EĞİTİM yayınevi

DIGITALIZATION AND SMART TECHNOLOGIES IN GASTRONOMY

Editors: Dr. Cihan CANBOLAT, Dr. İbrahim ÇENİÇ



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PREFACE

Dear Reader,

Our book on digitalization in gastronomy and technologies entering the kitchen was written by experts in the field of gastronomy. This resource, where you can access a lot of information about the technological developments in the kitchen, will add vision to the chefs of the future. If you are wondering how the technology, which always provides convenience to human beings, has entered our lives in kitchen, you can start the adventure with the first chapter. We wish you delicious reading.

Editorial Board

PRESENTATION

Cultural and economic sustainability in food and beverage is possible with differentiation. The subject of technology also emerges as a current element for differentiation in businesses. This book contains many technologies and innovations about gastronomy. I think it is a qualified book that will contribute to the related field.

Prof. Dr. İrfan YAZICIOĞLU

An up-to-date book with many interesting titles has been created. Technological developments are rapidly advancing in the field of gastronomy, as in all other fields. In order to follow these developments, such books will contribute to the future of gastronomy.

Assoc. Prof. Dr. Ümit SORMAZ

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Dr. Cihan CANBOLAT,
Dr. İbrahim ÇEKİÇ

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DIGITALIZATION AND SMART TECHNOLOGIES IN GASTRONOMY

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DIGITAL TWINS OF LOCAL CUISINES: IS IT POSSIBLE?

Reha KILIÇHAN[5]

INTRODUCTION

Humankind has produced much more of the knowledge it has accumulated since its existence at a great pace while individuals, societies, and the paradigms surrounding them have changed drastically, particularly in the last two centuries. The incredible development of technology in this process has brought along many social and economic changes with it. Today, the decreasing number of craftspeople and small business owners operating in their small shops every passing day are among the most notable examples of this change. This change in our environment has affected people's consumption habits and we have started to consume everything very quickly. As the new items they buy provide temporary satisfaction, people have become easily bored with the items they have. This situation did not happen unexpectedly, for sure. The industrial revolutions have left humanity alone with this situation by using all kinds of means over time.

Industry phase 1.0, the first of the industrial revolutions, began with the invention and use of steam-powered machines as a result of the realization of water and steam power at the end of the 18th century. The establishment of factories provided an opportunity to increase production as a support for human power. During Industry phase 2.0, which lasted through the end of the 19th century and the beginning of the 20th century, there were quite great advances in terms of increasing the welfare of society as a result of the use of electrical energy in production (technological developments such as automobile, bicycle, and gramophone production) and the increase in mass production (Atar, 2019: 101; Ilgaz, 2020: 7). The Industry phase

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3.0 refers to the period between the 1940s and the early 2000s, during which significant developments including computers, digital products and solutions, and the internet took the lead, and especially the progress in communication technologies was included in the production process. When the first three industrial revolutions are examined, it is understood that the mechanization, electricity, and information technologies are integrated successfully in the process of production, and from this point of view, Industry 1.0 has been considered as "the mechanization era'', Industry 2.0 as "the electric era'', and Industry 3.0 as "the technological era''. The Industry 4.0 phase we are in is defined as "the smart machines era'' that emerged with the approach put forward at the Hannover Fair in 2011 and is currently not possible to predict when it will end (Görçün, 2016: 141). So, the Industry 4.0 phase has emerged as a result of the developments and advances in the Industry 3.0 phase, which we experience as today's modern technologies are used such as the industrial robots and man-machine interfaces, the Internet of things (IoT), and the contact between the machines, artificial intelligence, and machine learning, data science and specialty, cloud computing systems and data centers, big data management, cyber security, virtual reality (VR), augmented reality (AR) and 3D printers technologies (Ilgaz, 2020; Özdoğan, 2018).

