

PERCEPTION OF INTELLIGENT PACKAGING IN THE CONTEXT OF BIOECONOMY

Loučanová Erika*

Technical University in Zvolen, Slovak Republic
E-mail: loucanova@tuzvo.sk

Parobek Ján

Technical University in Zvolen, Slovak Republic
E-mail: parobek@tuzvo.sk

Nosáľová Martina

Technical University in Zvolen, Slovak Republic
E-mail: nosalova@tuzvo.sk

Ana Dopico

University of Vigo, Pontevedra, Spain
E-mail: adopico@uvigo.es

Hupková Daniela

Slovak University of Agriculture in Nitra, Slovak Republic
E-mail: daniela.hupkova@uniag.sk

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Abstract: The research of new intelligent features has shown huge potential to optimize the supply chain and enhance consumer consciousness of product utilization. The implementation of bioeconomy principles in all sectors is essential in seeking to achieve Sustainable Development Goals. Innovation in the packaging industry can be considered as one of the key sectors in this approach. The study deals with the evaluation of the perception of intelligent packaging in Slovakia as ecological innovations through the Kano model. The results indicate that customer awareness of intelligent packaging as ecological innovation in the context bioeconomy is still at a low level in Slovakia. However, from the point of view of intelligent packaging, Slovak customers represent a key element of stakeholders for the management of innovation processes towards bioeconomy criteria.

*Corresponding author: Loučanová Erika. E-mail: loucanova@tuzvo.sk

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1. Introduction

The development towards a bioeconomy is generally understood by academics and policymakers as one of the elementary approaches to decrease dependency on non-renewable resources. Though, the research on bioeconomy at the particular microeconomic level remains insufficient. Particularly, research focused on the bioeconomy from the technology and innovation management concepts is particularly uncommon. On the other side, the significance of innovation and knowledge is considered as crucial to support the evolution towards a bioeconomy. The bioeconomy include three crucial issues from the innovation process point of view:

- appropriate stakeholder groups (their significance in the innovation development);
- the innovation network operative management and strategy;
- organizational issues identified as fundamentals for collaborative innovation.

Van Lancker et al. (2016) applied these issues for the identification of specific factors which influence the bioeconomy. According to these factors, they established basic descriptions of innovation processes in the bioeconomy. These methods are applied in companies for analyzing shopping behavior for the establishment of marketing strategy. A sustainable bioeconomy supports the modernization and strengthening of the industrial base through the creation of new value chains and greener, more cost-effective industrial processes. The deployment of innovative solutions for the production of new and sustainable bio-based products and packaging will also enhance our capacity to substitute fossil raw materials in very significant parts of the industry (e.g. construction, packaging, etc.) (European Union, (2018).

On the other hand, companies should focus on competitiveness advantage using innovative technologies in products and packaging. Nowadays, packaging can be considered as a marketing instrument where producers can refer their relationship to the environment. For instance, companies can identify and present how much-recycled materials utilize (Pajtinková-Bartáková, Gubíniová, 2012; Šupín, 2009, Paluš, 2004, Loučanová et al., 2016).

From the bioeconomy point of view, the production of good quality packaging is crucial, because the company has a responsibility for how packaging will be re-used (e.g. recycling) after the utilization of the product. The study deals with the perception of intelligent packaging in Slovakia. For companies, this information is

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crucial for understanding new challenges and future development of the packaging industry in Slovakia.

2. Literature review

From the material and techniques point of view, the packaging has been developed as a result of all socio-economic changes during the last decades. Nowadays, the packaging industry applies a lot of intelligent solutions and innovation. It has a significant potential to contribute the modern approaches as bioeconomy and sustainable development. For companies, the bioeconomy offers opportunities to achieve a competitive advantage. They can move to the circular and sustainable economy and transit industrial base on less dependency on fossil carbon. The sustainable bioeconomy contributes to climate change mitigation, in all ecosystems. The European Union significantly invested in this field of innovation and research and therefore started to apply on a common European bioeconomy strategy in the packaging industry too (Bell et al., 2018).

The packaging represents a set of tools for protecting the goods from possible damage. All functions of packaging focus on improving transport, handling, marketing, and final consumption (Zeman, 2005). Presently, materials of packaging identified a high and low-degree of proactive behavior. The supplementary packaging material represents an important part of the package to ensure specific tasks and full functionality. For instance, supplementary materials contain labels, nails, adhesives, corks, or caps (Dzurová, 1997 Kačenák 1996; Zeman, 2005; Loučanová et al., 2016; Straka, 2013). It is essential to understand how packaging features can affect these modern approaches in whole chain of custody: producers, consumers, as well as, suppliers (Loučanová, et al. 2016). Intelligent packaging is usually linked with functions for monitoring to extend shelf life, quality, ensuring product safety, product information, or warning about potential problems (Yam et al., 2005).

