An Overview of the Impact of the Food Sector "Intelligent Packaging" and "Smart Packaging"

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Abstract
The contribution of traditional packaging was significant to the initial development of food distribution systems; however, it can no longer meet the growing demands of modern consumers, businesses, and the rapidly evolving supply chain. New advances in various sciences, particularly in information and communication technologies (ICT), contribute to the emergence of new forms of packaging. The transition to "innovative packaging" with additional functions is beneficial for all participants in the food chain. "Intelligent packaging" and "smart packaging" both provide helpful information and continuous monitoring of the food / product safety and quality during the whole chain. Packaging should be seen as an entire system and offers many benefits to many sectors of our society, such as economic rewards, reduction of food waste, increased food safety, contribution to the circular economy, and in general, responds better to the growing demands of users in their daily lives. The current research reviewed a large number of relevant studies, discussed the main issues, and finally, functional outcomes were generated. Practitioners and academicians will benefit from the current study and acquire helpful knowledge on an exciting topic.

Keywords: Intelligent food packaging; smart packaging; food waste; consumer needs; social contribution;

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1. Introduction

Packaging is an exciting and multidimensional issue, having a significant impact on consumers, businesses, and the economy. The traditional form of packaging using classical printing technologies relies on the specific production process and the exchange of information between the producer, the retailer, and the consumer. Also, packaging is the

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center of intensive research work on the types of information, flows of data, and services that the packaged product should provide.

In the meantime, the requirements of the food industry participants have changed. Food quality is increasingly important and can be identified by many factors, including healthiness, consumer standards, nutritional values, and stability (Kotsanopoulos & Arvanitoyannis, 2017; Zhou et al., 2019). In addition, improving food safety and minimizing food waste are priorities of the food industry. The adoption of novel packaging technologies positively contributes to achieving these aims (Dobero et al., 2021). These technologies have been supported by developments in electronics and information and communication technologies (ICT) (Nomikos et al., 2005). At the same time, new materials create packages that can carry readable data and information (Siegemund & Krauer, 2004). Therefore, a transition from "passive packaging" to "active packaging" is observed, based on the following three main factors: the antimicrobial factor, the packaging material, and the technological side of the final production of packaging (Nicoletti & Serrone, 2017).

Thus, readable printed information and technical readable data must be incorporated into the package in many forms (sounds or smells) to protect the product's conditions (Nomikos et al., 2005). Sensors can track various significant information, focusing on the comparison of the printed descriptions with the actual conditions using the help of scanning. Based on the new technologies and in particular, new polymers material with the gradual application of technology, tagging applications such as RFID (Radio Frequency Identification) and EAS (Electronic Article Surveillance) systems, new forms of packaging "active packaging", "intelligent packaging" or "smart packaging" have emerged (Nomikos et al., 2005).

The relevant literature presents different types of "intelligent packaging", depending on the possibilities that every kind of this form of packaging can offer, where others may have the ability to interact with the inside of the package and others to interact with both the knowledge/information of the package and producers of each product (Dobero et al., 2021). "Intelligent packaging" includes science and technology that can enhance the shelf-life, improve safety, guarantee quality, and inform about any harmful changes occurring in the packages (Poyatos-Racionero et al., 2018; Wang et al., 2019). Furthermore, the evolution of "smart packaging" based on biotechnology prevents food spoilage, providing the most significant benefits to the users and managers of the food supply chain (Nicoletti & Serrone, 2017). "Smart packaging" consists of a "smart object" communicating with other "smart objects" and the surrounding environments (Nomikos et al., 2005)

Therefore, the transition to "smart" or "intelligent packaging" in recent years is closely related to the latest developments in technology, especially in the field of electronics and communications, the ever-increasing and ever-changing needs of consumers, the global problems such as the global food crisis, the food waste, the climate change, and the need for conversion to sustainable development. In addition, the new forms of packaging seem to affect digital commerce, waste management, the modern user and the user with disabilities, smart living, and finally, the social-economic system; issues which we are going to unfold below in this study.

