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Influence of Innovative Digital Tools in Retail on the Purchasing Behaviour: An Empirical Study Based on a Customer Observation and on a Customer Survey

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Abstract: Digitalization is fundamentally changing the retail sector, presenting both companies and customers with new challenges and opportunities. Innovative digital tools, such as self-checkout systems, are becoming increasingly important and are not only influencing process efficiency but also the purchasing behaviour of consumers. This study examines the impact of digital innovations on the purchasing behaviour of customers in the retail sector and shows how modern technologies can supplement or even replace traditional structures. The aim of the study is to develop a deeper understanding of which factors promote or prevent the acceptance of digital systems and how these can be successfully integrated into practice. The study combines theoretical approaches with empirical findings in order to derive practical recommendations for the retail sector. Therefore, this study involves first observations in a supermarket aimed at capturing and interpreting consumer experiences in their natural context. Second a customer survey is conducted in the same supermarket. The findings reveal a picture of how digital tools, particularly self-checkout systems, influence customer purchasing behaviour in retail. In summary, while self-checkout systems offer significant benefits, their successful integration requires a balanced approach that addresses the diverse needs of all customer groups. By addressing these needs, retailers can maximize the efficiency and customer satisfaction of digital tools, ensuring their acceptance and long-term success in a rapidly evolving retail landscape.

Keywords: digital innovations; digital tools; purchasing behaviour; retail sector; self-checkout-systems

1 INTRODUCTION

Digitization has changed the retail sector enormously in recent years, with technological innovations such as self-checkout systems playing a key role. These systems allow customers to complete the payment process independently, potentially leading to shorter waiting times and a more efficient shopping experience. The retail sector is currently at an all-time high in the use of self-checkout technology. Over 5,000 shops in Germany already offer self-checkout options, an increase of 117 per cent compared to 2021 [1]. Despite this dissemination, questions remain about customer acceptance and the actual impact on purchasing behaviour. It is unclear how different customer groups react to this technology and what factors influence its use.

The aim of this study is to investigate how self-checkout systems affect people's shop-ping behaviour in the retail sector and what changes this technology brings to consumers' everyday lives. The focus is on analysing customer behaviour and preferences to better understand how these systems are used in practice and how they impact on the shopping experience. The goal of the study is to provide insights into the extent to which self-checkout systems are changing traditional shopping behaviour. It is looked on which factors determine the use of this technology in everyday life. This enables a deeper understanding of the interactions between customers and technology in the retail context.

2 LITERATURE REVIEW

2.1 Method and Focus of the Literature Review

The literature review of this study focuses on selected double blind peer-reviewed Journals included in VHB Rating 2024 [2] or in the "Resurchify" information portal [3]. The analysis presents an overview and insights into the research areas of digital innovation, retail management, and behavioural economics. A non-systematic literature review approach is applied, as it is more flexible and as it provides a broader overview [4, 5]. With regard to the selection of literature sources, the most important keywords which were searched were: "self-checkout" in connection with "supermarkets" or "technological progress". The search continued with "innovations in supermarkets", "customer behaviour in supermarkets" and "current changes in supermarkets". In the further process, it was searched for authors who have already published on the subject of "technology in retail". Due to this selection, a high-quality literature review could be carried out [6]. The four phases of designing, conducting, analysing and writing the review were employed to delve deeper into the fundamentals of "digitization in supermarkets" [7].

2.2 Retail, Digital Innovation and Customer Behaviour

Retail is a complex system that represents an exchange between sellers and end consumers, where products are provided to fulfil customers' needs. This requires a deep understanding of customer behaviour in order to create personalised shopping experiences and maximise the efficiency of sales channels. Today, a distinction is made between traditional retail and online retail (e-commerce). The current state of research in retail has changed significantly in recent years due to technological innovations and changing customer requirements. In particular, the integration of artificial intelligence (AI) and data-driven approaches plays a central role. The use of AI has expanded massively in the retail sector in recent years, enabling better analysis of customer behaviour and optimised processes [8]. Omni channel strategies in particular are a key element of modern retail research. Retailers are increasingly endeavouring to integrate various channels in order to meet changing customer preferences [9].

