Supporting Small Businesses and Local Economies Through Virtual Reality Shopping and Artificial Intelligence: A Position Paper

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Abstract: The rise of e-commerce and online sales has had a detrimental effect on small businesses that lacked an online presence in recent years, with negative consequences for local services and economies. Despite attempts to digitize businesses, large corporations continue to hold a privileged position that allows them to capture the majority of sales. Small businesses may regain a competitive edge against large platforms by anticipating and adapting to the next phases of commercial evolution, which are likely to be heavily reliant on Virtual Reality shopping and Artificial Intelligence. In this article, we propose a platform that combines these two technologies and enables local businesses to join forces and overcome physical barriers, thereby providing a virtual world of unrestricted retail spaces. The system also proposes retail collection points and develops attractive leisure plans around these points through the outcomes of a recommender system, thereby promoting city activity and bolstering local economies.

1 INTRODUCTION

Small businesses have been declining in recent years due to the increase in online shopping. The popularity and increasing access to the Internet and mobile devices (By 2020, 59% of the world's population owned a mobile phone) have driven the growth of e-commerce, leading to a decrease in demand for products and services in physical stores, particularly in the small enterprise sector (Saha, 2015).

In addition to this fact, the COVID-19 pandemic consolidated the digitization process and increased online purchases due to the restrictions and safety measures implemented to prevent the spread of the virus (Paraschiv et al., 2022). This allowed many people to conduct basic transactions and run processes from their homes, contributing to the digitization of society.

However, this trend has had a negative impact on a significant part of small businesses, as many stores and local businesses have had to close due to lack of customers and income. This has caused a loss of jobs and economic opportunities in the communities where these businesses were located, and has contributed to the disappearance of the local identity and character of some areas. While the amount of online purchases in 2020 increased by 41%, the attendance of shopping centers decreased between a 20% and 45%, depending on the country, in comparison with the same period in 2019 (Paraschiv et al., 2022). In addition, retailers with online presence, such as Amazon or the Alibaba Group, registered an increment in unique visitors, revenue and many other indicators compared to before pandemic (Dumanska et al., 2021).

All the signs are that the pandemic's effect on consumption is liable to persist, such as the sales volume in e-commerce growing five times faster that offline retail sales in U.S. or over 65% of the people between Baby Boomers and Generation Z shopping mainly online since the pandemic breakout (Kim, 2022). Moreover, elderly people, who were the majority of small enterprises' customer base, use more frequently Internet to find information about goods and services and shopping/buying them, according to recent studies (Rybaczewska and Sparks, 2022).

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Despite these challenges, small businesses remain an important part of the economy and society in many places around the world (Ayandibu and Houghton, 2017). Many people still value and appreciate the added value that local businesses bring, such as personalized service, product quality, and community involvement. By recognizing and appreciating the added value that local businesses bring, residents of small cities can support these businesses and help ensure their continued success. This, in turn, can help to maintain a vibrant and thriving local economy, as well as a strong sense of community. Therefore, it is important to find ways to support and strengthen small businesses to ensure their survival and contribute to balanced economic and social development.

In these circumstances, public national and international organisms are supporting the digitization of small enterprises with funding initiatives. These are oriented towards the creation of their online shops. The motivation behind this approach lies in increasing the competitive capacity of small businesses, whose economic and human resources are very limited. However, the leading organizations in the sector have already explored how to enhance the shopping experience of its customers to promote new ways for online shopping. In this context, technologies such as Virtual Reality (VR), Augmented Reality (AR) and Artificial Intelligence (AI), like recommendation systems, play an important role. Applications like Amazon's VR kiosks or IKEA's Place AR are examples of the application of some of these technologies. This means that, despite the investment in digitizing small businesses, they might be soon be unable to compete when large corporations make further progress. In this light, it may be sensible for the digitization efforts of small retailers to be directed towards a state of evolution that is rapidly approaching in the coming years.

