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Proposal of innovative smart solutions for retail store in order to support competitiveness and sustainable development

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The Internet of Things (IoT) is becoming an increasingly important concept in various areas of our daily lives. With the development of information and communication technologies, the possibilities of IoT implementation are also expanding. The retail sector is also starting to make more significant use of IoT to improve and increase the efficiency of its business processes and more effective interaction with customers. Even though several partial IoT solutions have been implemented in retail, according to publicly available sources, there is no comprehensive IoT implementation in this sector. Therefore, we focused on the possibilities of creating a comprehensive proposal for the use of IoT in a retail enterprise in Slovakia. The main reasons for this transformation are the development of intelligent technologies, the increased demand of consumers for more convenient purchases and the efficiency of business processes, as well as to increase the competitiveness of the company. The aim of the contribution is to create a proposal for the implementation of IoT in retail, which will contribute to the sustainable development and competitiveness of the company. The result of the contribution is the creation of a proposal for the integration of the Internet of Things in retail, while the proposal is also applicable in other similar enterprises. The research methodology includes secondary sources and primary inquiry using an online questionnaire. The results of the primary research showed that a large part of respondents are interested in using IoT solutions in retail and that the implementation of these solutions affects their purchasing behavior. The conclusions of the paper indicate that the implementation of IoT solutions in retail would have a positive impact on the competitiveness of businesses. Factors that influence the choice of brick-and-mortar and online stores by customers were also identified. Customers' interest in IoT solutions, as well as their preferences when choosing stores, represent a guideline for businesses operating in the retail sector. The implementation of the proposed solutions is relatively demanding on financial resources, therefore a good financial condition of the company is a necessary condition. Further research should focus on the security risks, barriers, ethical privacy issues associated with the use of IoT in retail stores.

KEYWORDS

Internet of Things, retail, smart retail, sustainable development, competitiveness, IoT

1 Introduction

The Internet of Things is a term that is increasingly appearing in almost all areas of everyday life. The development in the field of information and communication technologies is related to

the expansion of possibilities and areas where the Internet of Things can be implemented. These areas also include retail, where merchants, in addition to storage and logistics, are also starting to implement the Internet of Things within stores, for example to improve and streamline business processes or for better interaction with customers.

Based on the information available, it appears that the retail sector has not yet fully embraced the Internet of Things (IoT) technology, with most retailers only utilizing a limited number of available solutions. Given the importance and relevance of this topic, the authors of a paper have developed a prototype proposal for implementing IoT technology in a specific company located in the Slovak Republic. The proposal is based on theoretical foundations, market research, and the unique characteristics of the company in question.

The use of IoT in retail is becoming more and more popular, based on the wide range of possibilities and improvements that IoT offers. In addition to the implementation of various solutions within e-commerce, active digitization and automation within brick-and-mortar stores is also growing. Among the main reasons for this transformation are the development of smart technologies, the growing demand of consumers for more convenient and faster purchases and the efficiency of individual processes within enterprises (Lin et al., 2019). It is necessary to point out that in individual cases it is not a complex use of the Internet of Things for individual companies. Working with the idea of how, in addition to logistics, it is possible to implement other Internet of Things solutions in the environment of online and brick-and-mortar stores is challenging for many retail businesses. However, businesses can gain a competitive advantage, greater flexibility, and visibility of individual processes and, ultimately, customer satisfaction (Roe et al., 2022) by automating and digitizing retail processes.

The Internet of Things can be considered an ever-new term that cannot be clearly defined, especially due to the vastness of the issue, its constant development, and the lack of standardization (Nord et al., 2019). Experts and renowned companies focused on the field of Internet of Things have formulated several definitions, which are presented in the following paragraphs. Oracle defines the Internet of Things as "a network of physical objects, things that, with the help of sensors, software and other technologies, serve to acquire and exchange data and information with other devices and systems via the Internet" (Oracle, 2023). According to the International Telecommunication Union (ITU), the Internet of Things can be viewed as "a global infrastructure for the information society that enables advanced services by interconnecting physical and virtual things based on existing and evolving interoperable information and communication technologies" (Zennaro, 2016). For the needs of the problem being addressed, the definition from the European Technology Platform for the Integration of Intelligent Systems (EPoSS) can be considered the most suitable: "The Internet of Things is a network of interconnected objects (things) that are uniquely addressable, with the fact that this network is based on standardized communication protocols enabling exchange and sharing of data and information, the analysis of which will make it possible to achieve higher added value" (Pohanka, 2023). It is not easy to specify the concept of the Internet of Things with one unambiguous definition that would allow understanding the meaning and principle of the Internet of Things. Companies and institutions interpret this term differently, also based on the number of areas that the Internet of Things affects (Feng L. et al., 2020). The essence of the definitions lies in the fact that the Internet of Things represents clearly addressable objects that are interconnected and communicate via the Internet using a wide range of technologies, intended mainly for the unambiguous identification of objects, mutual communication, generation, storage, processing and access of data and subsequent autonomous operation objects (Ramson et al., 2020). Within this area are offered:

- Identification technologies – include objects that must be clearly addressable and thus must have a unique identifier based on which it is possible to communicate with the given object (Wang et al., 2020). These are Internet protocols IPv6, which, in addition to the availability of huge capacity, provide up to 100 possible IP addresses for every atom on the surface of the Earth. They also support automatic configuration, integrated security, and new mobility functions, which enables a higher level of network complexity (Haggag, 2023).
- Communication technologies – represent interconnection and communication between objects as a key prerequisite for the successful deployment of the Internet of Things. Each technology has its own specifications, based on which it is possible to determine for which environment and for which IoT implementation scenarios it is suitable (Liu et al., 2020). There are six main wireless communication technologies available. Certain areas of use are typical for individual communication technologies based on different specifications (Le et al., 2019).
- Sensors – are simple devices that transform physical variables into electrical signals or changes in electrical properties. IoT sensors transform the variables they measure into digital data streams intended for transmission to the gateway (Kalsoom et al., 2020). Among the most used types of sensors within the IoT are, for example, temperature, pressure, optical, infrared sensors, humidity sensors, proximity, level or accelerometers and gyroscopes (Andreev et al., 2020).
- Cloud computing – a centralized system that helps deliver and transfer data and various files over the Internet to data centers. Access to various data and programs can be easily obtained through the cloud system (Surbiryala and Rong, 2019). Cloud computing aims to provide computing services, including servers, storage, databases, networks, and software through the cloud. Cloud computing offers faster innovation, flexible resources, and economies of scale (DeepShah, 2021).
- Big data – data that is generated in huge quantities by objects of the Internet of Things. This is the so-called Big data. Big data represents a set of structured, unstructured, and semi-structured data, usually in the size of petabytes and gigabytes (Rialti et al., 2019). Big data and its analysis are a key factor in the analysis of generated data within the Internet of Things, which leads to the optimization of processes and decision-making. The task of Big data is therefore the processing and analysis of a large amount of data in real time through special software tools and technologies (Al-Sai et al., 2022).