It would not be appropriate to evaluate all these industrial revolutions negatively only through today's "consumerism'' behavior. In fact, these developments are positively reacted in many different sectors and they have entered the process of increasing use each passing day with their beneficial aspects. For instance, while tourists save time and cost as a result of the developments mostly in transportation in the tourism sector that billions of people participate in traveling movements every year, they can easily get information in advance about the destinations they will travel to thanks to the digital and virtual platforms (internet service providers, automation programs, virtual reality, augmented reality, etc.) This situation can also have an impact on the travel preferences of tourists traveling for different purposes. To clarify with a different example, the tourists, who are traveling for gastronomy tourism purposes, are in search of information about the local cuisine of the destination they are visiting and they can make decisions with the help of technological developments such as smart tourism technologies (the Internet of things, mobile communications, cloud computing, artificial intelligence, etc.) and the digitalization developments emerging with the Industry 4.0 (Karamustafa and Yılmaz, 2019). In this context, the fact that the businesses providing services in the destinations follow the current developments may provide advantages in terms of competitive advantage.

In recent years, the internet of things technology, which is developed as a result of the spread of all smart devices, especially mobile phones used by people, the

increase in wireless networks, and the increasing cheapening of embedded systems and sensors, and defined as "that things such as machinery, hardware, etc. get contact among themselves through virtual personalities and abilities they get and being able to directly perform some of the functions in consequence of this contact", become widespread each passing day (Görçün, 2016: 147). It is known that the "digital twin" technology, which can be briefly referred to as the "virtual presentation of physical products" in the internet of things and is one of the modern technologies used in Industry 4.0, is developing day by day and used in different sectors.

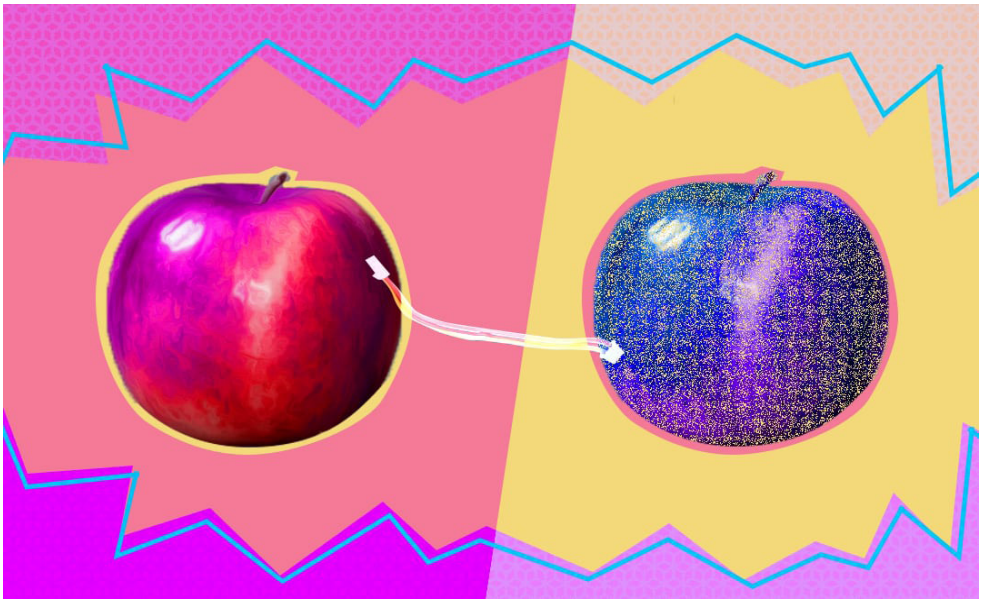


Figure 1: Digital Twin Apple Example

Source: IoT For All. (2022). How Digital Twins Can Help Retailers Give More to Food Banks, https://www.iotforall.com/wp-content/uploads/2019/02/2.19.19-How-Digital-Twins-Can-Help-Retailers-Give-More-To-Food-Banks.jpg, (E.T.: 10.09.2022).

Although it has become widespread in some sectors and academic studies have been carried out in related fields, there is a lack of information in the literature, especially in the context of food and beverage businesses and gastronomy. Based on this gap, the topics of local cuisines, which are an important gastronomic trend, and digital twins, which are another important technological trend, are presented within the scope of this book chapter under the title "digital twins of local cuisines". To evaluate these two independent trends under one roof, the concepts of local, local food, and local cuisine were explained first, the importance of local cuisine in tourism was mentioned, and the local cuisine in terms of supply and demand was evaluated based on a literature review. Then, the topic of digitalization in food and beverage businesses was examined and digitalization applications in the kitchen,

restaurant environment, and service were indicated. Later, the concept of digital twins was explained, a conceptual model was developed, the topic of digital twins was examined within the framework of the metaverse universe, and the topic of local cuisine was synthesized together and it was evaluated in terms of supply and demand. In the conclusion part, the possible benefits of digital twins for food and beverage businesses are revealed, the possible problems and difficulties in the application are mentioned and the recommendations for future studies are given.