The innovations focused on intelligent packaging are defined as "any autonomic changes with a positive impact on the customers". Usually, these innovations are safer and healthier and provide an increment of customer comfort. Simultaneously, they correspond to more efficient solutions (Loučanová et al., 2017). The intelligent packaging can be associated with intelligent innovation. These innovations in the sense of intelligent packaging are focused on sustainable development and can be identifying as eco-innovation.

The eco-innovations are defined as innovations focused on decreasing of the total amount of emissions, energy demands, and health risks. The eco-innovations apply new approaches as a circular economy, new ecological materials, and renewable energy resources (Lešková, 2009). It is necessary to realize changes in the utilization of resources form the global point of view. We have to move from fossil

fuels and materials to bio-based materials (as renewable materials). We have to find different supply chains and ensure to increase in the interconnection between existing technologies platforms. Therefore, it is needed creation and exchange of new knowledge across scientific disciplines which require R&D and target technology development and innovation, linking the knowledge-based bioeconomy to technology and innovation management research (Golembiewski et al., 2015).

3. Methodology and empirical data

The study is focused on the identification of the perception of packaging innovations in terms of the functions towards principles of the bioeconomy. A method of the Kano model is applied to understand how final consumers accept these innovative features. The principal idea of the Kano model is to capture customers' opinions according to the requirements of an observed object (Goodpasture, 2003).

The study comes true to the follows steps:

- identifying individual parameters of packaging innovation (questionnaire), questions were asked on selected parameters for intelligent packaging (the concept of intelligent packaging, availability, awareness, functionally, voice performance, the attractiveness of packaging, advertisement, freshness indicators and price);
- analysis of a questionnaire for gathering specifiable information;
- questionnaire measures (minimum sample of respondents 100, the survey was conducted in 2019);
- mathematical and statistical evaluation;
- display the results in a matrix of innovations perception in terms of the functions.

The first step is represented by a market survey. We applied the questionnaire, which provides particular questions–statements. Collected data are analyzed by KANO model. The answers were collected by questionnaires through electronic forms as well as by personal survey. For preliminary research, the sample of respondents was set at 120 customers. However, the survey was not a random choice. During the survey, we kept the same proportion of respondents for each given age category. According to the KANO methodology, the questionnaire consists of pairs of positively and negatively conceived statements. For the question analysis, the Likert scale is applied. Each statement is evaluated on a scale from 1 to 5. Based on the draft, the higher number (5) represents stronger agreement or strong disagreement.

Answers are evaluated according to the cross rule (Figure 1). According to the KANO approach, the responses are evaluated by two-factor analysis based on age

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categories. From the point how respondents perceive new packaging, the findings were included in the following categories:

M – are obligatory requirements that customers consider as normal and are automatically expected. These requirements can be identified as primary or basic and therefore. They only deal with customers in the event of non-compliance.

O – are one-dimensional requirements that are represented by those product attributes that lead to fulfillment and satisfaction in the event of non-compliance to customers' dissatisfaction.

A – are attractive requirements that have a clear impact on customers' satisfaction because it is a requirement that customers did not expect.

R – are contradictory or reverse requirements in some literature (Loučanová, 2016).

I – are requirements that do not have any influence on customers. They are also called irrelevant requirements.

Q – are sceptical requirements (Grapentine, 2015).

		Answer to the Dysfunctional Question				
		Like	Acceptable	No Feeling	Must-be	Do not like
Answer to the Functional Question	Like	Q	A	A	A	O
	Acceptable	R	I	I	I	M
	No Feeling	R	I	I	I	M
	Must-be	R	I	I	I	M
	Do not like	R	R	R	R	Q

Figure 1 The Kano Model

Source: Grapentine, 2015, Ducár et al., 2006

The Kano model divides the monitored packaging functions into categories of mandatory, attractive, indifferent and reverse functions. Subsequently, the model applied comparison analyses to identify and measure comparable data. The analysis identifies the differences between customers' perceptions of active packaging functions and intelligent packaging functions. According to packaging functions, we considered the expansion of protection and containment function as the nature of active packaging. The expansion of communication and convenience function is considered as a nature of intelligent packaging. This approach comes from the definition by Yam et al. (2005).