Although the new forms of packaging are a trendy subject in the relevant literature, the present paper reviews the possible impact of new forms of packaging on society, briefly presenting some significant studies for each issue, discussing the main points, and finally, valuable outputs were generated. Practitioners and academicians benefited from the current research acquiring helpful knowledge.

2. Literature review

2.1 New forms of packaging

The role of food packaging is vital in protecting food, extending its shelf-life, and leading to outstanding quality and safety along the production chain and during the time of storage (Dobero et al., 2021). The advancements in new technologies and the evolutions in various sciences have led to new forms of packaging. A broad classification of packaging food includes the following four types: "passive packaging", "active packaging", "intelligent packaging", and "smart packaging" (Nicoletti & Serrone, 2017). The basic "passive package" offers the fundamental properties: of protection, preservation, and presentation. "Active packaging" is the form of the package when it can interact in the same way and/or react to various stimuli to keep the internal part of the products of higher quality (Nicoletti & Serrone, 2017).

"Intelligent packaging" is related to those systems that can be easily implemented into food packaging and provide real-time quality information, require high-cost, sophisticated instrumentations, and complex integration into existing packaging materials, and finally, access and minimize the insurgence of food-borne disease and food waste (Dobero et al., 2021). To achieve monitor the food product's condition "intelligent packages" use a variety of signals (Aschemann-Witzel et al., 2016; Poyatos-Racionero et al., 2018; Kalpana et al., 2019; Müller & Schmid, 2019), whereas "active packages" increase the food shelf-life by acting on the context surrounding the food. Both forms of packaging may work in synergy, creating "smart packaging" (Chen et al., 2020; Lydekaityte & Tambo, 2020). Moreover, some lower-cost solutions offer helpful services. Thus, simple and easily readable information concerning food quality over a long period is provided by food quality optical detection systems based on colorimetric sensors. The sensitivity of such colorimetric devices and sensors may be further improved by combining them with an RFID leading to the improvement of safety and quality. At the same time, it reduces food waste and limits costs (Mondal et al., 2019; Landaluce et al., 2020).

It is noteworthy the economic impact of the new forms of packaging. Thus, the market for "active", "intelligent", and "smart food packaging" is rapidly expanding, from 38 billion USD worth of packages being sold in 2020 and about 50 billion USD expected by 2026 (increased by 32%) (Mordor Intelligence, nd).

2.2 "Intelligent packaging", "smart packaging", and "active packaging"

The contribution of new forms of packaging is important for all the participants in the product chain. "Intelligent packaging" possesses the ability to monitor the product condition content, the external environment in which it is stored, and the interaction with the product content to ensure maximum lifetime and high quality (EFSA, 2009). Also, it provides information about the content, manufacture time, or storage conditions (Nicoletti & Serrone, 2017).

During production and before delivery, chemical and microbiological tests of the products are implemented, but not after their delivery to the supermarkets. By applying "intelligent packaging," we can monitor and display the quality from the factory to the final consumer (Ghaani et al., 2016; Sohail et al., 2018). Furthermore, "intelligent packaging" is related to the introduction of innovations in packaging design for users' convenience and usefulness or for firms in the supply chain to benefit (Kim et al., 2016). In this way, the product can react to stimuli generated by the environment or packaged product. It reflects the change to make the product more available, practical, and long last (Kim et al., 2016).

Technologies used in this form of packaging are indicators, sensors, and data carriers (Müller & Schmid, 2019). According to the information flow in an "intelligent packaging" system, data labels, processing, and communication networks can combine and support a mechanical decision-making system. For example, in a warehouse area, decisions can be made automatically based on the available quantity of food and the situation in which they are, to order new quantities so that the stock of the warehouse is quickly and easily replenished (Saiz-Rubio & Rovira-Más, 2019). Similarly, an "intelligent package" that detects a spoiled product can inform a central information system of the product's condition and location on the shelf of a supermarket so that it can be withdrawn before a consumer buys it (Yam et al., 2005; Saiz-Rubio & Rovira-Más, 2019.