Thus, we find it essential to identify solutions that permit small shops to band together, overcome the physical limitations of their small spaces, and offer competitive prices, thereby concurrently stimulating the activity of the city. VR and AI-based solutions can meet these requirements. The true potential of using VR is to improve online shopping customer's experience, bringing it closer to a physical store experience, while solving limitations of space and how much time it is available (Xi and Hamari, 2021). AI will allow us to improve business efficiency by increasing online sales as well as boosting local businesses in a cooperative way.

The aforementioned challenges represent the main motivation to elaborate our proposal. In order to improve local economies and increase their competitive capacity, we propose an AI and VR-based platform where small businesses unite to present themselves to buyers. This increase in competitiveness is partly driven by the use of disruptive technologies, the ability to offer lower prices, and the elimination of physical space limitations. The platform, in addition to offering the ability to examine and evaluate products in a way similar to in-person shopping through VR, also includes the possibility of picking up purchased products at local pick-up points. Additionally, associated with the pick-ups, the platform will automatically make recommendations for visiting local shops where users can see the products that have caught their interest and leisure plans based on various factors such as user profile, purchased product, and the time of pick-up, among others. These plans represent an additional attraction for the buyer that could lead to purchasing products from local businesses and enjoying services, thereby strengthening the city's economy.

The platform aims to be an innovative e-commerce solution that allows small businesses (less than 10 employees) with limited resources to develop their commercial activities online, relying on VR and AI, while also promoting the city's economic life. The proposal would allow small businesses to compete with the big giants of e-commerce. Keep in mind that more than 9 out of 10 (93.5%) enterprises in the European Union are micro enterprises [1].

The remainder of the paper is structured as follows. In Section 2, related works regarding VR shopping proposals and prototypes are presented. In Section 3, the proposed platform and the underlying architecture are discussed. Challenges regarding the development of this platform are shown in Section 4, meanwhile the conclusions and future work are presented in Section 5.

2 RELATED WORK

2.1 Virtual Reality Shopping

In (Speicher et al., 2017) a prototype of Virtual Reality Online Shopping Environment was developed and evaluated by the authors in terms of influence of user input (head pointing and speech) and output (desktop and Head Mounted Display (HMD)) on task performance and user's preference and behavior. After carrying a survey where participants identified positive and negative aspects of online shopping, the authors

[1] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Structural_business_statistics_overview

developed a prototype for desktop and smartphone VR cases, where user input was limited to voice and head pointing. Following the analysis of a case study carried, design guidelines for virtual reality shopping environments are proposed.

Later on, the same authors developed another VR shop prototype using the Apartment metaphor (Speicher et al., 2018) in order to study different selection and manipulation techniques of products (grab and beam) and different types of shopping carts (basket and sphere). The authors carried a study with a prototype they developed. They concluded that immersion and user experience were the most important aspects for volunteers, as well as they introduce suggestions to reduce motion sickness and types of products suitable for VR shops.

In (Veneruso et al., 2020) a VR application that runs on Oculus Rift device is developed with the aim to create a Virtual Dressing Room (VDR) based on VR rather than on Augmented Reality (AR). The main idea behind such application is to represent how clothes fits in an avatar made by the customer based on body shape and size of the clothes selected.

In (Shravani et al., 2021) a VR online shopping platform named VR Supermarket is presented. Such system consists on a VR application developed in Unity and deployed in the HTC Vive VR System, and a dynamic recommendation system based on purchase history hosted in a web server. While the VR application handles the user input through controllers and headset, it also interacts with the web server, that is supported by an SQL database to make recommendations. At the same time, the VR application requires a NoSQL database for supporting data storage and retrieval of products, supplementary information or user information, among others.

The virtual environment that we aim to develop is expected to change dynamically the products presented based on the recommendations made. However, the user will be allowed to visit the available stores at any time.

2.2 Recommendation Systems

Recommendation systems have played a significant role in the success of e-commerce systems by providing personalized product and content suggestions to customers based on their past behavior and preferences. These systems use various algorithms, such as collaborative filtering, content-based filtering, hybrid algorithms, and matrix factorization (Hussien et al., 2021), to analyze customer data and generate recommendations that are tailored to each individual user. Collaborative filtering algorithms, for example, use data on customer preferences and past behavior to make recommendations based on similar users, while content-based filtering algorithms use data on the characteristics of individual products to make recommendations based on customer preferences (Hwangbo et al., 2018). Hybrid algorithms, on the other hand, combine different types of algorithms to provide more accurate and personalized recommendations.