In order to achieve sustainable competitive advantages through efficiency and customer satisfaction, supermarkets are implementing more and more self-checkouts in practice [10]. As in practice consumers often favour technologies that

are intuitive and convenient to use, supermarkets see great potential in this technology. Factors such as technological infrastructure, employee acceptance and customer requirements play an important role in implementation. However, it should be noted that these technologies can not only reduce costs, but also bring new challenges, for example in terms of theft prevention and technological maintenance [11]. Integration into omni channel strategies and overcoming barriers to acceptance by customers and employees are key factors contributing to the success of supermarkets [12]. Overall, the research shows that technological developments in retail are currently one of the most important topics shaping the current time.

Digitalization has profoundly transformed the retail sector in recent years, redefining traditional business models. Studies on the development of digital business models show that retailers are compelled to adapt their strategies by integrating modern technologies to stay competitive. Key elements of digital transformation include digitized business pro-cesses like optimized supply chains, data-driven decision-making and innovative customer interactions [13]. These digital innovations enable retailers to improve efficiency and enhance customer satisfaction. Innovation thus provides stability, as it enables companies to swiftly respond to structural changes in the market and seize emerging opportunities early on. High flexibility allows a company to act more effectively than its immediate competition and fully exploit potential opportunities [10]. The current state of research on digital innovation in retail highlights the significant role of data-driven technologies and strategic approaches in enhancing competitive advantage [14]. Longitudinal studies indicate that data-driven innovation, coupled with marketing agility, is crucial for competitive advantage in a dynamic market. Agility and adaptability are particularly advantageous in times of market turbulence, helping firms respond effectively to consumer needs [15]. By being the first to introduce innovative services, companies can achieve significant competitive edges. However, imitators can also succeed through fast-follower strategies, allowing them to avoid the pit-falls of pioneers and respond more quickly to market needs [16].

Digital and innovative transformation not only reshapes business processes but also fundamentally changes consumer behaviour. Today's customers expect seamless experiences across multiple channels, a concept known as omni channel interaction. This involves integrating physical stores, online platforms and mobile applications to create a cohesive and personalized shopping experience. Research indicates that social media and data analytics play a crucial role in crafting these tailored shopping experiences. Retailers must increasingly adapt to these digital shifts and develop innovative strategies to meet the expectations of modern consumers [17]. Digital innovations using smart technology, such as self-checkout systems, are a particularly important topic. These simplify the shopping process by reducing waiting times and replacing traditional checkouts. They are part of a comprehensive strategy for 'smart retail', which includes personalized offers via apps, real-time order tracking and contactless payment. Such technologies improve efficiency and meet the expectations of digital accessible consumers in an increasingly tech-accessible retail landscape [18]. Digital innovations are therefore not just a tool for the external image of supermarkets, but an important step towards sustainable success. Self-checkout tills are the first step in modern checkout systems.

In the context of digital tools in retail, behavioural research explores how heuristics - mental shortcuts - affect purchasing decisions. For instance, self-checkout systems might reduce the perceived waiting time, influencing customers' satisfaction and future shop-ping behaviour. However, these heuristics can also introduce biases, such as anchoring or loss aversion, which impact choices related to product selection or impulse purchases [19]. The presentation or 'framing' of options in digital interfaces, such as promotional offers displayed on self-checkout screens, can significantly alter customer preferences and behaviours [20].

Social factors also play a crucial role in retail behaviour. Concepts like fairness and reciprocity may affect how customers perceive the use of self-checkout systems compared to traditional cashier interactions [21]. For example, some shoppers might prefer human interaction for a sense of fairness or out of social habit, while others may appreciate the efficiency and privacy of digital alternatives. This social dimension influences customer acceptance and satisfaction with innovative technologies [12].

Behavioural research further examines time-related trade-offs in retail. Self-checkout and other digital innovations can reduce perceived inconvenience and waiting times, thereby enhancing the overall shopping experience [22]. However, systematic biases, such as the tendency to undervalue future outcomes, might also influence decisions like participation in loyalty programs or adoption of new digital services [12].

Overall, applying behavioural economics in the retail sector offers practical insights into how digital tools reshape customer experiences and purchasing behaviour [23]. This understanding can inform more effective implementation strategies for self-checkout systems, personalized marketing and other technological innovations, ultimately improving customer satisfaction and driving business success [24].

2.3 Retail, Digital Innovation and Customer Behaviour

Based on the theoretical insights, the following four specific research guiding questions (RQ1, RQ2, RQ3 and RQ4) were formulated to guide the empirical investigation of this study:

- RQ1: Do customers favour digital tools over traditional options when paying in supermarkets? Why or why not?
- RQ2: Does the age of the customer influence the choice of checkout when paying in supermarkets?
- RQ3: Does the number of items purchased influence the choice of checkout when paying in supermarkets?
- RQ4: How does the average waiting time at self-checkouts differ from the waiting time at conventional checkouts in supermarkets? How do the average waiting times change at peak times?