Based on the customer requirements, the comparison analysis was applied by the Kano model. Following about mention analysis, the weight of requirements was assigned. Each identified requirement is market by value 1. This value is multiplied by weight according to the identified category. In case: "M" obligatory requirements weight is 3, "A" attractive requirements have weight 2, "O" one-

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dimensional requirements have weight 1, "I" indifferent requirements or not having an impact have weight 0, "R" contradictory requirements have weight -1, "Q" skeptical have weight -2 in different age groups and their sum (Loučanová et. al, 2014, 2015; 2016). Factor size is the weighted arithmetic average of the percentage proportion of identified requirements and their weights of individual examined parameters. Based on the sum of values, we are able to compare perceptions of active and intelligent packaging functions by consumers and we identify the target age group for active and intelligent packaging.

According to collected data, the modified typology matrix of packaging innovations perception is created. The matrix describes two essential factors: different age groups and innovative status. The status is determined based on the results of the market survey. It represents a sum of the identified requirements imposed on the new packaging by their functions according to the assigned weights as indicated by Loučanová (2015, 2016) and Loučanová et al. (2017). The significance of the identified requirements influences for new packaging according to their functions is defined as the weighted average of the identified requirements percentage. According to the above mention analyses, the conclusion describes the phenomenon of a packaging innovations perception through a trend analysis characterized by a mathematical function in MS Office. Then we analyzed the relationship between the age and innovation status of intelligent packaging.

4. Empirical results

Under the influence of global development, attitudes toward packaging materials are considerable. The consumers' approaches to the product packaging and favorite functions are changes as well. Innovative packaging is the output of original and unconventional solutions. The study describes a perception of intelligent packaging as innovation from the bioeconomy point of view. We focused on the evaluation of availability, functionality, and other requirements by using the Kano model. The hypothesis based on the assumption, that new products do not have equal success in the market (Chukhray, 2012). Some products are accepted by consumers almost immediately, whereas others need much time to get consumers' appreciation. Even a very successful innovation can fail because consumers are unaware of it (Garcia-Torres, 2009).

The results of our research indicate that intelligent packaging has various impacts on consumers in different age categories (Table 1). Based on the customer requirements by Kano model was assigned the weight of requirements. This value is multiplied by weight according to the identified category. In case: "M" obligatory requirements weight is 3, "A" attractive requirements have weight 2, "O" one-dimensional requirements have weight 1, "I" indifferent requirements or not having an impact have weight 0, "R" contradictory requirements have weight -

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1, "Q" skeptical have weight -2 in different age groups and their sum. Factor size is the weighted arithmetic average of the percentage proportion of identified requirements and their weights of individual examined parameters.

Table 1 The intelligent packaging perception in different age categories and the innovation status

Age / Parameters	15-26		27-40		41-60		61 and more	
Concept of intelligent and active packaging	A	2	A	2	I	0	R	-1
Availability	I	0	I	0	I	0	I	0
Awareness	R	-1	I	0	R	-1	R	-1
Functionality	O	1	I	0	I	0	I	0
Voice performance	I	0	I	0	I	0	I	0
Attractiveness of packaging	I	0	I	0	I	0	I	0
Advertisement	I	0	I	0	I	0	I	0
Freshness indicators	Q	0	Q	0	Q	0	Q	0
Price	I	0	R	-1	I	0	R	-1
Innovation status	2		1		-1		-3	
Age / Parameters	15-26		27-40		41-60		61 and more	
Concept of intelligent and active packaging	27,84	2,00	40,52	2	34,68	0	35,15	-1
Availability	54,12	0,00	41,52	0	56,1	0	49,7	0
Awareness	49,13	-1,00	43,28	0	86,74	-1	61,74	-1
Functionality	28,20	1,00	54,75	0	6,82	0	35,33	0
Voice performance	47,24	0,00	61,24	0	57,58	0	56,1	0
Attractiveness of packaging	45,74	0,00	50,15	0	49,7	0	35,15	0
Advertisement	47,10	0,00	57,25	0	49,09	0	57,58	0
Freshness indicators	37,14	0,00	31,55	0	35,15	0	41,82	0
Price	48,42	0,00	52,79	-1	53,33	0	57,36	-1
Factor size	3,86		3,14		-9,64		-17,14	

In Slovakia, the consumers' awareness of intelligent innovations is still very low. Consumers do not positively evaluate these features. This fact is apparent in particular from the frequency of identified irrelevant (I), questionable (Q), and reverse (R) requirements by the Kano model (see Table 1).