The terms digital transformation, automation, logistics and storage are closely related to the issue of the Internet of Things (Reinartz et al., 2019). Digital transformation uses technology to create new values and services for stakeholders to innovate and acquire capabilities for rapid adaptation to changing circumstances (Dang-Pham et al., 2022). The implementation of automation technologies, techniques and processes increases or creates efficiency,

reliability and speed of tasks that were previously performed by humans, respectively tasks that could not be performed before (Sundari et al., 2021). Within logistics, it is necessary to monitor several activities at the same time, for example supply chain or storage (Tran-Dang et al., 2022). The implementation of IoT solutions in the framework of storage leads to transformations into so-called smart storage. Smart storage represents complete or partial automation of all warehouse processes and activities through the integration of new technologies to increase productivity and reduce costs (de Vass et al., 2020). The implementation of IoT solutions within storage is a key factor for ensuring competitiveness, or increasing it (Sun et al., 2020).

In the field of retail, implemented IoT solutions are mostly focused on logistics, storage, and process optimization (Har et al., 2022). Currently, merchants have already discovered the potential of solutions and IoT implementations are also taking place in other online and offline areas within the retail trade, but the presence of a certain methodology prior to the implementation of selected elements in the company's activities is absent (Xu J. Q. et al., 2020). Effective smart solutions and applications of the Internet of Things for retail represent: Smart warehouse, RFID tags, Sensors and cameras, Smart shelves, Smart mirrors and screens, Wearable devices, Navigation, Beacons, Smart price tags, Barcode, Smart shopping, Online environment, Virtual shopping, Manual personalization, Mobile application (Fernandes and Morais, 2021). The implementation of individual solutions in retail depends on various factors, such as the area in which the company operates, the size of the sales area, the size of the warehouse, the type of assortment sold, the technical and digital skills of the employees, but also on whether the company only has a brick-and-mortar store or an online store or hybrid sales method, i.e., that it has a physical store as well as an online store (Kaur et al., 2022).

Thanks to the development of information and communication technologies, new possibilities for the sale of goods have arisen. Virtual and online technologies have enabled the creation of new channels, traditional retailers have started selling via the Internet and have become multi-channel retailers (Zarifis, 2019).

Multichannel retailing is a strategy in which retailers use multiple independent channels to reach customers and sell their products or services (Liu et al., 2018). These channels can include physical stores, online stores, mobile apps, catalogs, social media, call centers, and other platforms (Cicea et al., 2023). The goal of multi-channel retailing is to provide customers with more convenient and flexible purchasing options, thereby increasing the retailer's reach and improving the customer experience (Thaichon et al., 2022).

Based on a similar principle, but with some significant differences, the Omnichannel approach in retail represents an integrated customer experience across different channels. The goal is to provide customers with a consistent and connected experience regardless of where and how they choose to shop or interact with a retailer. The difference between a multichannel and an omnichannel approach in retail lies primarily in the levels of integration and customer experience (Thaichon et al., 2022; Cicea et al., 2023).

In a multi-channel approach, retailers use multiple sales and communication channels, but these channels often operate independently or with minimal integration. Customers can shop in different channels, such as physical stores, online sites, or mobile apps, but their experience and interaction with each channel can be different. Data and information obtained from individual channels are not necessarily shared or used across other channels (Liu et al., 2018; Hussein and Kais, 2020).

An omnichannel approach focuses on integrating and harmonizing all channels to ensure a coherent and seamless customer experience. It does not matter through which channel the customer accesses the retailer; can start a process in one channel and finish it in another with a smooth transition between channels (Asmare and Zewdie, 2022). Data about customers and their interactions are shared and used across all channels, enabling personalization and increased efficiency in customer service (Cicea et al., 2023). An omnichannel approach allows customers to interact with the retailer in different ways, such as buying a product online and picking it up in a brick-and-mortar store, or viewing a product in-store and then purchasing it online (Iglesias-Pradas and Acquila-Natale, 2023). This approach also helps retailers to better understand their customer's preferences and purchasing behavior by analyzing data from different channels, which can lead to more effective marketing strategies and personalized offers (Stojković et al., 2016).

In multichannel and omnichannel retailing, pricing for the same products sold through different channels is important. When buying clothes or perfumes, customers prefer a brick-and-mortar store to try the products and therefore accept a higher price in a brick-and-mortar store compared to an online store. On the contrary, if, for example, access to a brick-and-mortar store is difficult, customers will prefer an online store and accept a higher price for products (Nazari et al., 2023). Returning goods is also related to online shopping. People often order multiple sizes of one product, keep only one product size, and return the other product sizes to retailers. There are risks associated with returning orders, such as the returned goods being damaged, dirty, or missing some parts of the product. Retailers also need to focus on the reverse logistics system and on creating a system so that customers cannot return one order multiple times through different channels, and thereby causing a loss to the retailer (Zhang et al., 2023).

As part of the implementation of IoT solutions in areas where interactions with customers take place, the digital skills of the residents of individual countries and the created environment and support from the state are also important factors (van Deursen et al., 2019). The creation of adequate conditions by the state and residents with digital skills enable not only simpler implementation of IoT, but subsequently, in combination with effective and functional IoT solutions, also conditions for the growth of the competitiveness of individual enterprises within the framework of strong competition (Lee, 2019).

