 4 (with normal distribution and standard deviation 1). |
| NaN | Non-peak hours | During the remaining hours, the number of arriving customers was set to 2 with normal distribution and standard deviation 1. |

## Citations
| Unnamed: 0 | Unnamed: 1 |
| --- | --- |
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| NaN | Rajic, T., & Dado, J. (2013). Modelling the relationships among retail atmospherics, service quality, satisfaction and customer behavioural intentions in an emerging economy context. Total Quality Management & Business Excellence, 24(9–10), 1096–1110. https://doi.org/10.1080/14783363.2013.776759 |
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