The other types of packaging are "active packaging" and "smart packaging". "Active packaging" interacts with the product content in such a way as to extend the product's life. Also, "active packaging" refers to incorporating additives into packages to maintain or extend fresh vegetable or livestock products' quality and shelf life (Lee et al., 2015). This form of packaging keeps the quality of food by explicitly affecting the atmosphere of the packaging (Dobero et al., 2021). Thus, it may be helpful to bind oxygen, carbon dioxide, or water by expelling CO_2 or ethanol and antimicrobials to slow or prevent reactions (Müller et al., 2019).

"Smart packaging" is the result of the coexistence of conventional printing (graphic) communication with electronic technology, and it consists of the traditional printed substrate, with the RFID system integrated (Nomikos et al., 2005). However, "intelligent packaging", extend the "smart packaging" which includes information about the product condition, date, place of production, storage or cooking method, and origin, and may be able to transmit to consumers (Lee et al., 2015).

The "smart packaging" has communication capabilities, uses an information system, and is identified as a unique product. It can form a new communication behavior through traceability in the supply chain (Butler & Harrop, 2005). Aaron & Baumgartner (2004) suggested that in the design of "smart packaging" should be taken into consideration the creation of the conventional form and the electronic technology as well as the documentation, images, drawings, and colors, but also the possibilities of the new dynamics of the RFID system. The RFID system includes the antenna, the chip, and the reading system (antenna receiver), in conjunction with operating and interaction software programs, for the communication of the product with the information system (Ros & Thomas, 1998).

In addition, the development of new food packaging materials remains a significant challenge. A distinction must be made between (a) the optimization of material properties, (b) the introduction of "active and intelligent materials" and (c) the new design and presentation techniques (Realini & Marcos, 2014). However, it should not be forgotten that recycling is not automatically enabled in the case of composite materials and that the environmental balance of new materials must be checked in each case. Nanotechnology is one of the critical technologies of the 21st century and contributes to recycling. Furthermore, nanomaterials are expected to become the building blocks for the next generation of products and consumer goods (Food Security Information Network, 2019). However, to give to package 'a life' or have a package that 'does something' could succeeded only after being activated by the consumer, such as heating or cooling itself (Müller & Schmid, 2019). As Kim et al. (2016) pointed out, "active packaging" and "smart packaging" provide additional functions to the basic one and can be supported by

"intelligent packaging" solutions. Finally, these new forms of packaging present significant advantages for all, consumers, businesses, and the economy.

2.3 Food waste and developing countries

A well-preserved product in the food chain is essential for all, and in a wider context, it positively contributes to the needs that exist on our planet, especially in countries where the proper distribution of products is a matter of human survival. Therefore, it is important to improve the food supply chain management and lessen global food waste and environmental pollution (Aramyan et al., 2020; Liegeard & Manning, 2020). The new forms of packaging can contribute to achieving these targets.

According to official figures from the United Nations (UN), in 2018, more than 113 million people in 53 countries experienced intense hunger problems that required UN intervention. Thus, in 2018, the countries with the worst food crisis were Yemen, the Democratic Republic of the Congo, Afghanistan, Ethiopia, the Syrian Arab Republic, Sudan, South Sudan, and northern Nigeria. Only two-thirds of the total number of people with severe malnutrition live in these eight countries (Food Security Information Network, 2019). Furthermore, the World Bank's Food Summit in 2008 strongly criticized the failure of developed countries' governments to provide food aid and make progress on food waste, as the summit meeting had committed in 1996 (Wang et al., 2019). About 1/4 to 1/3 of the produced food annually is not consumed as it has been spoiled or lost until it reaches the final consumers (The World Bank, 2019).