Comparing countries from the point of view of the Internet of Things is not easy, mainly because there is no direct assessment of the readiness and level of implementation of the Internet of Things in individual countries. However, there are evaluations available that are focused on digital transformation, competitiveness, the use of information and communication technologies, i.e., they evaluate areas closely related to the Internet of Things. Among the most important assessments are the NRI, DESI, Cisco Digital Readiness, GII and the IMD World Digital Competitiveness Ranking (Stavytskyy et al., 2019; Veselica, 2019).

In the following part, the authors of the article focused on the NRI Index, which is considered one of the most comprehensive assessments of readiness for ICT implementation, and more and more governments of individual countries are using it as the basis of their national ICT strategies (Silvia et al., 2022). The NRI index consists of four basic areas, which are Technology, People, Governance and Impact (Dutta

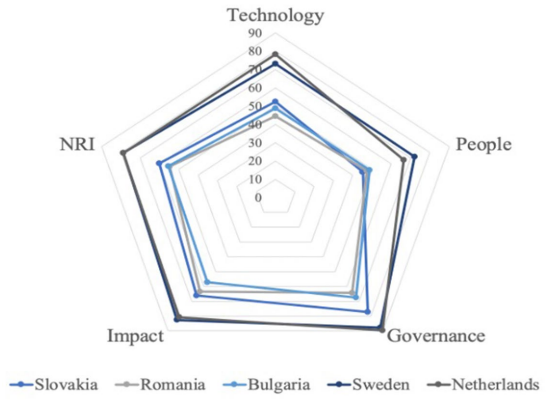

FIGURE 1
Comparison of selected countries in the NRI 2022 index.

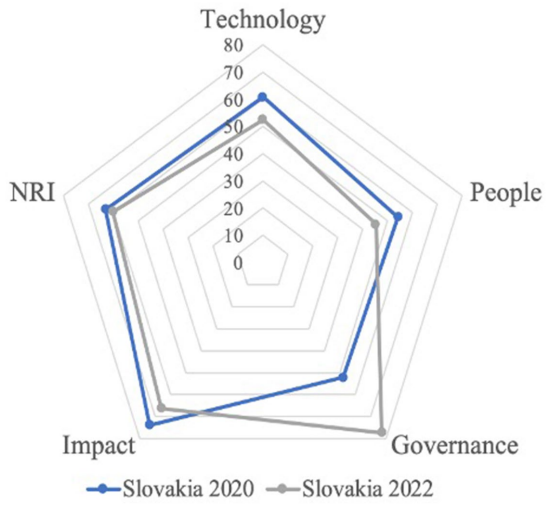

FIGURE 2
Comparison of the ranking of the Slovak Republic in the NRI index 2020 and 2022.

and Lanvin, 2020). Each of the basic areas consists of 3 sub-areas, which are shown in the following figure (Dutta and Lanvin, 2022). In addition, individual subareas are made up of more than sixty other indicators. The NRI index includes an assessment of 133 countries, which represents 98% of world GDP. For the needs of the concept of solving the issue, only member countries of the European Union were selected. The results of selected countries within the NRI 2022 index are shown in the Figure 1 (Dutta and Lanvin, 2020; Dutta and Lanvin, 2022).

In connection with the investigation of the index, the authors focused on the best rated countries, the EU average, Slovakia, and the countries with the lowest rating. Among the best rated countries are Sweden and the Netherlands. Sweden ranked first in the EU and scored 78.91 points. The Netherlands took second place and scored 0.9 points less than Sweden. Both countries scored best in the Public Administration pillar. Slovakia and the two worst rated countries, Bulgaria, and Romania, lagged the EU average, which reached the level of 66.5 points. Slovakia received the most points in the Public Administration pillar, with a total rating of 60.27 points. Bulgaria took the penultimate place with a score of 55.51 points. Romania took the last place and scored 54.89 points. Both countries scored best in the Public Administration pillar. A comparison of the achieved rating within the NRI index from the point of view of the Slovak Republic is shown in the Figure 2 (Dutta and Lanvin, 2020; Dutta and Lanvin, 2022).

In the year-on-year comparison of the rating of the Slovak Republic in the NRI 2020 and 2022 indexes, it achieved an improvement in the rating only within the Public Administration pillar. In all other assessed pillars and in the overall rating of the index, the country recorded a year-on-year deterioration in its rating. In both comparative assessments, the Slovak Republic received the best assessment within the Public Administration pillar. The country achieved the worst rating in the People pillar. In 2022, the Slovak Republic lagged the EU average by 6.71 points and in 2020 by 6.23 points (Dutta and Lanvin, 2020; Dutta and Lanvin, 2022).

The Internet of Things connects the physical world with the virtual one, bringing new and extensive possibilities (Xia, 2020). There is mutual connection and communication between clearly addressable objects, while communication can take place through different technologies. An important role in the implementation of IoT is also played by the digital skills of the inhabitants of individual countries, as well as the created environment and support from the state (van der Zeeuw et al., 2020). The implementation of IoT solutions allows retailers to save time and costs, but also to gain a competitive advantage (Shankar et al., 2021). Smart solutions can be implemented both online and offline. From the global point of view of the country, the industry, it is possible to consider the share of brick-and-mortar and online stores. The implementation of IoT solutions within retail should also be adapted to the stated fact (Huterska and Huterski, 2022).

2 Materials and methods

The main goal of the contribution of the author's collective is the proposal for the implementation of IoT solutions in a specific enterprise, to create a prototype for other or similar types of enterprises in the retail trade. The contribution is, among other things, focused on the Internet of Things and smart solutions that can be implemented in retail and the analysis of the current state in the digitalization of the economy and society. The reason for focusing on IoT solutions is that they enable retailers to streamline and improve activities not only within the company, but also activities that involve interaction with customers. These solutions also contribute to increasing competitiveness and sustainable development. The object of investigation is a specific enterprise and the possibilities of implementing IoT solutions in its enterprise. Secondary sources and foreign authors, available mainly in the Web of Science database, related to the issue of the Internet of Things and its implementation in retail became the main pillar for processing the proposal.

