

Service Process Enhancement in Medical Tourism with Support of Augmented Reality

Medikal Turizmde Artırılmış Gerçeklik (AG) Destekli Hizmet Süreci İyileştirmesi

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Abstract

Digital technologies play a critical role in streamlining the supply chain process and reducing operational time in service businesses, as demonstrated by the COVID-19 pandemic. Service providers may be able to do their tasks quickly and effectively if they digitize their processes. The goal of the project was to create an application that supported augmented reality (AR) for the order-picking process for a medical facility. Reducing order picking time is this study's secondary goal. Adobe Aero is used in the development of AR apps. Data for 278 observations during a month were analyzed in Minitab-21 using comparison groups. The order-picking process may be implemented using AR, according to the results, and there is a substantial difference in order-picking time after implementing the AR-supported model ($p < 0,05$; mean order-picking time before 0,64, after 0,45). In contrast to the traditional method, the box plot in the AR-supported model indicates that the data range is large and uniformly distributed. AR is a useful tool in the service supply chain for order picking. Order picking time is positively impacted by the AR-supported model.

Keywords: Service-Supply Chain, Order Picking, Augmented Reality, Health Tourism, Tourism.

Jel Codes: L84, L86, M11.

Öz

COVID-19, hizmet sektöründe tedarik zinciri süreçlerin kolaylaştırılmasında ve işlem sürelerinin kısaltılmasında, dijital teknolojilerin hayati olduğunu ortaya çıkarmıştır. Süreçlerini dijitalleştirmiş hizmet işletmelerinin de operasyonlarını zamanında ve etkin bir şekilde tamamlaması mümkün olacaktır. Bu çalışmada bir sağlık kurumunun sipariş toplama sürecine ilişkin Artırılmış Gerçeklik (AG) destekli bir uygulama geliştirilmesi amaçlanmıştır. Sipariş toplama süresinin kısaltılması da çalışmanın ikincil amacıdır. AG uygulaması için Adobe Aero kullanılmıştır. Grupları karşılaştırmak için bir aylık sürede toplanan 278 veri, Minitab 21 ortamında analiz edilmiştir. Sonuçlar göstermektedir ki geliştirilen AG uygulaması, sipariş toplama süreci için kullanılabilir. Diğer bir sonuç ise, AG uygulamasından sonra sipariş toplama süresinde anlamlı bir fark ölçülmüştür ($p < 0,05$, önceki ortalama: 0,64, sonraki ortalama: 0,45). Kutu grafiğinde özetlendiği gibi geleneksel yöntemin aksine, AG-destekli model ölçüm sonuçlarında verilerin daha homojen ve geniş bir aralıkta yayıldığı görülmektedir. Geliştirilen AG uygulaması, hizmet tedarik zincirinde sipariş toplama süresini kısaltmak için uygun bir araç olarak kullanılabilir. AG destekli model, sipariş toplama süresinin azaltılmasında pozitif bir etkiye sahiptir.

Anahtar Kelimeler: Hizmet Tedarik Zinciri, Sipariş Toplama, Artırılmış Gerçeklik, Sağlık Turizmi, Turizm.

Jel Kodları: L84, L86, M11.

1. INTRODUCTION

The World has been challenged with the COVID-19 pandemic which has greater expansion than ever. Even though it was the biggest pandemic: The Black Plague (in 1347s, 200 Million people were killed), now it is reported that COVID-19 will have more effect than ever with confirmed 767 726 861 cases WHO, (2023). So many people have died, and even more people have become ill and lost their jobs & family members, the economy has nearly collapsed in some countries and the inflation rate and production amount decreased dramatically worldwide in the last pandemic. Loss in working hours because of illness, and time that people stay at home and hospitals could be recovered through digital technologies in each industry mostly in health care and health tourism areas.