Looking towards 2050, we face the additional challenge of feeding a population that is eating more – and mainly has better and healthier diets – and is expected to surpass the 9 billion mark (FAO, 2014). On a global base, a more strategic way of resource allocation is required mainly for agricultural research purposes, as the financial and human resources are limited (FAO, 2014). At the same time, farmers, and humanity as a whole, are already facing the new challenges posed by climate change. Moreover, the 2030 Agenda for Sustainable Development puts forward a transformational vision recognizing that our world is changing, bringing new challenges in how food is produced, distributed, and consumed – and fresh food security, nutrition, and health (FAO, 2019). Although the following is not an easy task and requires great efforts from many players (UN, governments, private and state-owned organizations), an important proportion of the not consumed products can direct to the countries with a large part of the population living in poverty. A significant contribution is expected from "intelligent packaging" in combating the food crisis and reducing food waste through more efficient food management (Food Security Information Network, 2019).

2.4 Food waste and packaging

When food is not consumed for its primary purpose, which is feeding, but ends up in landfills either because it has expired on the supermarket shelf or in consumers' homes, the global problem of food waste arises. Thus, food waste is one sustainability issue that must be tackled decisively (Aschemann-Witzel et al., 2016).

A large proportion of food (about 1/4 to 1/3 of them or 1.3 billion tonnes) is wasted or lost every year, negatively impacting the environment and climate (Siddiqui, 2019; The World Bank, 2019). Food waste currently produces 8% of greenhouse gas emissions and, therefore, food loss and food waste can be a tool in combating climate change (Siddiqui, 2019).

One of the UN's 17 Sustainable Development Goals (SDGs) set the target of halving food waste by 2030 at the retail and consumer levels and minimizing food losses along the production and supply chains (Mordor Intelligence, nd). Food waste becomes an essential issue for ecologically conscious and all food supply chain participants (Tichoniuk, 2019). Thus, more efficient food management is expected to reduce food waste (FAO, 2019).

The role of packaging to improve food management and reduce food waste is essential. However, conventional packaging related to inefficient food quality assurance systems, has limited potential for reducing food waste and does not directly respond to changing conditions in the food supply chain (Marsh & Bugusu, 2007).

On the contrary, the new forms of packaging consist of essential tools to sustain safety in the food chain, avoid undesired product changes, meet consumers' demands, increase food shelf-life, and reduce food waste (Tichoniuk, 2019). Packaging isolates the products from the external environment and provides, in general, the following four essential functions: protection, communication, convenience, and containment (Yam et al., 2005). In addition, packaging offers differently shaped and sized containers and fits the customer's lifestyle (Yam & Lee, 2012), protects the quality of the products, and contributes significantly to the safe delivery and preservation of packaged food (Dobrucka, 2013).

Many consumers throw away products that would have been suitable for consumption, depending on the content of the package, and especially products that consumers cannot realize the spoilage of product quality. There are biological or chemical processes that lead to the development of spoilage. Still, some minor variance as the color, the regularity, and especially the passing of the expiry date leads products to decompose in the bins. To reduce this accidental product waste, "intelligent packaging" is coming to contribute to that (Tichoniuk, 2019), by monitoring the condition of packaged foods through the provision of information regarding the quality of the packaged food during transport and storage (Nicoletti & Serrone 2017). "Intelligent packaging" systems like commercially available time-temperature indicators (TTIs) or integrity indicators, as well as constantly developed food freshness indicators, react immediately to significantly changing conditions that affect the state of packaged food (Schaefer & Cheung, 2018; Siddiqui, 2019). Furthermore, "active packaging" refers to incorporating additives into packaging systems to maintain or extend fresh vegetable or livestock products' quality and shelf life (Nicoletti & Serrone, 2017). Both forms of packaging are positively related to food/product quality and negatively associated with food waste.

2.5 The contribution of "intelligent packaging" to the digital commerce

Nowadays consumers' habits and daily needs have changed. The pandemic led consumers to shop online, and grocery retailers were already facing change and beginning to adapt to a world that is primarily run through the Internet of Things, software platforms, and programs. These systems run through cloud-based computing technology and servers that tie our lives together through our phones, computers, tablets, and even our grocery store checkout lanes (Bry, 2021). The first half of 2020 presented an important increase in e-commerce equivalent to that of the previous ten years. Because of these shifts, grocery retailers will need to fully embrace and adapt to new technologies (Briedis et al., 2020).