In order to fulfill the main goal and associated sub-goals, it was necessary to use several scientific and research methods: extraction method (study of literature, processing of book and internet resources as part of the development of theoretical starting points and analysis of the current state), synthesis method (processing of the proposal for the implementation of the Internet of Things in the selected enterprise and when unifying the obtained theoretical information), method of abstraction (collection and subsequent processing of information

related to the problem being solved), method of analysis (evaluation of the current situation in connection with the problem being solved within the framework of the Slovak Republic and the countries of the European Union), method of comparison (processing of the analysis of the current situation digitization of the economy and society, the use of information and communication technologies and the purchasing behavior of consumers within the Slovak Republic and the countries of the European Union), the method of induction and deduction (creating a proposal for the implementation of IoT solutions in the selected company and the final evaluation), the method of inquiry (finding the interest of consumers in the implementation IoT solutions within retail), mathematical-statistical methods (calculation of the selection sample and formulation of the results of primary marketing research).

The determination of consumers' interest in the implementation of IoT solutions in the retail sector was realized through inquiry – a questionnaire. The research problem of the primary marketing research was to find out the level of awareness of the implementation of IoT solutions in retail and their impact on the purchasing behavior of consumers. Objectives of marketing research:

1 To find out whether the respondents have encountered IoT solutions in retail.
2 To find out whether the respondents would be interested in using IoT solutions in retail.
3 To find out whether the implementation of IoT solutions would affect the purchasing behavior of the respondents.
4 To find out what factors have the greatest influence on respondents when choosing a store where they will shop.

The inquiry was carried out electronically through an online questionnaire, which was created through the website www.typeform.com. The research was preceded by testing to reveal unwanted errors in the questionnaire, which was attended by 30 respondents. The results of the testing were also used in the formulation of assumptions for the individual objectives of the marketing research. The obtained data were analyzed using the Microsoft Office Excel program. The marketing research budget was 0 €, due to own preparation, implementation and processing. The following variables were used to calculate the sampling using the formula, with the specific calculation shown in Figure 1.

- Number of SR citizens over 18 years of age – 4,432,419.
- Reliability of the estimate – 95%.
- Maximum permissible range of errors – 5%.
- Variability of the base file – 0.5.
- Critical value determined from the tables – 1.96.

$$n \geq \frac{N * t^2_{1-\frac{\alpha}{2}} * \sigma^2}{(N-1) * \Delta^2 + t^2_{1-\frac{\alpha}{2}} * \sigma^2}$$

$$n \geq \frac{4432419 * 1{,}96^2 * 0{,}5^2}{(4432419-1) * 0{,}05^2 + 1{,}96^2 * 0{,}5^2}$$

$$n \geq 385$$

The target group of the marketing research was residents of the Slovak Republic aged 18 and over. The selection of the target group was carried out based on the age structure of customers of TopSki stores, where most customers are aged 18 and over, which is probably due to the financial difficulty of buying sports equipment. Customers under the age of 18 are in most cases accompanied by their parents or another adult. The share of customers of TopSki stores under the age of 18 is negligible. Based on the calculation of the sample, it was necessary to get answers from at least 385 respondents. Respondents were approached by placing the questionnaire in groups on the Facebook social network. The questionnaire was successfully completed by 391 respondents, which means that the sample was filled. In addition to the results of the questionnaire survey, the proposed solution also reflects the requirements of retail store owners – streamlining internal company processes, using modern technologies, and improving the shopping experience of customers.

3 Results

For the needs of creating a prototype for a retail business, where the implementation of IoT elements will bring a quantifiable change, the company TSS Servis, s.r.o., which operates a brick-and-mortar and Internet store TopSki, focused on the sale of sports equipment, was selected. The company also operates the largest sports equipment rental shop in the Žilina region of the Slovak Republic, where ski equipment, snowboards, roller skis or bicycles are available for rent. A bazaar with ski and snowboard equipment and a service for skis, snowboards and bicycles are also available for customers. The basic principles of the company include a high-quality assortment of products, a pro-customer approach and expert advice (Zilinak, 2020).

3.1 Evaluation of primary research

As part of the research objective "Find out if the respondents have encountered IoT solutions in retail" it was found that only 33% of respondents had real experience with IoT solutions in retail. As part of the research objective "Find out if the respondents would be interested in using IoT solutions in retail" it was found that up to 80% of respondents would be interested in IoT solutions in retail, of which 32% of respondents already had experience with IoT solutions in retail. Of the respondents who are interested in IoT solutions, 61% of the respondents had a university education and 39% had a secondary education. From the research objective "Find out whether the implementation of IoT solutions would influence the purchasing behavior of respondents" it follows that up to 66% of respondents would prefer to shop in stores that have Internet of Things solutions. The results of fulfilling the research objective "Find out what factors have the greatest influence on respondents when choosing a store where they will shop" are shown in Table 1.

From the previous table, it follows that respondents are most often influenced by the expertise of sales assistants when choosing a brick-and-mortar store, namely 19% of respondents. The second most frequent answer, with a share of 17%, was the ease of shopping factor. The shop review factor has the least influence on the choice of

TABLE 1 The influence of factors on the choice of a brick-and-mortar store.

Question	Answer	Quantity	%
Which of the listed factors influences you the most when choosing a brick-and-mortar store?	Price	33	8
	Product offer	50	13
	Quality of products	61	16
	Store location	50	13
	Expertise of sales assistants	73	19
	Store reviews	17	4
	Appearance of the store	39	10
	Ease of shopping	68	17
Total	–	391	100

Source: own research.

TABLE 2 The influence of factors on the choice of an online store.

Question	Answer	Quantity	%
Which of the listed factors influences you the most when choosing an online store?	Price	104	27
	Product offer	48	12
	Quality of products	32	8
	Store reviews	53	14
	Delivery time	21	5
	Delivery price	12	3
	Clarity	24	6
	Sufficient description and representation of the products	97	25
Total	–	391	100

Source: own research.

brick-and-mortar store, with 4% of respondents indicating this answer. The results of the influence of factors on choosing an online store are shown in Table 2.

It follows from Table 2 that the price factor most influences respondents when choosing an online store, while 27% of respondents indicated this answer. The second largest share of influence on choosing an online store was recorded for the factor sufficient description and representation of products with a share of 25%. The delivery price factor has the least influence on the choice of an online store with a share of 3%. In addition to the questions that were created to verify the research assumptions, other questions focused on the level of implementation of the Internet of Things in retail and the purchasing behavior of consumers were also created. In the context of the question "Which Internet of Things solution would you be most interested in in retail?," the respondents most often marked the smart mirror that displays additional information about the product the customer is currently trying on (16%), virtual product testing via a mobile phone camera possibly a computer (14%) and personalized offers via a mobile phone or other wearable device based on movement around the store (13%). Respondents were least interested in smart price tags (1%), virtual shopping via a touch screen (3%) and shopping via a virtual store available on a website or mobile application (5%).