Other kind of algorithms are Graph-based algorithms, which use data on the relationships between different products and customers to make recommendations (Shaikh et al., 2017), Context-aware algorithms, which use data on the context in which recommendations are made (e.g. location, time, device) to provide more relevant recommendations, and Learning-to-rank algorithms, which use machine learning techniques to learn the relative importance of different factors in making recommendations (e.g. customer preferences, product characteristics, past behavior) (Karmaker Santu et al., 2017).

This has helped e-commerce businesses to improve customer engagement and increase sales by providing relevant and personalized recommendations to customers. In addition, recommendation systems can help to reduce the need for customers to search for products, thereby making the shopping experience more convenient and efficient.

In the context of VR shopping, recommendation systems can play a similarly important role by providing personalized product suggestions and recommendations to customers as they navigate virtual retail spaces (Shravani et al., 2021). By analyzing customer data and generating tailored recommendations, VR shopping platforms can improve the customer experience and drive business growth by providing customers with relevant and personalized suggestions (Huang et al., 2022). Furthermore, recommendation systems can help VR shopping platforms to overcome the physical limitations of traditional retail spaces by providing customers with a virtual environment that is tailored to their individual preferences and interests (Elboudali et al., 2020).

These solutions are aimed to make recommendations of products in order to increase sales. However, our recommender system have to deal with these recommendations and the generation of leisure plans based on the user's profile, the date and time of collection and the collection point.

3 SMART VR-shopping PLATFORM TO SUPPORT SMALL BUSINESSES AND LOCAL ECONOMIES

In our proposal, we consider the perspectives of both the buyer and the seller in the context of a platform for facilitating economic transactions. From the perspective of the buyer (see Figure 1), the platform aims to provide high-quality services and customization according to individual preferences and needs. Meanwhile, from the perspective of the seller and nearby businesses, the platform seeks to enhance sales and support the growth of local economies by generating plans that include limited time sales and leisure activities (see Figure 2).

The architecture consists of three distinct layers. The first layer acts as an input interface between the user and the system, either through virtual worlds or through the web (if the user prefers). This layer is responsible for capturing the user's interactions with the digital ecosystem.

The middle layer, responsible for automatic reasoning, is further divided into three sub-modules: (a) a module that progressively defines the user's profile and preferences, (b) a recommendation module that aims to offer the user the best alternatives based on the information profiled by the previous module, and (c) a module responsible for generating leisure/cultural plans associated with the product collection points.

Finally, the top layer is responsible for displaying the information generated for the user, including changes in the virtual environment based on previous interactions, recommendations, and plans generated, as well as mechanisms for formalizing purchases.

The following subsections describe in more detail each of the three main layers of the proposed architecture.

3.1 Input Interface Layer: Interaction Between the User and the Virtual World

Companies that compete in the retail sector are using AR and VR to create more immersive experiences for its customers. In literature, many theories that were applied to online and traditional shopping environments have been applied to VR shopping environments, as well as case studies. It has been stated that the interactivity of VR allows customers to understand better how to use a product and the fit of it, making customers feeling more reliable with their purchase decisions (Xi and Hamari, 2021). In addition, brands could enhance purchase behavior, satisfaction and brand loyalty thanks to the involvement that VR technologies provide.

Regarding devices and technologies used, HMDs are the most prominent devices in VR shopping studies. These provides a great range of input devices and tracking technologies such as VR controllers, head, hands and eye tracking, among others (Xi and Hamari, 2021). It is interesting to note that currently there are challenges being addressed to provide a high immersive experience that could simulate the inspection of a product in a physical store. For instance, an accurate hand tracking to manipulate products precisely is needed, as well as the responses of objects to such manipulations. We believe that interaction with virtual hands provide more immersion and better feedback to the customer than those made with controllers.