With these five research guiding questions the study addresses specific aspects that have not been fully explored in previous studies on self-checkout systems. It examines how demographic factors, such as age and familiarity with

technology, influence the choice between self-checkout and traditional checkouts. Additionally, it explores the impact of purchase size on checkout preferences and assesses how important the availability of both checkout options is to customer satisfaction. By focusing on these behavioural and situational factors, the survey provides deeper insights into the adoption and integration of digital tools in retail.

3 METHODS

3.1 Customer Observations

First this study involves *observation*s aimed at capturing and interpreting *consumer* experiences in their natural context. This approach enables observers to see how consumers interact with the self-checkout service. The focus is on uncovering the interactions between various actors within the consumption ecosystem. This method complements traditional surveys by not only documenting consumer experiences but also capturing their behaviours and the influences of other actors during the consumption process [25]. The aim of the observation in this study is to investigate the average waiting times of customers at the conventional checkout and at the self-checkout. In total 200 customers are observed on the 11th of November 2024 between 1 pm and 3 pm in a supermarket in Heilbronn, Germany. The survey period is deliberately chosen on the assumption that people tend to go shopping on Mondays, as shops are closed on Sundays. This is done with 100 people at a normal time (3 pm) and 100 people at the rush hour (6 pm) when there is a very high volume of customers. Particular attention is paid to queuing time and handling time so that a total time for the process can be determined in the end. Special incidents are also noted. Stopwatches, a note log and a table for data recording are available. The observation process includes the start of the queueing time, the end of the queueing time/start of the processing time and the end of the processing time. The resulting data forms the ideal basis for analysing and comparing the two checkout types.

3.2 Customer Survey

Second a *customer survey* is conducted in the same supermarket in Heilbronn, Germany, as well on the 11th of November 2024. Before participating, customers are pre-screened based on their apparent age and willingness to take part. The survey is conducted primarily through an online questionnaire. The persons carrying out the questionnaire ask customers directly after their shopping experience, where they still have the most memories. The questionnaire is either filled out by the respondent directly or on a mobile device by a responsible person from the survey team, who enters the data of the respondents so that the customers did not have to fill in the questionnaire themselves. For participants less familiar with digital tools, for example, such as older customers, direct interviews are conducted by the survey team. To ensure efficiency and comfort, respondents are guided through the questionnaire by the survey team using a mobile device, with the survey team reading out and explaining the questions directly. A mixed-methods approach is employed for the questionnaire [26]. Open-ended questions are posed, allowing customers to share their shopping experiences through self-checkout systems. Additionally, specific questions are included to gather precise in-formation, such as the number of items customers purchased [27, 28]. Firstly, demographic questions were answered. After that, the customers are asked which type of cash register they have chosen. Depending on the answer, the questionnaire is divided into the self-checkout and conventional checkout stands. The customers describe their shopping experiences and impressions. Finally, the customers state whether the choice between the different checkout options is important to them. A total of 103 customers participate in the survey, reflecting a diverse demographic pro-file. The respondents have an average age of 43, ranging from 7-12 years to 65+ years. The gender distribution is 50,5% male, 47,6% female and 1,9% diverse. The data collected was analysed in several steps. Firstly, the questionnaires were digitally recorded and stored in a structured database. Quantitative data such as preferred checkout type, waiting times and demographic information were analysed using statistical methods to identify key trends and patterns. Qualitative responses to open-ended questions were analysed to understand common themes, opinions and suggestions for improvement. The results were analysed both numerically and graphically to make the presentation clear and understandable.

4 RESULTS

The efficiency of new technologies in supermarkets often plays an important role, as it usually determines whether these technologies will prevail in the long term. In addition to the monetary factor, throughput and time savings are usually an important object of investigation [29]. In order to be able to measure the time differences, the queuing time, the processing time and the total time of 50 people each were measured at the self-checkout checkout and at the conventional checkout in a supermarket in Heilbronn, Germany. This was carried out at a normal time (3 pm) and at rush hour (6 pm). Considering the average waiting time, customers queued for 3 minutes and 10 seconds at the conventional checkout. At the self-checkout this time is reduced to 14 seconds. During the rush hour, the observed waiting time increases by 19,47% to 3 minutes and 47 seconds at the conventional checkout and by 114,29% to 30 seconds at the self-checkout. As it can be seen (Tab. 1) the queue time at the normal checkout is significantly higher at both normal and peak times, suggesting that the self-checkout queue is significantly shorter. During rush hours, the queue times at both checkouts also increase, which can be attributed to a higher observed volume of customers.