Only 129 respondents had real experience with IoT solutions in retail, which represents a share of 33%. Of the mentioned respondents, only 7% of respondents had experience with IoT solutions within Slovak brick-and-mortar stores and 28% of respondents within Slovak online stores, based on which it can be concluded that the respondents came into contact with IoT solutions in retail, especially in foreign brick-and-mortar and online stores. As part of the question "Which of the listed solutions in brick-and-mortar and online stores do you have real-world experience with?" respondents (129) had the opportunity to mark several answers, while most often marking the options of smart price tags (47%), personalized offers via mobile phone or wearable device on based on movement around the store (34%) and virtual product testing via a mobile phone camera or computer (32%). The least numerous solutions with which the respondents have real experience were the smart mirror (2%), shopping through a virtual store (2%) and scanning with a mobile phone to find out more information about the product (6%).

3.2 Design of customer oriented IoT solutions

The proposal for the implementation of customer oriented IoT solutions is mainly based on the results of primary research, the suitability and efficiency of use within TopSki stores and the importance of the implementation for the given type of business.

3.3 Smart mirror

This is the solution that the respondents expressed the greatest interest in as part of the questionnaire research. Through the smart mirror, the customer would have basic information about the product they are currently trying on, available sizes and color versions (Ogunjimi et al., 2021). If a size is available in stock that is not on the sales floor, the customer would have the option to "request a size" via the smart mirror. The customer thus obtains the necessary information about the product without the need for direct interaction with a store employee. At a time when customers would not be using the mirror, the surface of the mirror be used to project promotional materials or to promote the functions of the smart mirror and other IoT solutions. The functions of the smart mirror would be triggered in case of automatic reading of the RFID tag or by the customer's touch. From the point of view of brick-and-mortar store operations, the solution would relieve sales assistants and make the customer's purchasing process more efficient. Compared to hiring additional sales assistants, an IoT solution would be more effective, mainly because a significant rush of customers occurs only at certain time intervals of the day, and outside of these intervals additional employees would be unused.

3.4 Virtual shopping

A similar solution, such as a smart mirror, would also be appropriate to introduce in an online store (Oakley AirBrake, 2023). The implementation of this solution in an online store is not difficult, as there is no need for complex programming of the entire software for virtual product testing, but it is enough to insert one of the available software into the online store and insert the products that customers would try

through this software (Kim, 2022). Since the solution is aimed at testing products through the so-called "selfie" camera and the camera of a mobile phone, tablet, or computer, it would not be effective from the point of view of the operation of the online store to enable virtual testing of all products. This solution would be appropriate to focus mainly on products that cover a small part of the body and would be easily visible through the cameras and device screen, and at the same time on products for which such a solution is suitable and effective to implement also from a financial point of view. These are, for example, boots, ski boots, ski goggles and helmets or sunglasses, which are suitable for this solution both in terms of size and price. The proposed function of virtual product testing is shown in Figure 3.

3.5 Personalized offers and mobile application

Among the important activities of merchants is also motivating customers to buy in their store and using various methods to support sales. These methods also include personalized offers for individual customers (Riegger et al., 2021). Implementation in the online environment is simple and it is possible to use, for example, targeted advertising based on the movement of customers within individual parts of the online store. Within a brick-and-mortar store, these activities are somewhat more demanding, and it is necessary to install so-called beacons (Durdevic et al., 2022). However, to use beacons effectively, it is necessary to create a mobile application that will expand the possibilities of online shopping within the TopSki store. This is the function of virtual product testing, sending personalized offers, scanning products, navigating to products, and providing current and future availability of individual products. The application could also be used as part of other proposed IoT solutions. The goal of this solution is to increase the volume of sales, motivate customers to buy accessories, make further purchases and increase the number of visits to stores. After creating the mobile application, installing, and setting up the beacons, customers with the downloaded mobile application would receive special offers based on movement around the store and activity within the mobile application – Figure 4.

3.6 Mobile phone scanning

To positively influence the customer experience of shopping in the TopSki brick-and-mortar store, it would be possible to implement a mobile phone barcode scanning solution. For example, if the customer would like to find out the availability of a product in a specific size, it would be enough for him to scan the barcode located on the product with his mobile device. After scanning the barcode, the customer would be redirected to the store's website or mobile app, where they would be shown the product description, available sizes, and color options. Figure 5 shows the location of the scan function in the drop-down list and the product scan function (TopSki, 2023).

The option of scanning products would also be available to customers directly within the website and mobile application. In the case of registered customers, they would be directly notified that their size, which they preset as part of the registration process, is available or unavailable – Figure 6.

FIGURE 3
Virtual shopping.

FIGURE 4
Beacon notifications.

If the product size that the customer is interested in is not available on the sales floor, but is in stock, the "request size" option would be available to the customer after scanning. The request would be delivered to employees, who would prepare the product in the checkout area and mark the request as fulfilled, based on which the customer would be notified back that the product they requested is ready. The possibility to ask for the desired size to be brought from the warehouse would be available within the application and the website without the need to scan a barcode. The possibility would be systemically limited only to customers who are currently in the store premises. If a customer requested a size via the smart mirror in one of the fitting rooms, the staff would bring the product directly to that fitting room.

3.7 Navigation to selected products

Another extension of the mobile application, created based on the current website, is navigation. The location of the user within the store would be determined based on the mutual communication between the customers' mobile devices and the beacons, which are described in the framework of the personalized offer solution and the mobile application. At any time, the customer could create a shopping list of the products they are interested in within the application. After arriving at the store, all you must do is launch the mobile application, open the list of products, and click the navigate button. The customer would be shown a map that would guide them to the location of the product within the store – Figure 7.

FIGURE 5
Product scanning.