With the increased use of e-shopping, the transportation needs for fresh products have grown and changed. Preserving food quality is vital as it is directly related to the global target of improving the quality of our lives. The transition from "traditional packaging" to "innovative packaging" with additional functions is necessary for the consumer's demands.

It can quickly be developed with the support and progress of technologically advanced environments (Berg et al., 2020).

As consumers in emerging economies are directed to online shopping, "intelligent and autonomous shopping" is a reality as the following paradigm of Amazon Shop shows: "*scanning a smartphone app and strolling the aisles of the completely stocked store. The banks of cameras and sensors overhead track everything put into a shopping cart, with the help of artificial intelligence — rendering unnecessary the old-fashioned ritual of scanning and paying at a checkout stand. Items are charged to a shopper's Amazon account shortly after they walk through the exit*" (Henry, 2020, p.1).

With the rapid growth of e-commerce, a large part of internet users buys essential products, such as food and beverages, cosmetics, and medicines, and "intelligent packaging" and electronically coated devices are an important and necessary condition for accelerating the process of product collection and distribution (UNCTAD, 2020). The evolutions of e-commerce and the buying pattern of consumers are among the drivers of innovations in packaging design (Field Technologies, 2007; Khedkar & Khedkar, 2020). Consequently, it seems the new forms of packaging are inextricably linked with electronic commerce.

2.6 The contribution of "intelligent packaging" to the traceability of products - Quality and safety, environmental awareness

A "smart environment" mainly consists of "smart's energy systems" in which renewable energy sources are included and various home services ("smart home") (Lund et al., 2017). The evolution of technology, the interconnection, synchronization, and coordinated use of various technologies can provide an "intelligent environment" (Gretzel et al., 2015; Gretzel et al., 2016). Regarding packaging issues, TTIs are usually in the form of small stickers affixed to food packaging. These labels offer visual indications of the temperature history during the distribution and storage of the product, which is especially helpful in cases where the product has been exposed to changeable temperatures which are not suitable for proper storage (Yam et al., 2005).

The main objective should be the development of innovative solutions in food packaging for sustainable production processes. Thus, the new packaging forms, such as the "green label" incorporating biodegradable and recyclable films with properties for containing antimicrobials to monitor microbial contamination and food spoilage by plant-derived extracts (PDE) and food contaminants, are extremely helpful (Nicoletti & Serrone, 2017). In this sense, "intelligent packaging" provides the necessary tools to oversee the quality and safety of food and ensure that consumers have the best possible and safest products (Gretzel et al., 2015). Also, "smart packaging" protects against chemicals, and biological and natural alterations (Gumbleton, 2007). The end-user utilizing the provided information optimizes the product selection process, avoiding the supply of products that ultimately are not useful. In addition, "smart packaging" facilitates recycling, launching the flow of the product's components (Gumbleton, 2007).

The proper management of environmental resources mainly concerns the public interest (Gumbleton M, 2007; Vinod Kumar, 2020). The increasing number of environmentally conscious consumers and governmental policies on reducing waste are leading retailers and producers to follow more green practices. Thus, consumers' products and packaging must be free of harmful chemicals (Nicoletti & Serrone, 2017). Unlike common petroleum-based materials, companies have started to use new plant-based recyclable (PET) packaging (Gumbleton, 2007; Gavazzi et al., 2022). It is also the responsibility of retailers to protect families and communities and transform the marketplace sustainably.

Consequently, “smart packaging” minimizes food waste and reduces exhaust emissions. In addition, “intelligent packaging” can significantly contribute to the traceability of products throughout the supply chain. It offers the possibility of monitoring the position of the products from production to the distribution of products to the final consumers. Both forms of packaging significantly contribute to environmental protection (Wang et al., 2019).