Table 1 Waiting time (in min)

	Self-Checkout	Cash register	Change (%)
Normal Time	0:14	3:10	1257,14
Rush Hour	0:30	3:47	656,67
Change (%)	114,29	19,47	

Considering the average processing time, the results here are the other way round (Tab. 2). Here the processing time is 1 minute and 8 seconds at the conventional checkout, while it is 3 minutes and 8 seconds at the self-checkout. This picture can also be seen during rush hour. During this time, the

processing time at the conventional checkout increases by 11,76% to 1 minute and 16 seconds and decreases by 6,91% to 2 minutes and 55 seconds at the self-checkout. It can be seen that the processing time of the normal checkout is 63,83% lower than that of the self-checkout during normal hours and 56,57% lower during peak hours.

Table 2 Processing time (in min)

	Self-Checkout	Cash register	Change (%)
Normal Time	3:08	1:08	–63,83
Rush Hour	2:55	1:16	–56,57
Change (%)	–6,91	–11,76	

One reason for the longer processing time at self-checkout may be that 35% of the self-checkout users surveyed said that they only use it occasionally and 9% use it rarely (Tab. 3). This suggests that many shoppers are unfamiliar with the technology and need more time to complete the process than a trained cashier at a conventional checkout.

Table 3 Frequency of self-checkout usage

How often do you use Self-Checkout?	*n*	%
Always	7	15
Often	19	41
Occasionally	16	35
Rarely	4	9
Never	0	0
Total:	46	100

If now considering the total time for the two checkout types, it can be seen (Tab. 4), that the total time for the conventional checkout is 27,72% higher than for the self-checkout during normal hours. The total time also increases during peak hours. An increase of 49,27% is measured here. Overall, therefore, it can be seen that customers need more time to complete the checkout process at the normal checkout both at normal times and during the peak hours. It can also be seen that the total time spent at normal checkouts is 18,60% longer than at peak times. At self-checkout, however, the increase is only 1,49%. This shows that, on average, shoppers lose less time during the rush hour than at the conventional checkout.

Table 4 Total time (in min)

	Self-Checkout	Cash register	Change (%)
Normal Time	3:22	4:18	27,72
Rush Hour	3:25	5:06	49,27
Change (%)	1,49	18,60	

The customer survey in the same supermarket in Heilbronn, Germany, identifies primary reasons for choosing self-checkout and highlights its practical benefits. Customers were asked about their main reasons for choosing a self-checkout. The most frequently cited factors include shorter queue (80%), faster payment process (50%) and flexibility, e.g., to scan and pack at one's own pace (approximately 40%). These features align closely with the objectives of digital tools, which aim to enhance efficiency, save time and offer a more tailored shopping experience. Self-checkout systems were most popular among younger age groups (26-35 years and 19-25 years), indicating that digital natives are more inclined to adopt innovative technologies (Fig. 1).

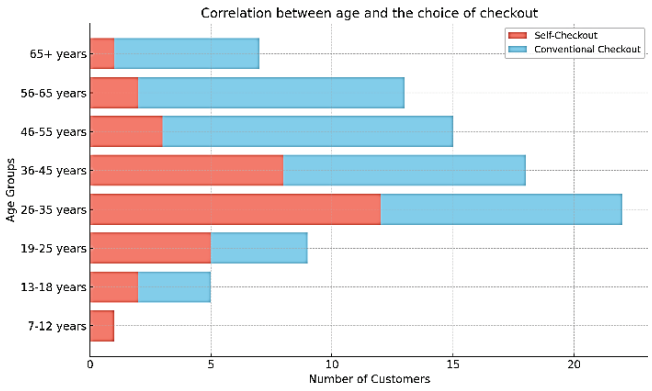

Figure 1 Connexion between age and the choice of checkout

Most respondents stated that they had chosen the conventional checkout. 46 of the 103 respondents stated that they had used the self-checkout. This means that 23,91% of respondents selected the conventional checkout. It can also be seen that the conventional checkout was chosen most often in the 26-35 age group with 24,6%, followed by the 56-65 age group with 19,3%. Self-checkout was used most frequently by the 26-35 age group with 26,1%, followed by 19-25 years with 21,7%. The result could be due to the increasing tendency towards self-checkouts among younger age groups, particularly up to the early thirties. While the older age groups from their mid-thirties to mid-sixties show a stronger preference for traditional checkouts. The age group from 26 to 35 is strongly represented in both categories, but has a higher distribution in traditional checkouts. This indicates that the choice of checkout is strongly dependent on familiarity with digital technologies and convenience preferences.