LOCAL CUISINE

To put the definition of local cuisine on a solid basis, it is first necessary to explain the concepts of "local" and "local food". The word "local" is used meaning of "belonging to or connected with the particular place or area that you are talking about or with the place where you live" (Oxford Learner's Dictionaries, 2022). The concept of "local food" (local food and beverage product) is defined in various ways with different points of view in the literature. As an example, while Sharma, Gregoire and Strohbehn (2009) define local food as products grown in that region and can be purchased directly from the producer or farmer's market, Wilkins, Bokaer-Smith and Hilchey (1996) define it as food and beverages produced in the same country, region or nearby region. It is worth noting that culture is an important point in the concept of local food. In this context, Inwood, Sharp, Moore and Stinner (2009) define local food as "food and beverages produced in a region that reflects the local culture of the related region". In the literature, the fact that foods have local characteristics is also limited by the concept of distance. For example, while Kang and Rajagopal (2014) emphasized that food should be produced at a maximum distance of 200 miles (about 322 km) to be considered a local product; Onozaka, Nurse and McFadden (2010) stated that it should be produced at a distance of 50 miles (about 80 km). Based on these definitions of local food, it is understood that in order for a food to carry local characteristics, it should be produced in a particular region, purchased at the farmer's market or directly from the producer, and within a certain distance between the point of production and consumption (Özdemir, Yılmaz, Çalışkan, and Aydın, 2015).

While Kim et al. (2009: 424) define the concept of local cuisine as the natural unique food and beverages produced in the local region; Horng and Tsai (2012) define it as the sum of food products, dishes, and cooking techniques enabling the emergence of a country or region's unique culinary culture. In another definition, Su and Horng (2012: 92) explain it as an important element revealing the cultural differences between societies and regions. With a broader definition; Durlu Özkaya (2009: 266) states that, in addition to the foods and beverages that a region or an area has, it is a unique cultural structure that consists of the methods related to the preparation, cooking, consumption, storage, and serving of these foods and

beverages, the tools and equipment used in their presentation, the location of the kitchen, the architecture, food ceremonies, and the beliefs and applications developed within this context. As can be understood from the definitions, the concept of local food is actually used for food and beverage products and the equipment used in local cuisine. We see the concept of local cuisine also as a cuisine where local food products are used and unique dishes bearing traces of local culture are presented.

The Importance of Local Cuisine in Tourism

Local cuisine is an important element of tourism in terms of reflecting the culture of the region, adding charm to the destination, and ensuring that tourists adapt to the local culture (Au and Law, 2002: 828; Çela, Lankford and Lankford, 2007). Tourists want to experience the local cuisine not only to appease but also because it is one of the purposes of travel. (Shenoy, 2005: 42). Nowadays, the number of people traveling to experience local cuisine is increasing every day (Hall and Mitchell, 2000: 447). Local food and beverages are powerful and effective tools in improving or worsening the profile of a region as a tourism destination (Toksöz and Aras, 2016: 177). Dishes with a unique geographical origin strengthen the image of the region and promote branding and the development of tourism (Green and Dougherty, 2008: 150). In this regard, local cuisine can be used as an important touristic resource for tourism and food and beverage operators.

The most important way to interact the local culinary experience with the tourism destination experience is to ensure that the local food and beverages take place on the menus of hotels and restaurants that conduct business in the destination and to organize local gastronomic events and provide the opportunity to experience the local foods and beverages belonging to the region by attracting the attention of tourists coming to the destination at the same time (Bucak and Aracı, 2013: 208; Ülker, 2020: 69). Therefore, it is extremely important for food and beverage businesses and hotels to offer dishes and beverages of local cuisine, especially for the development of gastronomic tourism (Karamustafa, Ülker, and Ülker, 2018: 812). For example, Yurtseven and Kaya (2011) investigated how many local products are included in the menus of food and beverage businesses in the research they conducted in Gokceada. In the results of the research, it was stated that visitors could not access enough local products and information in the business menus, they also did not see local cooking methods and presentations. However, the visitors stated that they wanted to taste a variety of local dishes. In this context, Inwood et al., (2009) stated that restaurant chefs, who are in a decision-making position, have a major role in placing local cuisine dishes and beverages on restaurant menus.