In order to build a customized experience for the consumer, the virtual environment should be able to adapt the products showed according to the user's preferences. Online shopping portals have made a large progress in this field with the aim to increasing the consuming intention of its visitors. In a VR shopping environment, the interactions performed in this that the devices allow us to register play a critical role to achieve it. Some variables that could be used to build a robust user profile are: time that an object is being watched (eye tracking) (Pfeiffer et al., 2020), time that an object is being inspected (hand tracking), number of times that a product is inspected or added to its wish-list, or the parameters changed to a given product such as color or size.

3.2 AI-Based Reasoning Layer

The products exhibited in the virtual environment will be supplied by the underlying AI layer, which takes the user profile as input in order to determine what products are the best to be recommended to such user. The first time a new customer uses the system, it does not hold any information regarding its preferences. Therefore, the system will have a set of generic profiles that contains common shopping preferences of a large number of consumers (Radu and Maican, 2015). These profiles will allow the system make the first recommendations before having knowledge of the user.

Later, the interactions that the user makes with the products presented in the portal, will trigger the AI-based recommendation system to update user's profile. Hence, the next time that the consumer gets into the VR environment, the changes in such profile will be reflected in the products showed to him/her, if the changes were significant enough.

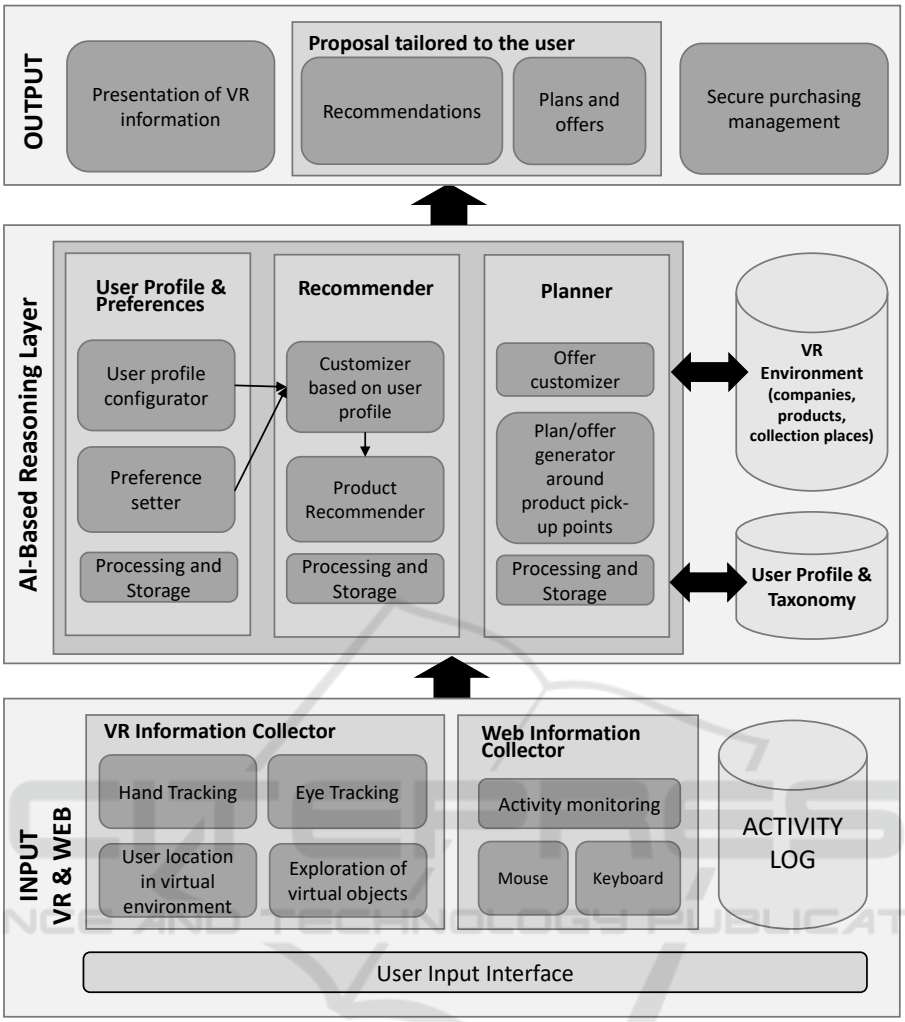

Figure 1: General architecture of an AI-based VR-shopping platform.