2.7 The contribution of “intelligent packaging” to waste management and mobility in a smart city

The “intelligent packaging” of a product follows it from the beginning to the end, from the production phase, transportation, distribution, consumption from the consumers, and waste and discard to recycling bins. The “intelligent packaging” provides the object’s location as garbage using the appropriate device. In particular, using MAR (Mobile Augmented Reality) in combination with LBS (Location Based Services) and location-based AR applications (LBAR), relying on GPS (Global Positioning System), built-in sensors, and digital compasses sup-porting geographic information, display multimedia information on tags about a POI (Point of Interest) (Erra & Capece, 2019). MAR gives many possibilities to monitor an object (i.e., waste bin), a worker, or a garbage truck coordinates to a server and display AR (Augmented Reality) using Google Maps (for free use) (Müller & Schmid, 2019).

“Smart mobility” is a general term used to describe many related technologies applied in transportation in urban areas, representing a new way of thinking about transportation, and creating a more sustainable way of living system (Noy & Givoni, 2018). Among other things, “smart packaging” uses barcodes and QR (Quick Response) codes and allows product traceability in the supply chain (Müller & Schmid, 2019). That optimizes the supply chain and logistic systems to reduce transport and traffic congestion positively contributing to environmental protection.

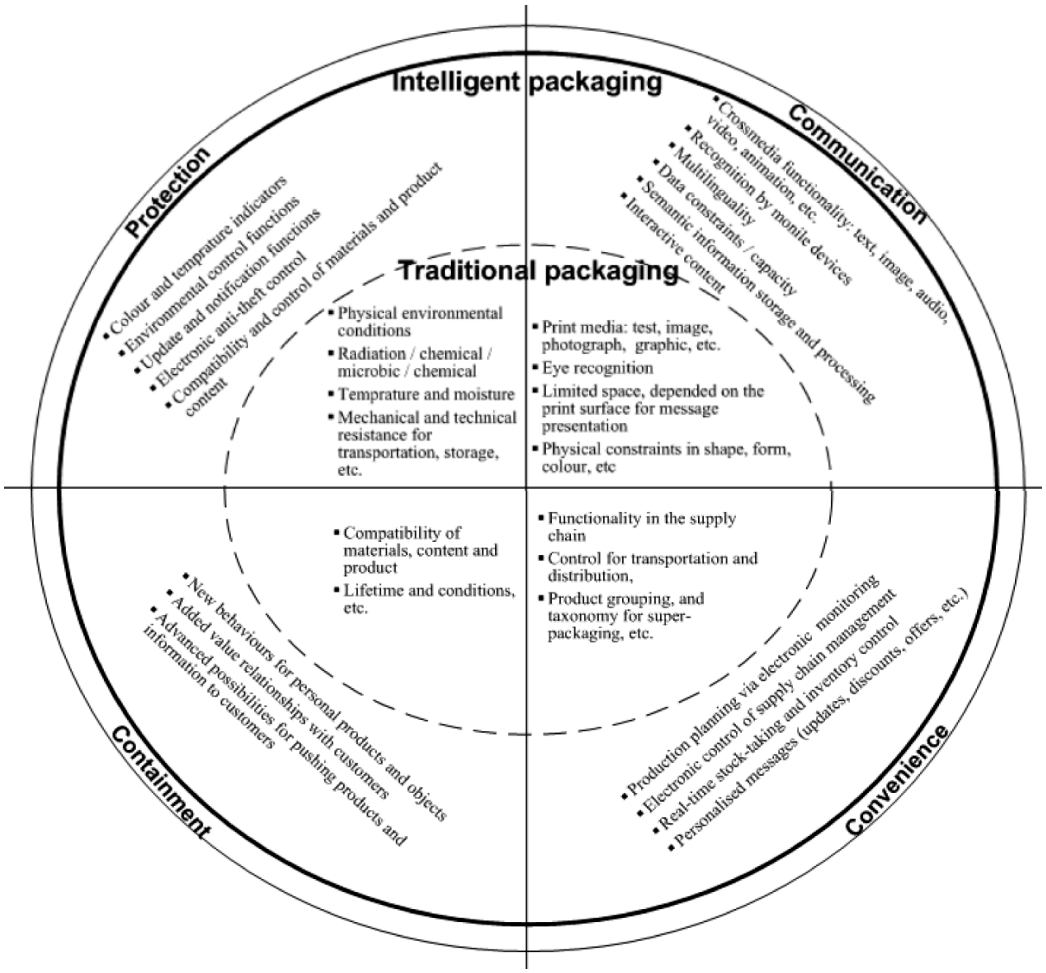
2.8 The contribution of “intelligent packaging” to living