Familiarity with self-checkout systems played a key role in their usage: respondents who described themselves as "very familiar" or "rather familiar" with the technology were significantly more likely to choose self-checkout. This familiarity fosters confidence and efficiency, as experienced users can navigate the system with ease. In contrast, those who identified as "not familiar" often took more time at the self-checkout, which may explain the longer average processing times compared to traditional check-outs.

Despite the growing availability of self-checkout systems, a significant proportion of customers continue to prefer traditional checkouts; 55,3% of respondents chose this option. Several factors contribute to this preference, highlighting the enduring importance of human interaction and familiarity in the shopping experience. First, personal contact with checkout staff remains a key reason for favouring traditional checkouts. Many customers value the social interaction and the sense of support provided by trained personnel, particularly in resolving issues or ensuring a smooth payment process. Additionally, traditional checkouts are particularly favoured for larger purchases, where staff assistance in scanning and packing items significantly eases the workload for customers. Furthermore, technological familiarity plays a crucial role. Older generations or less tech-savvy individuals often perceive traditional checkouts as a simpler and more reliable option, avoiding the potential stress or errors associated with using self-checkout technology. The importance of habit is also

evident, as long-standing customers often prefer the routines they are accustomed to, finding comfort in the predictability of traditional checkout systems. Lastly, the desire to avoid technical difficulties, such as malfunctioning scanners or user errors, further solidifies the preference for conventional cashiers. These systems are perceived as more efficient and problem-free, especially by those who may lack confidence in their ability to navigate digital tools effectively (Fig. 2).

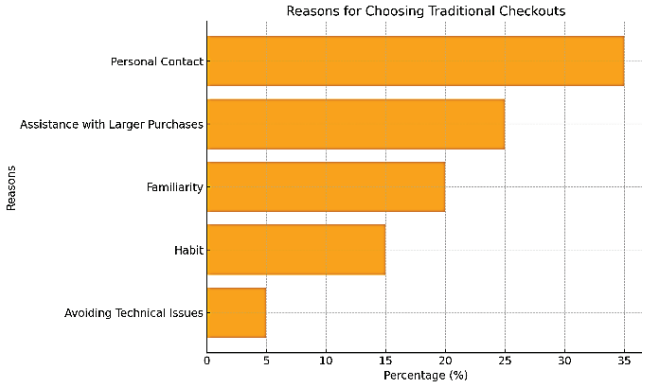

Figure 2 Reasons for choosing traditional checkouts

The data underscores the need for retailers to maintain a balance between innovative technologies and traditional services, catering to the diverse preferences and expectations of their customer base.

Next, this study looked at whether the number of items purchased had an influence on the choice of checkout. The analysis (Table 5) reveals a clear trend: as the number of items increases, the preference for conventional checkout also rises, while self-checkout is predominantly chosen for smaller purchases. For purchases of 1 to 10 items, over 80% of customers choose self-checkout. However, starting from 11 items, the preference for self-checkout decreases significantly, with conventional checkout becoming the preferred option, especially for purchases of 21 items or more (over 86%). These findings suggest that customers may be looking for personal interaction or assistance at the checkout for larger purchases, while preferring faster self-service for smaller purchases.

Table 5 Influence of the number of articles on the choice of cash register

Number of articles	Self-Checkout	Conventional checkout	Total (2 + 3)	Self-Checkout (%)	Conventional checkout (%)
1	2	3	4	5	6
1-3	5	1	6	83,33	16,67
4-10	19	4	23	82,61	17,39
11-20	17	18	35	48,57	51,43
21-50	4	25	35	13,79	86,21
>50	1	9	29	10,00	90,00
Total	46	57	103		

Then the question of whether the choice between self-checkout and conventional checkouts is important was asked. 42,7% of respondents stated that the choice was important to them. Surprisingly, less than 50% voted that the choice of checkout was important to them. People who categorise themselves as 'very familiar' or 'rather familiar' are more likely to answer 'YES' (75% or approx. 61,54%). People with lower familiarity tend to answer 'NO' significantly more often (approx. 64,29% and approx. 89,66%). A possible implication can be assumed. Familiarity seems to correlate with the assessment of the importance of the option. The more familiar someone is with self-service checkouts, the more likely it is that they consider the option to be important.