Additionally, this knowledge can also be used to encourage the buyer to visit physical stores where these products are located when they go to pick up a purchase at a pick-up point

Every time a customer wants to purchase a product, the portal will show the different buying options they can select (see Figure 4). These options include the price of the product itself and a generated plan that includes offers and activities from businesses that are near the product's collection point. Based on the collection point, the user's profile, and the pick-up time, the plan will include different offers and activities, enhancing the economic activity of the businesses included in the plan. Under this approach, we expect local economies to be strengthened.

One of the key aspects of ensuring the proper and long-term operation of the proposed platform is the association of small businesses in the area. The members of this association will be the companies publishing their products in the VR environment and the businesses that will be considered for generating the plans. In this context, it is important that the platform promotes the plans in a fair way, distributing sales and potential benefits evenly.

This strategy begins by displaying the buy options in a ranking-like style. The variables to be considered are the user's preferences, their geographical location, the geographical location of the collection point, and the sales and benefits recorded historically in the system. Therefore, the system will prioritize an option that is convenient for the consumer but also better distributes the benefits among the businesses in the association.

Once a purchase is made, the system will adjust the weights given to the different businesses, modifying the order in which future buy options and plans

Figure 2: Elaboration of plan after sale. It includes offers and activities around the product collection point.

will be suggested. For example, a store that has had many recent sales should be shown in a lower position for future potential purchases, even though its offer may be the best for the potential customer.

3.3 Output Layer

As mentioned earlier, the output layer is responsible for presenting all changes in the virtual world and the generated information (recommendations and plans) to the user.

Therefore, we developed a prototype using the Unity game engine for the Oculus Quest 2 VR headset as a first approach for this layer. The main idea is to represent a shopping center with various stores, each one focused on products based on their nature, such as clothes, lifestyle products, toys, etc. Hence, the user will be able to select a store of their preference to visit and interact with the objects there.

Additionally, when the user opens the application, the first room they will see contains products suggested based on the outcomes of the recommendation system, after the system creates the user's profile based on their preferences.

To simulate a shopping experience closer to a physical store, the user will use their hands to interact with the virtual environment (see Figure 3). Once the customer shows an intention to buy a product, it will click a panel with a shopping cart icon. After that, the buying options will be shown, indicating the

Figure 3: A sample of product interaction with hands in a VR store.

collection point and the points of interest with which the plan will be elaborated (see Figure 4).

In order to recreate a physical store as much accurate as possible, factors such as lighting, shadows and product size, among others, must be considered. Figure 5 shows some shelves with clothes. These products should look lifelike so that the user wants to interact with it. Digital assets like textures and materials should be used wisely to make the user feel that he/she is inside a real shopping center or store.

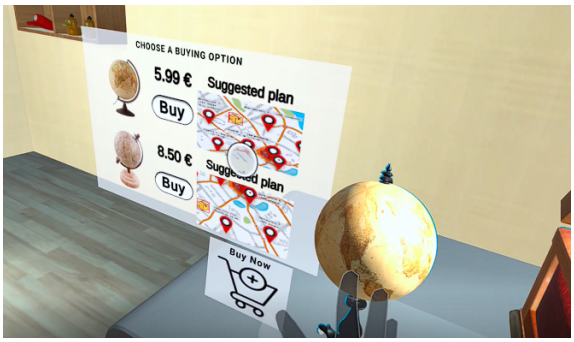

Figure 4: Prototype of panel with buying options for a certain product.