“Smart living” is a trend that includes adopting technological developments in every aspect of life. It provides original and innovative solutions to make people’s lives more effective, controlled, financially viable, productive, integrated, and sustainable (Poyatos-Racionero et al., 2018). By 2050 more than 66% of the world population will live in urban areas, while population living in rural areas will decrease, which requires sustainable urbanization (IEC, 2020). “Smart services” can contribute to this aim, feeding people in the new environment. According to Nam & Pardo (2011), the “smart city” concerns a combination of education training, cultural arts, business, and trade in a “smart way” (Nam & Pardo, 2011).

In this way, “smart packaging” indicates the current quality condition of products using indicators and sensors, increasing the security of products, promoting the health and well-being of citizens, and contributing to integrated household inventory management of products and waste (Verghese et al., 2015). For example, “smart packaging” connected to the “smart refrigerator” points to the shortage or expiration of products. Respectively related to a “smart bin,” diagnoses the level of trash or recognizes the waste species and separates recyclable from organic materials. In addition, many other applications can aim to improve consumer comfort, such as implementing “intelligent packaging” that can communicate with “smart electrical devices” to ensure the best possible result in preparing a meal. Such packages are already on the market and aimed at “smart microwave ovens” (Neielrath et al., 2011) i.e. to make food ready to consume. Therefore, “smart solutions” in the market provide high-quality services and significantly assist those who adopt them.

The following conceptual model (***Figure 1***) supports "smart packaging" functionality and usefulness. These "smart packages" will be around us in grocery stores and pharmacies, on the road (through poster printing), in books, and in other printing products. All these products/services can be corporate with NFC (Near Field Communications) system (Field Technologies, 2007; Nomikos et al., 2014).

Figure 1. The conceptual model, developed by Nomikos (2006)



Source: Nomikos (2006)

Consumers' lifestyles are changing from a social point of view. The increasing single-person living trend leads consumers to shop more frequently and in smaller quantities, and thus packaging should be convenient and in smaller size formats. Therefore, packaging solutions need to be timely and portable (CDF, nd). Lorenzi (2019) reported that consumers are becoming increasingly aware of packaging solutions and health benefits; there is an increased need for packaging that keeps products fresh and tasty as long as possible; while consumers want to minimize their impact on the environment.

There is also a part of consumers with disabilities, such as the elderly and disabled people, where the ability to get informed through technology and even the choice of e-shopping improves their degree of independence. According to the relevant literature, limited access to consumer information is a factor that eliminates disabled people from selecting items that meet their expectations and contributes to their exclusion from the economy and society (Howells & Chemers, 2005). Therefore, a lack of accessible information minimizes

individuals' independence and shows that the need for assistance in shopping requires additional cost and effort. Also, the needs of people with disabilities are addressed. Many electronic appliances are designed to be accessible to this growing proportion of the population, connecting them to the internet remotely, and programmed to remember preferences (IEC, 2020).

The contribution of "intelligent packaging" and "smart packaging" to the aforementioned issues is essential. Both forms of packaging are interrelated with consumer behavior and lifestyle (Apia, nd). Thus, "smart packaging" performs various tasks and functions describing the product and its characteristics, and communicating with customers (Lund et al., 2017). In this way, people's safety, well-being, and ease of satisfaction with daily needs are promoted (Bartlett, 2009). "Intelligent packaging" is expected to make it easier for consumers to use the products. It provides information about the product, instructions on handling it, preparing a meal, recipes, tips, and storing it. Also, this type of packaging constitutes an optimal way of disposing of the package after using the product's contents (Müller & Schmid, 2019).