Healthcare is a robust industry that has strong relations with travel, tourism, wellness, information, communication, and technology. The concepts of health and travel are often used together (Wong & Hazley, 2020). The reason for merging two concepts is the idea behind two is healing. Health tourism is aimed at improving health while on holiday (Connell, 2006). This improvement is mainly based and depends on digital technologies such as AR, as one of the immersive 3D ecosystems.

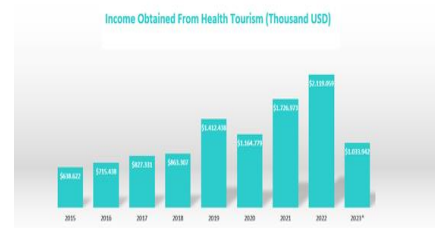
A growingly important segment in the tourism industry is health tourism. It brings in a sizable sum of money for the majority of nations. To put it simply, it's a type of tourism where travelers are driven by concerns related to their health. Health tourism is a niche area in tourism and has become more important than ever. It generates an important amount of revenues for most of the countries. With a simple definition, it is a kind of tourism in which people are motivated by health care matters. According to The United Nations World Tourism Organization:

'Health tourism covers those types of tourism which have as a primary motivation, the contribution to physical, mental and/or spiritual health through medical and wellness-based activities which increase the capacity of individuals to satisfy their own needs and function better as individuals in their environment and society' (WTO, 2018).

Health tourism including wellness and medical areas is the most affected and examined industry in nearly three years from 2020. Travel restrictions, quarantines, and remote working conditions change everyday routines for people of all countries. Compared to 2020(407.423) in 2021 the number of incomings (670.730) increased in Türkiye (Turkey) who are coming for medical purposes (USHAŞ, 2022). Apart from the pandemic effect, medical tourism was expected to generate 1,7-1,8 Billion USD in total. Compared with total tourism expenditure (3,5 Billion USD-UNWTO-pre-pandemic), it is a highly important amount for the tourism industry. The number of tourists visiting Türkiye is depicted in Graph 1.



Graph 1. The # Tourist Visiting Türkiye



Graph 2. The Income of Health Tourism

The number of incoming tourists increases in 2021 and 2022 when the effect of the pandemic decreases, and health tourism revenues have also increased respectively. The COVID-19 pandemic has altered lifestyles. Economies came up again in nearly Great Depression times of the 1930s. In a situation this dire, digitalization and remote control techniques are key to accelerating procedures, lowering error rates, and boosting efficiency. This is a developing topic, particularly in the healthcare sector. Augmented reality, or AR, is one of the useful technology instruments for digitalization in the service supply chain.

Service supply chain management (SSCM) is a management tool for orders, processes, and demands and has a main function in operation management in health tourism operations. The bottleneck at any stage resulted in long waiting times, long customer lines, and unsatisfied customers. To manage the process and be on time all SSCM operations should be scrutinized carefully and meticulously. The recent developments in technology solve real-time solution problems and get instantaneous responses. The increase in the implementation of digital technologies is also shortening processing times. Order picking is one of the main components of SCC operations considering the SSCM. Order picking is a broad meaning of pulling materials from original places, warehouses, or storage. Considering the repetitive processes in routine work, this process takes a long time in daily work. Besides, the bottlenecks in this process mean long waiting times and customer lines in facilities. The study tries to implement one of the digital technologies AR in the main SSCM operation to order picking as a case on healthcare facility. As a secondary aim, the study tries to decrease the order picking time on the process which is subjected to the study.

2. SERVICE SUPPLY CHAIN AND ORDER PICKING TIME

Service Supply Chain Management (SSCM) entails managing the orders, processes, information flow, capacity and demands, and customer and supplier relations from start to end of the customer order process (Ellram, Tate & Billington, 2004; Baltacıoğlu, Ada, Kaplan, Yurt & Kaplan, 2007; Arlbjørn, Freytag & Haas, 2011). Order picking, in particular, needs to be planned extremely carefully and precisely if there are many orders and only a few service providers.