The positive perception and attitude to the concept of intelligent packaging is evident in the age category 15 to 26 and then 27 to 40 years. For these consumers, intelligent packaging is interesting and attractive. On the contrary, the innovations are differently perceived by the older respondents. The age categories 41-60 and especially older respondents are specific by experiencing such innovation with negative satisfaction. With increasing age, the innovation status shows a downward trend, (see Figure 2).

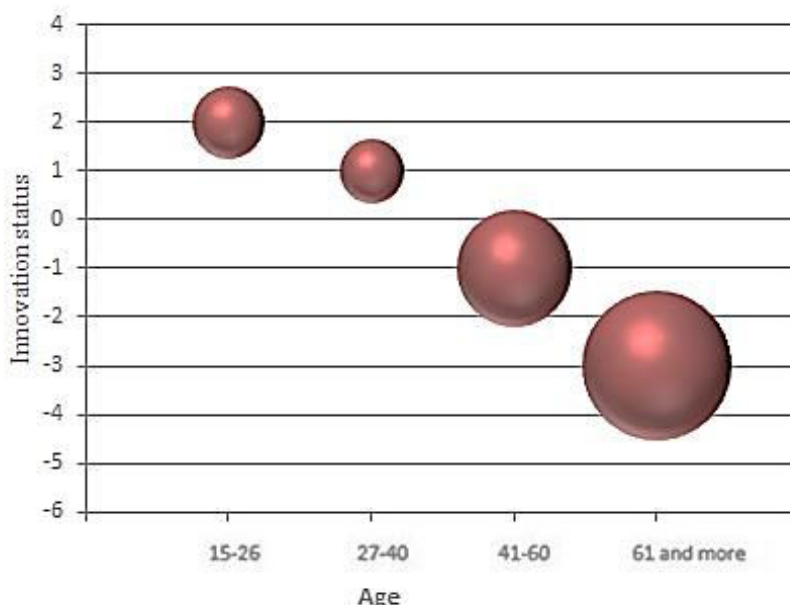


Figure 2 A typology matrix of intelligent packaging perception by respondents in Slovakia

The results have clearly confirmed the theoretical basis noting consumers' fears of innovation, especially more in terms of technical innovations (Rogers, 1995). The customer awareness of intelligent innovations in Slovakia is at a low level. Customers do not positively evaluate their features. This fact is apparent in particular from the frequency of identified Irrelevant (I), Questionable (Q) and Reverse (R) Requirements by the Kano model (see Table 1). The concept of intelligent packaging itself is attractive for respondents from 15 to 40 years old. Through the trend analysis, we investigated the relationship between age and innovation status of intelligent packaging innovations (see Figure 3). The polynomial relation $y = -0.0625x^2 - 0.35x + 2.4625$ at $R^2 = 0.9966$, at a confidence level of 99 %. This feature describes the relationship between the innovation status and the age of intelligent packaging consumers. We can say that the older consumer has the lower innovation status. The results comprehensively point to a positive shift in the evaluation of intelligent packaging by Slovak consumers. In the last age group, the same as in the first age group respondents identified only one of the packaging functions as important. Namely, the innovation of handling functions is the most important. Therefore, companies should focus on new packaging that would simplify product handling. Although their innovative status is low, simplify

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product handling has the biggest impact on this target group. We consider it as the key factor for buying a product. It has a clear effect on the satisfaction of these age categories. As Lesáková (2012) mentioned the reason is related to the type of transport because a significant share of consumers using their own transport to shop with higher age gradually decreases. The respondents in this age group are becoming dependent on shopping assistance. According to her research, the older people have increasing mobility problems.