2.9 The relation of "smart packaging" with the Society and Economy

The "smart packaging" facilitates the traceability of the products. To society, "smart packaging" and "intelligent packaging" help reduce tax evasion and contributes to the fight against crime such as cigarette smuggling (Schaefer & Cheung, 2018). "Smart governance" supports the decision-making process, focuses on both community and individuals and succeeds in sustainable urban development (Aggelidou, 2018). "Smart packaging" supports a "smart economy," the use of electronic trade, increases the productivity of advanced services, and emerges new products, and new business models (Romero et al., 2020).

"Smart packaging" provides opportunities to monitor product distribution chains directly or indirectly, extends products' lives, and improves quality and safety as products are consumed before their expiry date (Schaefer & Cheung, 2018). Consequently, in the city context, we achieve a reduction of waste and finance and human resources needed for the removal or the processing of waste. Also, retailers can sell products with a shorter lifespan, reducing waste food (discarded products that ended and were thrown away together with their packaging) (Heising et al., 2014).

3. Discussion

Nowadays "smart" usage captures innovative and transformative changes driven by new technologies. Due to differences in our lifestyles, packaging positively contributes to preserving fast-moving consumer goods (Mahera et al., 2015). Packaging also consisted an important marketing tool, contributing to the safety of a product (Mahera et al., 2015). The technology offers "smart solutions" and facilitates the transition from conventional packaging to "intelligent packaging" and "smart packaging". "Intelligent packaging" is mainly applied in the food industry but offers advantages in other areas as it ensures the high-quality level of products in the pharmaceutical and cosmetic industries (Apia, nd). However, this form of packaging is not very widespread because it requires additional cost, although there is a growing demand for the provision of information on packaging and consumers want to know about the ingredients and the storage of the products (De Jong et al., 2007), although most of them are not willing to pay more for that (Vanderroost et al., 2014).

However, the increased prices of well "smart packaged" products should be solved (Vanderroost et al, 2014). It is essential to inform the customers about the advantages of the systems to be more willing to spend more on food with "intelligent packaging". In addition, consumer confidence in the safety of the designs also needs to be strengthened (Han et al., 2005). Therefore, further steps should be taken to promote those technologies that further improve the new forms of packaging (Sohail et al., 2018). In addition, producers have to realize that the use of "intelligent packaging" and "smart packaging" can offer them a real competitive advantage, so more extensive use of these forms of packaging is proposed (Zhou et al., 2019; Apia, 2020). Finally, intensive research and innovation for the inexpensive, safe, and sustainable fabrication of eco-friendly "intelligent packaging" materials are recommended (Nomikos et al., 2005; Sohail et al., 2018).

4. Conclusion

The contribution of "smart packaging" in every aspect of life is significant and comprehensive. This form of packaging contributes to the traceability of products and the control of their transportation, quality, and safety of products, supply chain, and can apply in various industries (Balbinot-Alfaro et al., 2019; Mirza Alizadeh et al., 2022). "Intelligent packaging and "smart packaging" promote waste management and direct products that are not consumed to other countries that need them, provide economic benefits, and improve the daily life of citizens (Gregor-Svetec, 2018; Lova & Soci, 2020). In addition, these forms of packaging change consumers' habits, improve customers' services, help people to better interact with a house "smart devices", help people with disabilities to increase their independence and limit the required assistance in shopping and assist them in efficiently interacting with the store with the help of artificial technology, and contribute to the progress digital commerce (Bibi et al., 2017). Therefore, all the participants in the food industry can acquire significant benefits from the wider application of new forms of packaging, and more applications of them should be facilitated.

As mentioned, the contribution of "smart technologies" to various issues is great; and adopting a more socio-technical view is recommended to be used (FAO, 2019). Therefore, future studies are proposed to examine the relationship between packaging issues and human factors. Thus, studies that examine the impact of "intelligent packaging" and "smart packaging" on various variables such as their contribution to demand, customer satisfaction, etc., are helpful. Furthermore, studies that employ quantitative and/or qualitative methods are also suggested.

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