Order picking is the retrieving of material from the warehouse or its original place. Order picking is the most crucial process in the service supply chain (Giannikas et al., 2017; Manzini et al., 2015), that significantly affects customers' service perception and satisfaction. Order picking is accepted as the most labor-intensive and costly activity for enterprises (De Koster, Le-Duc & Roodbergen, 2007). The order-picking process is constituted 60 % of labor activities and its costs are estimated as 65 % of operating expenses (Gademann & Velde, 2005; Tompkins, White & Bozer, 2010). For the service industries, it is also an essential procedure. Any mistakes in the process may result in long waiting times and dissatisfied customers. The time of order picking for specific items can be a significant challenge in healthcare facilities. Due to the supply chain's operational complexity and economic significance, digital technologies like augmented reality are continuously employed in this process (Wang, Wang, Song & Su, 2020).

3. THE ENHANCED REALITY IN MEDICAL TOURISM

The use of new technologies in service processes increased demand for related services. The health care and medical tourism is one of them. Every advance in technology has a positive impact on health tourism (Helmy & Travers, 2009). The use of technology in any area of tourism affects the creator, protector, and enhancer (Stipanuk, 1993). Research revealed that the utilization of ICT, virtual technologies, and virtualization is an important parameter in competitiveness in the tourism industry (Bojnec & Kribel, 2004; Buhalis, 1998)). The quality of health services and good facility conditions make the tourist destination attractive (Üstün & Uslu, 2022). Researchers state that one of the most fundamental factors in choosing a hospital and city in medical tourism is the implementation and use of technology (Sonel et al., 2019). Augmented Reality (AR) is one of the suitable technologies for tourism and health tourism (Wong & Hazley, 2020).

According to Azuma et al. (1997), AR is a system that combines real and virtual in a single ecosystem and provides interaction with reality. AR has numerous implementations including warehouse planning routing, inventory management, last-mile delivery, staff training & consulting, and especially order picking (Ginters et al., 2020; Mourtzis, Samothrakis, Zogopoulos & Vlachou, 2019).

AR is used to decrease error rates, picking times, and learning times (Ponis et al., 2020; Reif et al., 2010). AR-supported systems can also have benefits such as; increased flexibility, improved reliability, increased overall speed, increased adaptability, increased safety and help young users to adapt and enjoy the new technology (Stoltz et al., 2017). AR-supported technologies provide digital transformation in the Industry 4.0 (I 4.0) age (Bright and Ponis, 2021). It is applicable for mobile devices even for daily life routines (Olsson et al., 2012). Using AR in operations has advantages in the faster learning curve, travel savings, and less downtime (Mainelli, 2018).

AR supported order picking studies fall into the subjects: visualization order picking instructions to decrease task completion times and errors, calculation perceived cognitive load (Muraier et al., 2018), to support warehouse operators and operations by decreasing error rates, picking times and learning times, increase the motivation of the user (Reif et al., 2009), to decrease dead times (Schwerdtfeger & Klinker, 2008), to increase user motivation, users' performance and job satisfaction (Plakas et al, 2020).

Health care is one of the revenue-generating service sectors that employ several supply chain operations, such as material handling, the flow of material, and the order-picking process. AR has applications in the healthcare industry's supply chain. According to research, using augmented reality (AR) can cut human error rates in the healthcare sector by up to 45% in some of the most important processes, such as drawing blood samples (<https://techinnovations.info>, 01.08.2022). It is a crucial step in the medical field's Service Supply Chains (SSCs).

However, AR implementation in tourism is frequently reviewed in cultural heritage and museums (Mesáro et al., 2016; Abawi et al, 2004; Alzua-Sorzabal, 200; Olar et al., 2019; Marimon et al., 2010) there are a few studies related on digitalization and I4.0 in medical and health tourism (Amouzagar et al., 2016; Wong & Hazley, 2020). A need exists in supply chain

activities enabled by AR, particularly in order-picking procedures in service industries, particularly medical tourism and health care.

Considering the volume of health tourism, this study describes the design and development of an AR-based application for a healthcare facility supply chain process and evaluates the application's effect on the process.