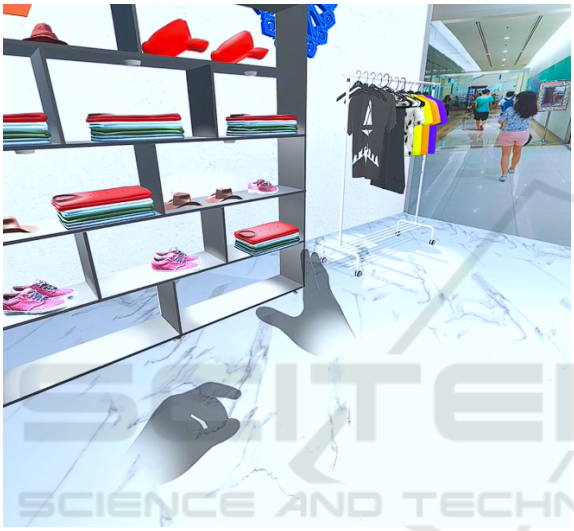

Figure 5: Shelves with clothes in one of the virtual stores.

4 DISCUSSION AND CHALLENGES

The implementation of the proposed virtual reality (VR) platform could bring significant benefits to society, small businesses, and local economies. By providing a convenient and customized VR platform for facilitating economic transactions, the platform has the potential to promote economic growth and support the development of local economies.

For small businesses, the VR platform offers a valuable opportunity to expand their customer base and increase sales. By providing easy access to a wide range of potential customers through immersive VR experiences, the platform can help small businesses to grow and thrive in a competitive market. Furthermore, the platform's ability to customize VR services and offers according to individual preferences and needs can help small businesses to better meet the needs of their customers and build long-term relationships.

For local economies, the VR platform has the potential to support economic development by promoting local commerce and fostering strong connections between businesses and consumers. By facilitating economic transactions and supporting the growth of small businesses through the use of VR technology, the platform can help to create jobs, stimulate economic activity, and strengthen the local economy.

In addition to the benefits discussed in the previous paragraphs, the proposed VR platform also has the potential to support eco-friendly solutions. By including pickup points as part of the platform, the need for packages to be shipped long distances can be reduced, which can help to reduce emissions from transportation. Additionally, the use of pickup points can reduce the amount of packaging and materials used for shipping, which can help to reduce waste and minimize the environmental impact of the platform.

Despite the possible benefits of the platform, we have identified challenges that will be faced during the development of the project. First, the underlying recommendation system algorithm must be defined to distribute potential sales and benefits evenly. The existing approaches and algorithms to build recommendation systems will be inspected to have a consistent background to define such algorithm. Such algorithm also involves the plan generator, which also should be fair. Moreover, we must explore the different VR devices and its services in order to find the one that provides the best hand and eye tracking, among others.

Another challenge regarding available VR headsets is its hardware limitations. The 3D models to be used like products and assets to build the stores must have quality enough to look realistic. However, they should be optimized to avoid overheating the headset, since it could make the user sick.

5 CONCLUSIONS AND FUTURE WORK

In this article, we have discussed the need for small businesses to digitize in order to improve their competitiveness and prevent their disappearance in the face of online retail giants. We have argued that resources and aid for digitization should be directed towards achieving a future state in which virtual reality (VR) and artificial intelligence (AI) will play a prominent role in the commercial landscape. Based on this idea, we have proposed a VR platform that allows small businesses to offer their products in an attractive and immersive way from the comfort of their

own homes. The platform also allows retailers to join forces to offer more competitive prices and incorporates pickup points to support local economies. In addition to the economic benefits of the proposal, we have also highlighted its potential to support eco-friendly solutions by reducing the need for long-distance shipping and packaging waste. Overall, the VR platform offers a comprehensive solution for promoting the growth of small businesses and local economies in a sustainable, digitally-advanced future.

The working lines on which we will strive include the precise scanning and integration of real products, including accessibility options to interact in the virtual space, modeling of user profiles through interactions with products or the dynamic generation of virtual exhibitors.

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REFERENCES

Ayandibu, A. and Houghton, J. (2017). The role of Small and Medium Scale Enterprise in Local Economic Development (LED). 11:133–139.

Dumanska, I., Hrytsyna, L., Kharun, O., and Matviiets, O. (2021). E-commerce and M-commerce as Global Trends of International Trade Caused by the Covid-19 Pandemic. *WSEAS TRANSACTIONS ON ENVIRONMENT AND DEVELOPMENT*, 17:386–397.