3.8 Availability of products

The final part of the customer centric IoT implementation is the sharing of information about the availability of individual products. Information would be available to customers through a mobile application, website, smart mirror, and info center. The info center would be an interactive touch screen that customers would use to browse all available products and get product information from one place. The info center would feature the use of the aforementioned mobile application on a larger touch screen available to all customers. The information center would be located near the entrance to the store, so that customers, if interested, can view the entire offer in one place before passing through the store. The aim of the info center is to expand the possibilities of access to the range of products, thereby increasing the comfort of customers. Figure 8 captures the display of product availability information in the mobile application environment.

Information on the availability of individual products would consist of the number of pieces in stock and, in case of unavailability of products (which will be in stock soon), would indicate the date of re-availability of a specific product. If the product was not currently available and had not been ordered, information about the long-term unavailability of the product would be shared with the customer. However, in case of interest,

FIGURE 6
Information about product availability.

FIGURE 7
Navigation to the product.

FIGURE 8
Product availability notifications.

they can be informed about the re-availability of the product via e-mail. Product availability information would be shared with customers based on the implementation of IoT in warehousing, which is described in the next section of the chapter.

3.9 Design of enterprise oriented IoT solutions

The proposal for the implementation of IoT solutions with an orientation to internal company processes is based on the effectiveness of individual solutions, the benefits they would bring to the company and the justification of the implementation to streamline internal company processes, analyzing the purchasing behavior of customers, and simplifying the work of store employees.

3.10 Storage

For the functionality of the solutions mentioned above, such as a virtual mirror, navigation to selected products or information on product availability, the use of RFID technology, or the implementation of IoT within storage or inventory management, is essential. Within the design of solutions for TopSki stores, the implementation of IoT in storage is the most material and time-consuming part. Before implementation, it is necessary to ensure the necessary elements, which include RFID readers, RFID printer, RFID tags, IoT gateway and RFID tag tracking software. After securing the necessary elements and installing them, it is necessary to assign RFID tags to individual products and place them on the products. The goods would be recorded by automatic RFID readers almost immediately after being received in the warehouse. After implementing the readers, the company would have an overview of all the products that are currently in the store. Before that, however, it is necessary to install and set up the software that will process the read RFID tags, analyze individual data through Cloud computing and send notifications to the responsible person (Škiljo et al., 2020). In addition to being used for a detailed stock overview, the implementation of RFID technology is also necessary for the company to provide information on the availability of individual products through a mobile application, website, and smart mirrors, which was described in the design of customer-oriented solutions. Due to the limited sales area, only a few pieces of individual products are exhibited. This often leads to situations where employees have to bring the necessary products from the warehouse in a short time if customers are interested. To facilitate the search for products in the warehouse, it would be advisable to implement a system that makes this activity significantly more efficient. Figure 9 shows the product availability and location information in the employee application environment (Yong et al., 2022).

Employees would have the exact location of individual products available, see Figure 10, while part of the information would come from RFID readers, which would provide them with information about the floor where the product is located. If the product was located on the floor where the warehouse is located, then the second part of the information would be given based on the scheme that is described in the following paragraphs and shown in Figure 9.

The scheme represents the division of the warehouse into zones and the marking of individual shelves for easy orientation when searching for products. Colors would be assigned to individual zones, shelves would be marked with a corresponding number, and bar codes would be placed on individual shelf levels. When receiving new goods, employees would place the goods in the warehouse and then scan the barcode of the product through a mobile device with a mobile application for employees and the barcode of the corresponding position in the warehouse. The product location information would thus consist of one letter and four numbers: X1 – warehouse zone, X2 – shelf designation, X3

FIGURE 9
Product location and availability. Source: TopSki (2023).

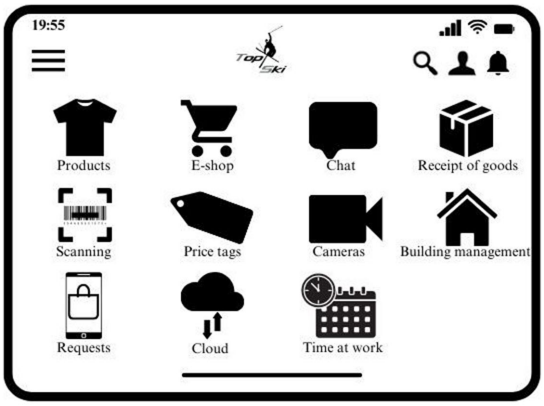

FIGURE 11
Application for employees.

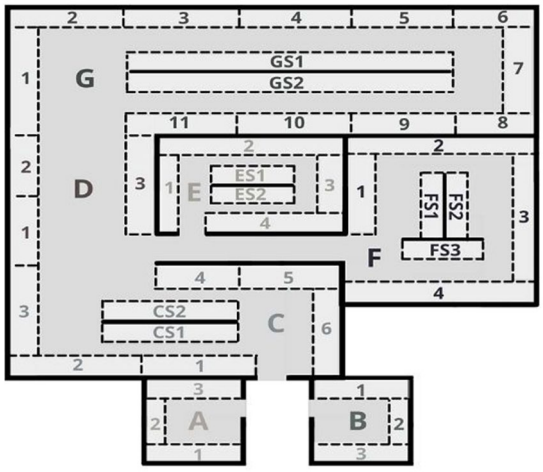

FIGURE 10
Warehouse divisions.

– shelf floor designation, X4 – shelf order designation. When searching for a specific product, for example skis, the product position would be set as "A 3 3 2," i.e., that the product is placed in zone A, in the third rack, on the third shelf and second from the left. Given that customers would be able to request a certain product via a mobile device or smart mirror, employees must be able to fulfill customer requests as quickly as possible.

3.11 Mobile app for employees

Part of the proposed mobile application is the expansion of its functionality for employees. Employees would be assigned identification numbers with which they would log into the application. In addition to the usual functions intended for customers, the employees would also have access to information about the products together with their location, an overview of the products available in stock, an overview of the products requested by customers, confirmation of the preparation of the requested products, an overview of orders within the online store and preparation of orders for dispatch, scanning for receipt of goods and their placement in the warehouse or the possibility of internal communication with other employees. Part of the functionalities for employees would also be intelligent building management (a function available only for selected employees) or the possibility of monitoring the sales area through a camera system. The menu of functions of the application for employees is shown in Figure 11.