4. MATERIALS AND METHODS

It is a cross-sectional study. The proposed AR-supported model helps users to get information about the material while seeing it simultaneously. Additionally, it is anticipated that using an AR-supported model to visualize information about linked items will shorten the time it takes to realize and comprehend. Thus, the proposed model aims to decrease the order picking time. It denotes a reduction in operating time overall for a service supply chain.

4.1. Research Location and Period

The study was conducted in a hospital and data was collected between a month between 09.00-17.00 hours randomly.

4.2. Representative and Population

The prospected model is available as a mobile app. In this manner, the user can use his mobile device—a phone, tablet, etc.—to control the process. Digitalization simplifies the procedure compared to traditional ways, as it is an emerging topic in this "post-COVID-new normal" period.

To see the pattern of the process and time between the order-picking cycle, manual operations are observed. In the first randomly observed 100 data the number of error occurrence level is 10 %. The study holds under % a 95 confidence level. The required number of observations(sample) has been calculated as 139 in order to ensure normality and homogeneity ($p > 0,052$ for normality, $p > 0,514$ for homogeneity).

4.3. Dependent and Independent Variables

The dependent variable is order picking time. The Independent variable is the proposed AR technology.

4.4. Unit of Analysis

Study based on order picking in service supply chain operations at hospitals. Therefore, the unit of analysis in this study is the order-picking process in the hospital.

4.5. Data Collection Tools

In order to collect data, an observation form is used in this study. Order picking time is observed before and after AR-mobile application implementation by means of observation forms.

4.6. Problem Synopsis

The AR-supported model provides information for the material from mobile applications. It helps in picking the right material. The study has also a secondary aim such as: decreasing order picking time. Thus, the problem statement and hypothesis are:

Problem: Is the AR-supported order-picking process applicable to hospitals?

The proposed model tries to decrease order picking time. To use any paper list or any document, the user can just use a mobile phone. Employing the mobile app, the right material will be picked for the first time. It means a decrease in time for the order-picking process.

H1: There is a significant decrease in order picking time after AR-supported model implementation.

4.7. Procedures

Procedures Hospitals use a vast array of materials. Mistakes may most likely happen on materials with comparable physical displays. This research will involve the use of tubes of various colors and purposes. Some examples are shown in Picture 1.



Picture 1. Some Materials were Subjected to This Study

The study concentrated on two varieties of blood sample collection tubes: serum and blood collection tubes. Yellow tube is called an SST (Serum Separator Tube) and is used generally for serum and blood separation purposes in Microbiology, Biochemistry, and hormonal tests. A yellow tube generally is used for blood serum. Purple tubes are for Complete Blood Count (CBC), known as hemogram. They are very similar objects in physical appearance. The color of the cap is also not always deterministic for example for new personnel who do not have enough experience in the process. As a result, additional information can occasionally be crucial to the procedure. The initial stage of the investigation involves assigning an ID to the items that are being studied to streamline the procedure. Material information is given in Table 1.

Table 1. The Information about the Material Subjected to the Study

Material Type	Name	ID	Function
Yellow	Serum Separator tube	SST	Taking Blood Serum
Purple	Hematology & Cross Match Tube	CBC	For Hematology tests and -cross-match analysis

The data regarding the materials utilized for the AR-supported model was compiled in Table 1. The second step of the study is developing the AR-mobile app. AR app is developed on Adobe Aero. The only required device to visualize and to insight into the created AR model is a mobile phone. There's no need to carry a hand terminal, a gadget, a paper list, etc. thanks

to AR-assisted systems. Using a specially created augmented reality app, all relevant material information is displayed on the user's phone when they launch the application and point it at the content. The third and final phase of the research involves evaluating the effectiveness of the created application in terms of order picking time during blood sample collection and contrasting the outcomes of the traditional system and the novel AR-supported model.