5 CONCLUSIONS

5.1 Discussion

The findings of this study reveal a picture of how digital tools, particularly self-checkout systems, influence customer purchasing behaviour in retail. While 55,3% of respondents still opted for traditional checkouts, 44,7% chose self-checkout systems. On one hand, the data high-lights the substantial advantages these innovations provide, such as shorter queue times and greater autonomy, which relates strongly with younger, tech-savvy customers. On the other hand, the longer processing times and the dependence on costumers' familiarity with the technology are obstacles for a broad acceptance (RQ1).

The findings from the survey at Edeka Heilbronn demonstrate the increasing influence of digital innovations, such as self-checkout systems, on customer behaviour and preferences. While 55,3% of respondents still opted for traditional checkouts, 44,7% chose self-checkout systems

The adoption of self-checkout systems appears to be influenced by demographic factors, such as age and familiarity with technology. (RQ2) Younger generations, often referred to as digital natives, demonstrate a higher likelihood of choosing self-checkout due to their comfort with the technology. Older customers or those less familiar with self-checkout tend to favour conventional checkouts, due to a preference for personal interaction and support. This divergence underscores the importance of addressing both generational and experiential differences when implementing such technologies.

Another notable observation is the strong connexion between the size of a purchase and checkout preference. While self-checkout systems excel in efficiency for smaller purchases, conventional checkouts remain the preferred option for larger purchases with assistance in scanning the large amount of products. This suggests that while self-checkout systems enhance convenience for quick transactions, they do not yet serve as a comprehensive replacement for conventional checkouts (RQ3).

The longer processing times at self-checkouts compared to conventional checkouts indicate a significant limitation. This discrepancy can be attributed to two factors: the learning curve associated with using new technology and the occasional need for staff intervention in cases of errors or technical issues. These challenges highlight an area where retailers must focus on improving usability and providing better support to first-time or in-frequent users. But when speaking about time, the study still showed that the total time on the self-checkouts are shorter, which is due to the fact that the queue is shorter than at the conventional checkout. From a business perspective, the data presents an opportunity for retailers to streamline their operations. While self-checkout systems offer queue time reductions, their longer processing times reduce the overall efficiency gain. Addressing these

inefficiencies can unlock greater potential for these systems (RQ4).

In summary, while self-checkout systems offer significant benefits, their successful integration requires a balanced approach that addresses the diverse needs of all customer groups. By addressing these needs, retailers can maximize the efficiency and customer satisfaction of digital tools, ensuring their acceptance and long-term success in a rapidly evolving retail landscape.

5.2 Limitations and Future Research

This study has some limitations that may affect the interpretation of the results. The size amount of people participated in the survey was rather small and limited to one supermarket in Heilbronn, which limits generalisability. Future studies could include larger and more diverse samples from different locations. As the study period was limited to one day, longitudinal studies could also help to better understand seasonal and long-term changes in behaviour.

In addition to the aspects analysed, it would be interesting to investigate how the introduction of self-service checkouts affects sales and goods throughput. It could also be investigated whether the use of such technologies could replace staff in the long term and what the social and economic consequences of this would be for the retail sector. Such findings could provide valuable information for strategic planning in the sector.

5.3 Practical Implications

The results extend the understanding of the interfaces between digital innovation and consumer behaviour. There are recommendations for retailers on how to implement and optimise self-service checkouts. Targeted customer training on how to use the technology and a more intuitive design could improve adoption and efficiency. In addition, companies should strategically plan the introduction of such technologies in order to secure economic benefits and increase customer satisfaction without neglecting social factors.

Increasing technological change in retailing raises social issues, particularly in terms of potential job losses or loss of human interaction. It is important to minimise potential negative social impacts through social measures and appropriate integration of technologies into existing work structures. At the same time, such technologies offer the opportunity to improve working conditions by reducing the burden of routine tasks. And in times of shortage of skilled staff self-service checkout can be one solution for the retail sector.

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