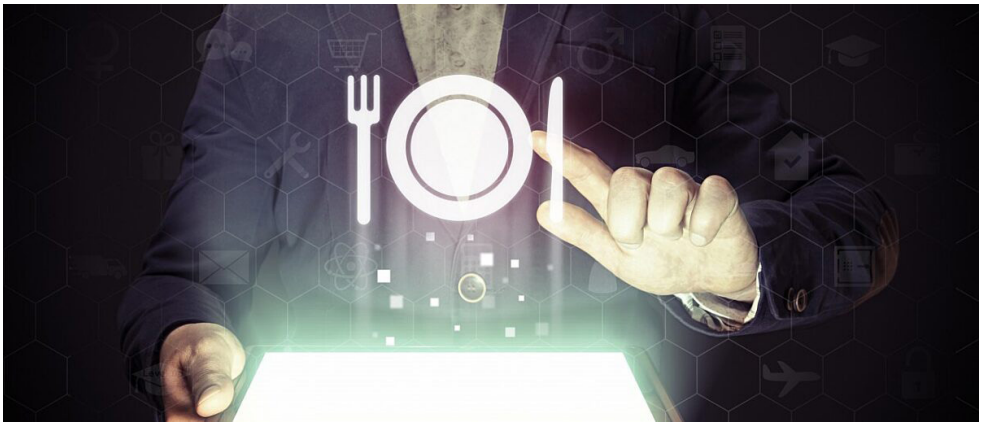


Figure 2: Digital Twin Management

Source: EIT Food. (2022). Digital Twin Management, https://www.eitfood.eu/files/_1200x514_crop_center-center_82_line/AdobeStock_137800326.jpeg, (E.T.: 10.09.2022).

When the studies related to local cuisine and tourism are examined, it is possible to say that there is a consensus on the benefits that the use of local cuisine provides to the destination and that it is an element of attractiveness for tourism destinations. Based on this inference, local cuisine can be considered an extremely important element in tourism.

An Evaluation of Local Cuisine in Terms of Supply and Demand

In the relevant literature, local cuisine is discussed with the dimensions of supply and demand. While the supply of local cuisine consists of businesses and background stakeholders that offer local culinary products such as hotels and restaurants and play a leading role in production, the demand for local cuisine is determined by the customers themselves and professionals with decision-making authority such as kitchen chefs and business managers.

Studies in the literature have addressed the demand for local cuisine from the following aspects: factors affecting the consumption of local food by tourists (Fields, 2002; Kim et al., 2009; Chang et al., 2010; Mak et al., 2012), perceptions of chefs and business managers about the qualities of local food (Strohbehn and Gregoire, 2003; Onozaka et al., 2010; Curtis and Cowee, 2009), the benefits of selling local food and their perceptions regarding the obstacles (Gregoire and Strohbehn, 2002; Strohbehn and Gregoire, 2003; Inwood et al., 2009; Kang and Rajagopal, 2014), their experiences with local foods (Sharma, Moon and Strohbehn, 2014), their attitude towards local food (Starr, Card, Benepe, Auld, Lamm, Smith and Wilken, 2003; Gregoire, Arendt and Strohbehn, 2005; Green and Dougherty, 2008) and their intentions to buy local food (Strohbehn and Gregoire, 2003; Curtis and Cowee, 2009; Inwood et al., 2009; Kang and Rajagopal, 2014). It is seen that the research on the supply of local cuisine is pointed out in many studies on the topics such as