Elboudali, A., Aoussat, A., Mantelet, F., Bethomier, J., and Leray, F. (2020). A customised virtual reality shopping experience framework based on consumer behaviour: 3DR3CO. *International Journal on Interactive Design and Manufacturing (IJIDeM)*, 14(2):551–563.

Huang, J., Zhang, H., Lu, H., Yu, X., and Li, S. (2022). A novel position-based vr online shopping recommendation system based on optimized collaborative filtering algorithm.

Hussien, F. T. A., Rahma, A. M. S., and Wahab, H. B. A. (2021). Recommendation systems for e-commerce systems an overview. *Journal of Physics: Conference Series*, 1897(1):012024.

Hwangbo, H., Kim, Y. S., and Cha, K. J. (2018). Recommendation system development for fashion retail e-commerce. *Electronic Commerce Research and Applications*, 28:94–101.

Karmaker Santu, S. K., Sondhi, P., and Zhai, C. (2017). On application of learning to rank for e-commerce search. In *Proceedings of the 40th International ACM SIGIR Conference on Research and Development in Information Retrieval*, SIGIR '17, page 475–484, New York, NY, USA. Association for Computing Machinery.

Kim, R. (2022). Retail After COVID-19: Use Virtual Reality to Enhance Ecommerce. pages 118–123.

Paraschiv, D. M., ŢIţan, E., Manea, D. I., Ionescu, C. D., Mihai, M., and Şerban, O. (2022). The change in e-commerce in the context of the Coronavirus pandemic. *Management & Marketing*, 17(2):220–233. Num Pages: 220-233 Place: Bucharest, Poland Publisher: De Gruyter Poland.

Pfeiffer, J., Pfeiffer, T., Meißner, M., and Weiß, E. (2020). Eye-tracking-based classification of information search behavior using machine learning: Evidence from experiments in physical shops and virtual reality shopping environments. *Information Systems Research*, 31(3):675–691.

Radu, L. and Maican, C. (2015). Personalization in e-commerce using profiles similarity. *Bulletin of the Transilvania University of Brasov. Series V : Economic Sciences*, 8.

Rybaczewska, M. and Sparks, L. (2022). Ageing consumers and e-commerce activities. *Ageing & Society*, 42(8):1879–1898. Publisher: Cambridge University Press.

Saha, A. (2015). A Study on "The impact of online shopping upon retail trade business". *IOSR Journal of Business and Management*, 2:74–78.

Shaikh, S., Rathi, S., and Janrao, P. (2017). Recommendation system in e-commerce websites: A graph based approached. In *2017 IEEE 7th International Advance Computing Conference (IACC)*, pages 931–934.

Shravani, D., R, P. Y., Atreyas, P. V., and G, S. (2021). VR Supermarket: a Virtual Reality Online Shopping Platform with a Dynamic Recommendation System. In *2021 IEEE International Conference on Artificial Intelligence and Virtual Reality (AIVR)*, pages 119–123.

Speicher, M., Cucerca, S., and Krüger, A. (2017). VRShop: A Mobile Interactive Virtual Reality Shopping Environment Combining the Benefits of On- and Offline Shopping. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies*, 1(3):102:1–102:31.

Speicher, M., Hell, P., Daiber, F., Simeone, A., and Krüger, A. (2018). A virtual reality shopping experience using the apartment metaphor. In *Proceedings of the 2018 International Conference on Advanced Visual Interfaces*, AVI '18, pages 1–9, New York, NY, USA. Association for Computing Machinery.

Veneruso, S. V., Catarci, T., Ferro, L. S., Marrella, A., and Mecella, M. (2020). V-door: A real-time virtual dressing room application using oculus rift. In *Proceedings of the International Conference on Advanced Visual Interfaces*, AVI '20, New York, NY, USA. Association for Computing Machinery.

Xi, N. and Hamari, J. (2021). Shopping in virtual reality: A literature review and future agenda. *Journal of Business Research*, 134:37–58.