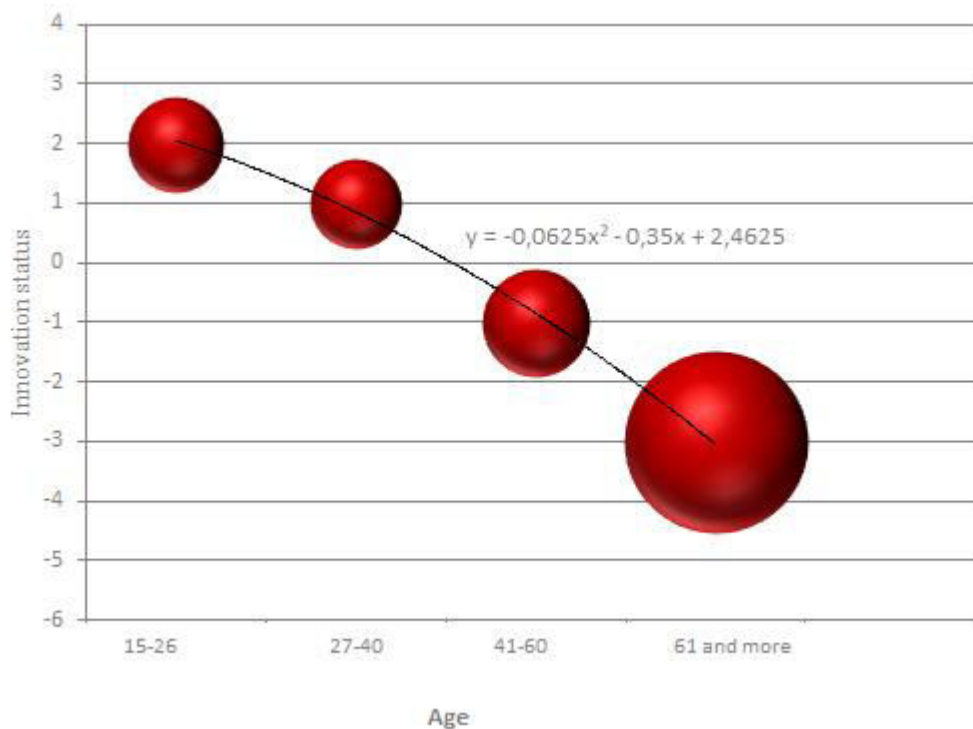


Figure 3 A typology matrix of intelligent packaging perception by respondents in Slovakia with polynomic function

In terms of management aspects, intelligent packagings from the customer’s perspective are need to be upgraded according to different age categories. This can be reflected in the performance of companies and their investment decisions (Balteş et al. 2014; Ipate et al. 2015; Regattieri et al. 2014 and Borlea et al. 2016). The results point the perception of intelligent packaging as an eco-innovation in Slovakia and linking the knowledge-based bioeconomy to technology and innovation management research. The acquisition of theoretical knowledge can

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lead to their real implementation in practice and help to increase the performance of enterprises in their investment decisions in the context of innovation and environmental processes (Ipate et al. 2015, Loučanová et al. 2018). The importance of innovation is considered crucial to making the transition towards a greener economy (Van Lancker et al., 2016). Research and innovation investments by public and private actors are supporting the shift from a conventional consumption and mass production model to food system supporting sustainable food and nutrition security for all. It calls for a more customized food consumption model, while simultaneously improving sustainability, safety, resilience and resource efficiency of food production.

These investments drive solutions in the area of smart packaging, intelligent and active packaging or smart local food systems to name just a few. At the same time, actors within the food system increasingly acknowledge that they need to engage more with citizens to design new solutions and to rebuild trust in the food systems. The research presented based on these analyses provides both theoretical and practical information for innovators in the area of intelligent innovation issues specifically focused on intelligent packaging and bioeconomy. The acquisition of theoretical knowledge can then lead to their real implementation in practice and help to increase the performance of enterprises in their investment decisions in the context of innovation and environmental processes, as stated by several authors Ipate et al. (2015) and other.

5. Conclusions

The aim of the research is to highlight the different views on active and intelligent packaging functions by consumers. During the last period, these innovative technologies are strictly connected with new strategies. Bioeconomy as a tool for sustainable management also focuses on packaging, as well as, different other sectors.

That is why the study analyzed the new possibilities to find gaps in the market and identified how consumers accept these innovations. The results can be applied by companies to encourage them to involve bioeconomy principles not only to the production of goods but also to their packaging. Based on the Kano model, results show requirements for new packaging in terms of all parameters of the intelligent packaging as ecological innovation in the context bioeconomy. The Kano model indicates that the older consumers have the lower innovation status. However, they have the highest need for packaging innovation. On the other side, they are not interested in all packaging functions. Finally, we can conclude that all age categories of consumers require ecological innovation in the packaging in the context bioeconomy, but with different intensity of influence. The age is a limiting factor in the implementation of smart packaging as an eco-innovation in practice.

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Therefore, from the point of view of intelligent packaging, Slovak customers represent a key element of stakeholders for the management of innovation processes.

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Author Contributions

Erika Loučanová, Ján Parobek, Martina Nosál'ová, Ana Dopico and Daniela Hupková elaborated chapters' literature review, methodology and empirical data, empirical results and conclusions.

Disclosure Statement

The authors declare no conflict of interest.

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