contribution to the cooperation between tourism and agricultural industries, cost reduction, the benefit it provides to destination competitiveness, shaping local identity, providing sustainable regional development and the contribution it provides to the maintenance of local gastronomic culture (Sims, 2009; Sharma et al., 2014; Inwood et al., 2009; Okumuş and Çetin, 2015; Guan and Jones, 2015). Based on the literature review, one could say that the topic of local cuisine is a very comprehensive topic in terms of supply and demand, as well as being a gastronomic trend. Based on the current literature review, it is seen that the studies on local cuisine mainly focus on chefs, restaurant managers, and the motivations that influence consumers to buy local food. The benefits, opportunities, and obstacles of purchasing local food products are also examined in the literature. In addition to these issues; it is seen that studies on revealing the profiles of consumers and chefs who buy local foods, the use of local cuisine in destination marketing as an element of attractiveness, the perception of chefs about local foods, the place, and importance of local cuisine in the travel experience, have also been conducted. In this context, it can be said that various studies that approach the topic of local cuisine from different views have been carried out. However, since there is no study on the local cuisine trend and the digital twin trend, this book chapter is important as it is one of the first academic studies to address these issues.



Figure 3: Digital Twin Airline Caterer Example

Source: APEX-The Airline Passenger Experience Association. (2022). Real Food, Virtual Kitchens: With Digital Twins, Two Is More Efficient Than One - Illustration by Oscar Matamora, https://apex.aero/articles/real-food-virtual-kitchens-digital-twins-two-efficient-one/, (E.T.: 10.09.2022).

DIGITALIZATION IN FOOD AND BEVERAGE BUSINESSES

Digitalization is defined as the process of adopting and using multifaceted socio-technical facts and digital technologies in broader individual, organizational and social contexts (Legner et al., 2017: 301). Moreover, it can be said that digitalization has become an important power affecting interpersonal relationships, consumer behavior, and marketing activities of businesses in our daily life and business life. So, today, most consumers make decisions under the influence of digitalization, and the businesses, that are aware of it, have been working to meet their potential consumers' desires, needs, and demands by understanding them and considering their socio-demographic characteristics. Food and beverage businesses also contact their customers through social networks (*Instagram* etc.) and they also engage in social media marketing through various means such as video marketing, content marketing, mobile marketing, and effective use of social media (Pamukçu and Tanrısever, 2019). Another issue related to digitalization is the technologies that can be used within the scope of digitalization such as enterprise resource planning, business intelligence, cloud computing, internet of things, artificial intelligence, financial technologies, and blockchain technologies, and the use of these technologies is becoming widespread in food and beverage businesses every day. Businesses that have succeeded in digitalization by using technology increase their service quality, save time, reduce their costs, and increase their sales and efficiency. From this point of view, it is possible for the businesses that have digitalized by using technology to ensure customer satisfaction and protect their market shares (Işık, Işık and Işık, 2016).



Figure 4: Digitalization

Source: Siemens. (2022). Spot on for the Digital Twin, https://new.siemens.com/global/en/markets/food-beverage/webcasts.html, (E.T.: 10.09.2022).

Digitalization in the Kitchen, Restaurant and Service

The use of technology in business kitchens has reached indispensable dimensions in food and beverage production. So, businesses have been using technology effectively in a wide range from food preparation to taste and flavor enrichment, meeting customer needs and expectations, the gastronomic experience in an impressive manner, and making the foods and beverages produced healthily (Spence and Piqueras-Fiszman, 2013). The change has been gaining momentum each day with the improvement of the equipment and tools used in the kitchen with the influence of the development of technology and digitalization. For example, developments such as remotely controllable smart ovens, robot chefs, 3D printers, smart refrigerators, and temperature-controlled pans are popular examples in today's kitchens (Kayran, 2021; Kılıçhan and Yılmaz, 2020). Although these developments are directly proportional to the level of technology readiness of chefs working in the kitchen, they also provide benefits in terms of saving time, quality, labor, and waste in kitchens (Çalhan and Kılıçhan, 2018). As a result, positive effects are observed on productivity and customer satisfaction. The most widely used examples of digitalization in the restaurant and service areas of businesses are QR codes and tablet menu applications (Sürücü, Ülker and Hassan, 2018). Applications such as robot waiters, robot bartenders, robot busboy, robot host/hostess, smart tables, telematics banquet, and conveyor belt systems are also among the applications frequently used in various countries of the world (Kayran, 2021; Kılıçhan and Yılmaz, 2020). While the saving on personnel costs is provided in the businesses using these technologies, constantly working with the same standard brings continuity, and possible failures caused by personnel are prevented. This situation again provides an increase in service quality, customer satisfaction, and productivity in the business.