4.8. Data Collection

Data is collected between a month between 09.00 and 17.00 hours randomly. Observation will be done in order to get results for:

- The natural pattern of the process
- Calculate the order picking time

The AR-assisted model has been developed in AR Adobe software. Although the model was created on a desktop with a 512 GB capacity with processor 11th Gen Intel(R) Core (TM) i9-11950H @ 2.60GHz 2.61 GHz, 16.0 GB RAM, 64-bit operating system Windows 10 Enterprises, it has also a mobile app.

4.9. Statistical Analysis

On Minitab 21, data will be examined and test statistics will be computed. The outcomes obtained before and after the installation of AR are compared using descriptive statistics. In addition to descriptive statistics, a box plot will be drawn. $P < 0.05$ was used to allow type 1 error.

5. RESULTS

Results showed that the AR-supported system is applicable for the process, subjected to this study. The AR app's screenshots are provided here.



Picture 2. The Snapshot from an AR Implementation SST Picking Process

With the use of supporting elements like check marks and drop symbols, as well as acronyms like SST in Picture 2, the AR software facilitates comprehension of the material's function. An image from the AR application for SST picking is shown in Picture 2. Additional symbols, images, and three-dimensional objects are needed to complete the suggested model's augmentation. In the case of simplification, only three symbols from the software were used: SST, check marks, and drop.

The CBC tube selection procedure is another use. Image 3 is a screen grab from Adobe Aero.



Picture 3. The Snapshot from an AR Implementation CBC Tube Picking Process

CBC is another material that is subjected to this study. 3D objects will appear when the user opens the app on their phone and points it at the material. Additionally, the AR app makes it obvious if the user is still unsure if the content is appropriate. The environment is further enhanced via apps.

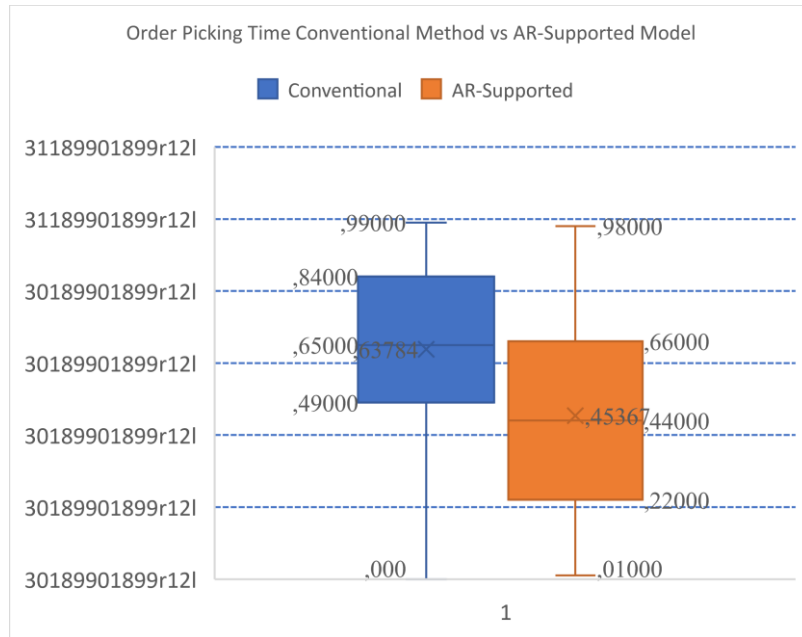
The study is trying to realize the AR app for one of the daily operations in the service supply chain. Besides, the process should be more reliable utilizing a designed model. The designed system in this study is more reliable than the conventional one. The study holds % a 95 confidence level the number of observations is 139 before and after the AR implementation. The test statistics are summarized in Table 2.

Table 2. Test Statistics

	#of Observations	Mean	STD Deviations	P
Conventional	139	0,64	0,25	0,000
AR supported Model	139	0,45	0,26	

*P (= 2,08E-09) < 0,05

In Table 2 order picking time is measured before and after the AR-Supported model was implemented. Also, with comparing two groups P-value has been calculated as < 0,05. Thus, the developed AR-supported model has a positive effect on decreasing order picking time. Since the statistics are significant, the AR-supported system is valuable for the concerned process. Also, the box plot is supported by the test statistics.