3.12 Smart price tags

Smart price tags are also related to the mobile application. Even though the respondents in the marketing research showed little interest in this solution, it is a solution that is simple and effective considering the range of products sold. Customers must be informed about the current price of the products. Since there are many products, manually marking the products when changing their price is time-consuming (Miguez et al., 2019). Figure 12 shows the smart price tag and its setting in the application environment for employees.

For this reason, it would be advisable to implement smart price tags with a digital display. The communication of smart price tags is based on RFID technologies, and therefore it would be possible to use the infrastructure that is necessary for stock monitoring. The smart price tag display would show the barcode of the product, its name and price. There would be an additional barcode on the frame of the display, which could be scanned through the application for employees and subsequently modify the displayed area of the display. It would be possible to edit the content of individual smart price tags even without scanning, using a mobile application or an information system via a computer. The modification carried out in the environment of the mobile application or information system would be transferred to the screen of the smart price tag via the RFID infrastructure.

3.13 Sensors and cameras

Since this is a complex proposal for the implementation of IoT, it would be appropriate to also implement solutions aimed at intelligent

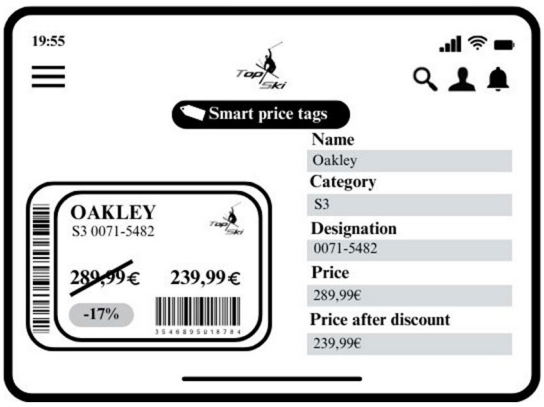

FIGURE 12
Smart price tags.

TABLE 3 Budget.

Item	Estimated price in EUR	
	Minimal	Maximum
Smart mirror – 5x	17,600	24,000
Virtual shopping – 36 months	3,900	6,500
Mobile application	12,000	15,000
Optimizing the website	0	1,500
Beacons – 7x	350	1,200
Mobile information center	300	800
RFID technology	2,750	4,000
Smart price tags – 1,000x	4,000	11,000
Sensors for intelligent control and safety – 30x	1,100	2,500
Cloud computing – 36 months	1,500	2,400
Tablets – 8x	1,200	4,000
IT support	1,000	3,000
Material	50	200
Marketing communication – 3 months	450	3,000
Total	46,200	79,100

Source: own research.

building management, which include temperature, lighting, entrance gate and garage door control and air quality monitoring within the store. To increase the comfort of customers, sensors would be implemented to monitor the number of free parking spaces, while this information would be available to customers via the website and mobile application, or monitoring the number of customers who are currently in the brick-and-mortar store.

The implemented solutions focused on building management would also include sensors focused on building security and protection. This is the implementation of sensors to monitor the windows and doors of a brick-and-mortar store. Data originating from the functions of the mobile application used by customers in the brick-and-mortar store, beacons, smart mirrors, and the info center would also be evaluated. The obtained data would then be analyzed through cloud computing, and the business owners would have a detailed overview of the movement of customers around the sales area and the products that customers paid attention to during their visit to the store. Subsequently, it would be possible to optimize the distribution of products within the store, marketing communication, discounts, or the structure of the offered assortment.

3.14 Budget

An important factor in the category of small and medium-sized enterprises, to which the selected enterprise also belongs, are the costs necessary for the implementation of the proposal for the implementation of IoT solutions. Because the implementation of IoT solutions within retail is not yet widespread and the proposal consists of a combination of several IoT solutions, it is not easy to clearly determine the specific price of the implementation for the selected company. Prices for individual components and services vary widely depending on manufacturers, compatibility, regions, quantities, functions, and requirements. Therefore, within this subchapter, an estimate of the costs necessary for implementation is developed based on the available information. An overview of costs for individual items can be found in the Table 3.

4 Discussion

The integration of intelligent solutions and the transformation of retail began to appear in scientific works to a more significant degree around 2012 (Pantano and Timmermans, 2014; Bodhani, 2019; Chuang et al., 2019). Technological development has enabled the development of sophisticated services and solutions that have enabled the beginning of the transformation to smart retail. The main expected benefits of the proposal include reducing operating costs, improving customer experience, improving the supply chain, improving the efficiency of internal company processes or increasing competitiveness. The expected benefits are in line with existing studies in this area (Pantano and Timmermans, 2014; Adapa et al., 2020; Feng C. et al., 2020). In addition, it is also possible to improve inventory management and improve customer experience in retail (Al-Fuqaha et al., 2015).

An important factor in the success of intelligent solutions is their creation from the point of view of UX and UI design. The solutions were meant to be user-friendly to ensure significant usefulness of the interaction, which is in line with the studies conducted (Chang and Chen, 2021; Lin, 2022). The quality of the goods sold is also a prerequisite for the success of the integration, it is unlikely that customers would prefer a store with low-quality goods, just based on the use of smart technologies (Grewal et al., 2020; Shankar et al., 2021). Another important question is whether shopping convenience and customer experience have such a significant impact on consumer purchasing behavior. In addition, this fact may vary based on the geographical area. However, according to some authors, shopping convenience is one of the important factors of shopping behavior (Ozturk et al., 2017; Li et al., 2018).

Limitations of the design also include a lack of standardization and interoperability of IoT elements. This statement is especially important in a complex design where several different IoT solutions are supposed to work together within one ecosystem. In addition, for the correct effectiveness of the design, cooperation of the solutions must be ensured, since the proposed solutions are dependent on each other. Thus, standardization and interoperability can be considered as one of the most significant obstacles of the Internet of Things (Al-Fuqaha et al., 2015; Lin et al., 2019). In addition, insufficient standardization and interoperability can lead to a significant increase in the costs of integrating solutions or subsequent administration (Xu X. et al., 2020).