DIGITAL TWIN

Digital twin technology, which emerged as a result of NASA's matching technology, was first introduced by Dr. Michael Grieves in 2002 at the University of Michigan for the creation of the Product Lifecycle Management (PLM) center and the conceptual model was presented again by him in 2006 (Grieves, 2016; Grieves, 2006). Although this model was originally called as the "Information Reflection Model'', it was later named as the "Digital Twin'' in the NASA Technology Roadmap in 2010. Digital twin is defined as a digital profile of a physical object or process that helps to optimize business performance in the past and present behavior of real-time and based on the data measurement of one of the most important components of Industry 4.0. The Internet of things; large, cumulative, real-time, real-world and is regarded as a key technology for the realization of cyber physical systems (Kumaş and Erol, 2021: 691-692). In other words, the digital twin is a dynamic, virtual representation or model of a part, object, machine or even the entire production

process. It consists of the physical element itself, the virtual representation of the element, and the connectivity functionality that allows data to go back and forth between the physical and virtual object.

When the conceptual model in Figure 5 is examined, it is seen that there is a three-stage process from the physical environment to the digital environment. Digital shadow, which includes all details such as operational state data, process data, facility and infrastructure data, is being created from the digital master data in which the original and physical product features exist and, finally, these two main layers are integrated and the digital twin is produced (Kumaş and Erol, 2021: 692).

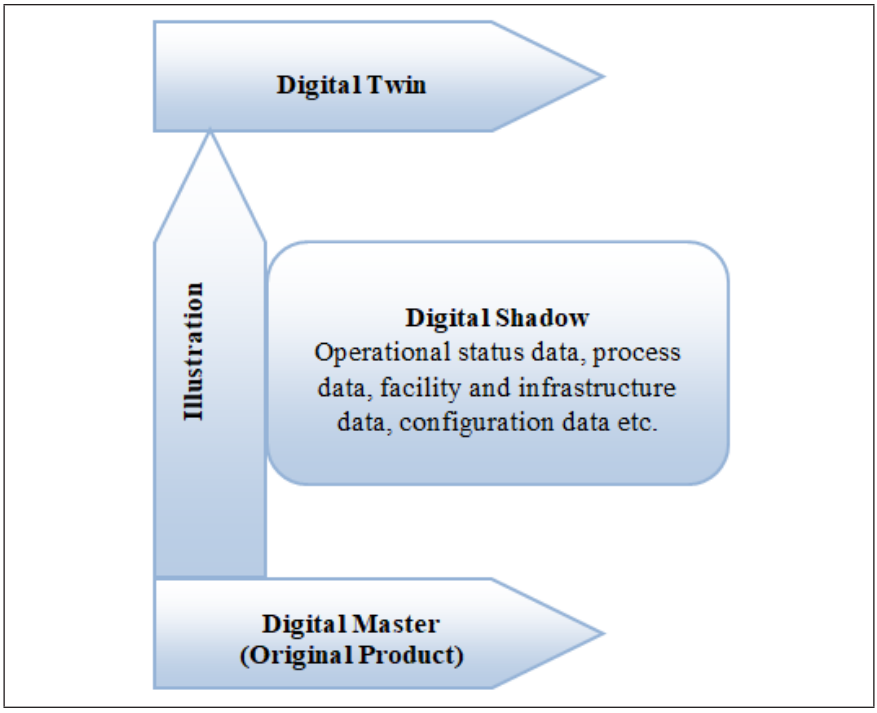


Figure 5: Conceptual Model for Digital Twin

Source: Kumaş, E., & Erol. S. (2021). Endüstri 4.0'da Anahtar Teknoloji Olarak Dijital Ikizler. *Politeknik Dergisi*, *24***(2), 691-701.**

Step by Step into the Metaverse Universe with Digital Twin Technology

The fact that all objects which physically exist, products, production processes, and even people could have digital twins in the near future in the metaverse universe which is defined as a virtual reality environment where the users can interact with other users through a computer-generated environment (Oxford Learner's Dictionaries, 2022) is one of today's discussion topics. So, we see the news about lands, buildings, and shops being sold in the metaverse universe every day. However, what we should keep in mind is that the equivalents of the assets in the virtual world

must also exist in the real world. This is where digital twin technology steps in. Without any physical product, data cannot be collected about this product and its digital twin cannot be produced. This also applies to the products produced by food and beverage businesses.