Graph 1. Box-Plot of Conventional Method versus AR-Supported Model

According to the box plot data range is wide and data are spread homogenously in AR supported model compared with the conventional method. Besides, in the AR-supported system, order picking time is decreased as shown in Graph 1. Also, according to the box plot median line of the AR-supported model is not aligned with the conventional system. It means, there is a significant difference between groups. Thus, the AR-supported model has a positive effect on decreasing order picking time.

6. DISCUSSION

It is known that the use of technology makes significant contributions to improving processes in labor-intensive sectors such as the service sector. Health tourism is also one of the labor-intensive sectors with increasing demand. It is seen that the digital technologies used have positive effects on improving the processes. In this study, the improvement in the process was demonstrated through the application of AR in a labor-intensive, error-prone process on SSCM.

Service supply chain differs from traditional manufacturing supply chain operations. Customer orders initiate the service supply chain mechanism. Since there is more than one order and in most cases, there exists only one service provider, then the service supply chain operations become crucial. Consequently, in order to prevent client complaints and service lines, it is critical to efficiently organize and oversee the procedure within time constraints. The study focused on one of the human-intensive and error-prone processes on SCCM: order picking with the implementation of AR.

Apart from a few applications on digitalization issues on medical and health tourism issues (Amouzagar et al., 2016; Wong & Hazley, 2020), no further research has been found on health tourism and AR implementation. There are a few studies have been found on the application of AR in tourism. The studies in the field of tourism focused on cultural heritage and museums. The studies in the fields of cultural heritages and museums generally were

intensified on the digitalization, remote viewing, and promotion of museum objects and, in general, in the field of marketing (Mesáro et al., 2016; Abawi et al, 2004; Alzua-Sorzabal, 200; Olar et al., 2019; Marimon et al., 2010). Since there is no research on process improvement in any operational perspectives in health tourism is evaluated as a gap. The main results revealed that AR technology decreases the order picking time significantly. The study is focused on similar items in the blood sample-taking process. Order picking time is short when considering other materials from the main warehouses. Order picking time can be evaluated and shown to be brief, however, in large healthcare facilities, this process can be repeated thousands of times a day. As a result, the order picking time for such a particular item could be disastrous.

7. LIMITATIONS AND STRENGTH OF THE STUDY

The study focused on two types of blood sample-taking tubes. They are the blood and serum-taking tubes. In order to simplify the process only two types of tubes were subjected to this study.

Digitalization has become an emerging buzzword after COVID-19. Besides, the healthcare is the main sector in which the digital technologies are mostly used. Based on this evidence, the approach and the developed AR-app, make the study novel. Eventually, the most prominent outcome of this study is the AR app for the healthcare industry.

8. CONCLUSION

Digital movement into human life accelerated after the COVID-19 pandemic. Maybe the pandemic is one of the facilitators of this digital revolution. In any event, businesses as well as individuals work extremely hard to embrace the digital age. For the time being, most of the technologies are accessible. Even individuals can create content. Furthermore, enterprises are very keen on so-called 'digital transformation'. They want to use new technologies in their operations in order to eliminate errors, and waste and speed up processes. Since the creation convenient and immersive ecosystem, AR-supported technologies are frequently preferred. AR has the potential to revolutionize various industries by improving operational efficiency, enhancing customer experiences, and increasing productivity.

The study can be extended to measure order picking time for some other materials for example materials used in surgery operations or emergencies. The study may also be enlarged to measure the learning effect of AR supported system. It is possible to get prospected results using learning curves.

AR has many functions in the manufacturing, service, health, education, and tourism fields. The idea behind AR is to create an immersive 3-D ecosystem for users. Hence, AR can also measure the process performance, decrease process/transaction times, and decrease learning times in any part of the tourism and service fields.

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