Important topics also include security and privacy protection, which is clearly linked to the use of IoT solutions in retail. Customers could worry about their privacy, for example, in the case of a smart mirror, when customers might think that the mirror is recording them while they are changing. It would be necessary to clearly declare that customer data is safe, and their privacy or security will not be compromised in any way. Of course, the proposed systems will collect sensitive data about shopping habits, movement around the store, etc., but they will not be paired in any way with specific persons or data based on which persons could be clearly identified. Several authors also included security and privacy among the key challenges of IoT (Chen et al., 2018; Lin et al., 2019).

The implementation of the proposed solutions is relatively demanding on financial resources, therefore a good financial condition of the company is a necessary condition. Businesses can use financing through external sources, for example, bank loans, entry of new investors, or participation in programs provided by the state. However, the return on investment can also be debatable, as it depends, for example, on the goods sold, the current setting of internal company processes, the purchasing power of the population, etc. Companies can therefore be in good financial condition, they can obtain external financial resources, but without a return on investment at a sufficient level, the implementation of the proposal will not be successful or attractive for them. Certain risks are associated with the implementation of the proposed solutions, which may have a negative impact on the company. Implementation can be difficult for some companies in terms of time and necessary resources. A prerequisite for successful implementation is also the interest of customers in given solutions, which, however, may differ in different regions, for example in the case of the purchase of ski equipment, which is more interested in mountainous and more economically developed regions.

Implementing IoT solutions in retail stores has the potential to revolutionize inventory management and improve the overall customer experience. By leveraging IoT technologies, retailers can streamline their operations, increase efficiency, and provide personalized service to their customers. Future research in this area needs to focus on developing practical solutions that can be easily implemented in retail businesses and provide real benefits for both retailers and customers. In addition, research should address potential ethical and privacy issues associated with the use of IoT solutions in retail and explore ways to promote sustainability and reduce environmental impact. Finally, research should focus on identifying potential barriers to adopting IoT solutions and developing strategies to overcome them. Questions that need to be answered by further research and the practical integration of smart solutions in retail include – What are the potential security risks associated with the implementation of IoT in retail stores and how can they be mitigated? What are the most effective IoT solutions to improve inventory management in retail stores? What are the costs associated with implementing IoT in retail stores and how can retailers ensure that the benefits outweigh the costs? How can retailers measure the ROI of IoT implementations in their stores? What are the potential environmental impacts of implementing IoT in retail stores? Research should also focus on the development of new efficient smart solutions; identification of marketing strategies to support IoT solutions in retail; X. exploring new technologies that can be integrated with IoT solutions to improve the shopping experience, such as augmented reality or artificial intelligence; developing sustainable IoT solutions that can help retailers reduce their environmental impact and promote sustainability.

5 Conclusion

The use of the Internet of Things and the resulting benefits have been a topic of interest for several years. Implementing IoT solutions in retail stores can help improve business processes and customer interactions. The contribution is focused on the design and implementation of IoT solutions in a specific retail store in Slovakia to create a prototype for other similar businesses in the retail sector, while the result of the implementation of the proposal should be an increase in the competitiveness of the business and its sustainable development. The paper highlights the importance of IoT solutions in retail. Using IoT solutions can help retailers improve their business processes, reduce costs, and increase customer satisfaction. One of the main challenges of IoT integration is the lack of comprehensive implementation of IoT in the retail sector. While there have been partial implementations of IoT solutions in retail stores, there is no comprehensive IoT implementation. This can be caused by the complexity of the retail industry and the lack of standardization of IoT solutions, but also by concerns about the costs of implementation or the technical complexity of implementation.

The proposal for the implementation of the Internet of Things and intelligent solutions was developed for the brick-and-mortar TopSki, which is focused on the sale of sports equipment and accessories. The proposal consisted of six solutions intended for customers – smart mirror, virtual shopping, mobile application and personalized offers, barcode scanning, navigation to products within the brick-and-mortar store and sharing information about product availability to customers. The second part of the proposal was focused on internal company processes, while the proposal consisted of four solutions – a mobile application for employees, storage optimization, smart price tags and camera sensors for smart control of the building, monitoring of customer purchasing behavior and building security. Based on the available information, the budget for the implementation of the proposal was set at €46,200 – €79,100, depending on the final selection of components and services.

The successful implementation of the proposal would provide customers of TopSki online and brick-and-mortar stores with new shopping opportunities in both online and offline environments, an increase in comfort, ease of shopping and the ability to provide customers with a positive shopping experience. The implementation of new technologies would be interesting not only for existing customers but also for potential customers. The benefit for employees would mainly consist of facilitating work activities based on access to information via a tablet and an application for employees. For the company and its owners, the implementation would bring new possibilities in the areas of marketing communication, monitoring of purchasing behavior, sales support, optimization of costs, or efficiency of internal company processes. The implementation would also contribute to improving the image of TopSki stores and increasing their competitiveness.

It follows from the conducted primary research that the respondents clearly showed an interest in using intelligent solutions in the purchasing process. The integration of smart technologies would also positively influence the shopping behavior of customers, preferring those retailers that provide a better shopping experience through smart solutions. The clear benefits of integration include streamlining internal company processes, improving the shopping experience, gaining a competitive advantage, or fulfilling the principles of sustainable development. However, the created proposal should be subjected to further scientific research, especially in the field of technological implementation and testing in practice. The actual creation of a smart store prototype would provide more detailed information about the budget needed to implement the design, as there are many technological solutions with diametrically different technical specifications that may not be compatible. The available technological solutions also differ significantly in the finished price, which in the end can significantly increase the cost of implementing the design. It would also be possible to obtain information about the reliability of individual solutions and about the subsequent administration of the entire system. Another limitation is the implementation of primary research only within the Slovak Republic, the digital skills of individual countries, respectively. Geographical areas. The proposal can also be applied in other areas of the retail sector. In this case, however, the limitation may be, for example, the type of goods sold, the size of the store and stock, but also the economic condition of the company, since the integration of the proposal requires significant costs, which may cause the proposal to be economically disadvantageous for some enterprises. Nevertheless, the created proposal can be considered a good basis for further research in this area. It also represents an inspiration for the further development of the retail sector in the field of integration of modern and intelligent technologies.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

KŠ: Writing – original draft, Writing – review & editing. FB: Writing – original draft, Writing – review & editing. PJ: Writing – original draft, Writing – review & editing. MK: Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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