Today, there are some sectors that already make use of digital twin technology such as automotive, retail, pharmaceutical, green energy, climate change, factory production, and engineering. It is also expected that it will be used by many more sectors in near future such as tourism and food and beverage operations particularly. Big brands such as Forever21, Nike, Samsung, Dogtas, Nef, and AktifBank, which have started to serve in the Metaverse universe and continue their work, offer the best examples of this. That the chain businesses serving in the food and beverage industry such as KFC, TacoBell, Pizza Hut, McDonald's, BurgerKing, Panera Bread, and Wendy's have started to apply for offering virtual food and beverage and virtual products and services to the United States Patent and Trademark Office shows that the digital twin technology can be widely used in this sector in the future.



Figure 6: KFC NFT+Metaverse Trademark Applications

Source: EconoTimes. (2022). NFT: KFC, Pizza Hut, Taco Bell Owner Files Nonfungible Token Trademarks, https://www.econotimes.com/nft-kfc-pizza-hut-taco-bell-owner-files-nonfungible-token-trademarks-1630844, (E.T.:10.09.2022).

It is not a coincidence that the current attempts in the food and beverage sector are made in the fast food sector, which is more industrialized. Because in fast food businesses, all processing steps are carried out within certain rules and programs, and their standards are predetermined applications. In this context, an accurate

description of the food and beverages can be provided by using the IoT devices and sensors to collect data from the environment where the physical environment is located beside a combination of the augmented reality (AR) in the food and beverage businesses to create digital twins and to realize the virtual (VR) and remote control of objects in a more realistic way of visualizing them. However, this situation is not as easy as it might seem for local cuisines. So, the local culinary products are not produced in systematically operated kitchens as in fast food restaurants. Not all types of processing steps are specific and standardized. For example, wherever you go around the world, while a product you buy in a McDonald's restaurant follows basically the same processes using the same production equipment, a manti restaurant serving in the same province may offer the product by following different processes in different branches. The most important reasons for this difference in the local cuisine are that standard recipes cannot be created properly and that the chefs involved in the production follow their own unique methods of working. However, if all businesses produce food and beverage products using the same production equipment, sticking with standard recipes and production techniques, then it may be possible to implement digital twin applications in local kitchens. Thus, businesses that are in competition in the future can save both time and financial resources by implementing digital twin applications.

On the other hand, consumers may want to experience the digital twins of local cuisines supported by virtual reality and augmented reality technologies. So, it would be more beneficial to use more realistic and controllable technologies for the success of digital twin technology in the food and beverage sector. Therefore, having an idea about the shape or appearance of the dishes or beverages they want to order without leaving their physical location can be effective in the decision-making and purchasing processes of potential consumers.

CONCLUSION AND EVALUATION

Digital twin applications, which can be simply expressed as creating a virtual copy of an object, product, or production process existing in the real world to test its performance and effectiveness, can have a number of benefits for food and beverage businesses. These can be to increase efficiency, optimize processes, reduce costs, reduce the error rate and positively influence the decision-making process of consumers about the product. Thanks to this technology, digitalized businesses can develop a product by reaching their potential customers through social networks and creating products that meet the requests and needs of customers in a virtual environment. Operations can achieve customer loyalty by offering more personalized products.

On the other hand, there may be some problems at the institutional acceptance point in the application, especially for businesses that offer food and beverage

products for the local culinary trend. The fact that it particularly requires high-cost investment can be considered a significant problem for small-scale local cuisine restaurants. Another important problem is related to data security regarding the necessary proper data collection, processing, integration, and storage of the data required in local cuisine restaurants. As can be understood, the digital twins are still a debatable issue and open to improvement and understanding since the creation of digital twin technologies both come into our lives recently and we do not have the opportunity to compare the results of application in different sectors and different sizes in companies. Considering these limitations, it is unlikely that digital twins of local cuisines will be created in the near future, but it may be possible with the development of technology and the steps taken together with the corporate acceptance of these technologies by businesses.

Additionally, the knowledge, perception, and attitudes of potential customers, business managers, and kitchen chefs on the topic of digital twins can be examined in future research on this issue. Based on the results of these studies, food and beverage businesses can make decisions on whether to work on creating digital twins of local cuisines.

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