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THE USAGE OF KANO MODEL IN INDUSTRY 4.0 CONDITIONS

Radosław WOLNIAK

Silesian University of Technology, Organization and Management Department, Economics and Informatics Institute; rwolniak@polsl.pl, ORCID: 0000-0003-0317-9811

Purpose: The purpose of this publication is to present the usage of Kano model approach in Industry 4.0 conditions.
Design/methodology/approach: Critical literature analysis. Analysis of international literature from main databases and polish literature and legal acts connecting with researched topic.
Findings: The integration of the Kano model with Industry 4.0 represents a promising strategy for advancing product development, bolstering customer satisfaction, and enhancing overall competitiveness in the digital landscape. This integration combines the systematic approach of the Kano model with the innovative technologies and principles of Industry 4.0, offering manifold benefits while addressing various challenges. The Kano model's structured framework aids in comprehending and categorizing customer preferences, facilitating effective resource allocation and feature prioritization to drive heightened customer satisfaction and loyalty. Meanwhile, Industry 4.0's transformative technologies revolutionize manufacturing, fostering greater efficiency, flexibility, and responsiveness to customer needs. Despite its potential, integration hurdles include organizational understanding gaps in Industry 4.0, necessitating education, collaboration, and pilot projects for smoother assimilation. Additionally, challenges in data integration require robust architectures, quality assurance measures, and advanced analytics to harness the full potential of the Kano model within Industry 4.0. Addressing scalability concerns mandates modular design, standardized processes, and investments in scalable technologies to sustain integration efforts amidst organizational growth.
Originality/Value: Detailed analysis of all subjects related to the problems connected with the usage of Kano model in Industry 4.0 conditions.
Keywords: Industry 4.0; Quality 4.0, quality management; quality methods, Kano model.
Category of the paper: literature review.

1. Introduction

The Kano model and Industry 4.0 represent two distinct yet complementary frameworks that play crucial roles in modern business practices and product development strategies. The Kano model, as previously discussed, provides a structured approach to understanding and categorizing customer preferences and requirements. It helps businesses prioritize product

features and allocate resources effectively by differentiating between basic, performance, and delight attributes. By leveraging the insights offered by the Kano model, companies can tailor their offerings to better meet customer needs and expectations, ultimately driving customer satisfaction and loyalty (Barsalou, 2023; Maganga, Taifa, 2023).

On the other hand, Industry 4.0, often referred to as the fourth industrial revolution, encompasses the integration of advanced technologies such as artificial intelligence, Internet of Things (IoT), robotics, and big data analytics into manufacturing and production processes. Industry 4.0 aims to create smart factories and supply chains that are more efficient, flexible, and responsive to customer demands. Through the digitization and automation of various tasks, Industry 4.0 enables companies to achieve higher levels of productivity, quality, and customization while reducing costs and time-to-market.

The purpose of this publication is to present the usage of Kano model approach in Industry 4.0 condition.

2. The basics of Kano model approach

The Kano model, developed by Noriaki Kano in the 1980s, is a theory widely used in product development and customer satisfaction management. It offers a structured approach to understanding and categorizing customer preferences and requirements. This model is particularly valuable for businesses striving to enhance their competitive edge by delivering products and services that not only meet but exceed customer expectations. At its core, the Kano model proposes that customer satisfaction is not solely determined by meeting basic requirements but also by addressing additional factors that contribute to overall user experience. It introduces three main categories of product attributes: basic, performance, and delight (Yanamandra et al., 2023).

Basic attributes are fundamental features or functionalities that customers expect as a minimum requirement. These attributes, when present, do not necessarily lead to increased satisfaction, but their absence can result in significant dissatisfaction. For example, in a smartphone, basic attributes might include the ability to make calls, send text messages, and access the internet. Customers generally take these features for granted, and their presence is essential for the product to be considered functional and acceptable. Performance attributes refer to features that directly correlate with customer satisfaction in a linear manner. As the performance of these attributes improves, so does customer satisfaction. However, the absence of performance attributes does not necessarily lead to dissatisfaction. Instead, their presence enhances the perceived value of the product. Using the smartphone example, a longer battery life, faster processing speed, and high-resolution camera would be considered performance attributes. Customers appreciate these features and derive satisfaction from their presence (Singh et al., 2023).

Delight attributes, also known as exciters or delighters, are unexpected features that go beyond customer expectations and evoke a positive emotional response (Gajdzik et al., 2023). Unlike basic and performance attributes, which customers can articulate, delight attributes often surprise and delight customers, leading to increased loyalty and positive word-of-mouth promotion. These attributes differentiate a product in the market and create a lasting impression on users. In the context of a smartphone, features such as facial recognition, augmented reality capabilities, or personalized virtual assistants could be considered delight attributes (Jokovic et al., 2023).

The Kano model further distinguishes between must-be, one-dimensional, attractive, indifferent, and reverse attributes, based on how customers perceive the presence or absence of each attribute. Must-be attributes are basic features that are expected and result in dissatisfaction if absent but do not necessarily increase satisfaction when present. One-dimensional attributes are performance features where an increase in functionality directly leads to increased satisfaction. Attractive attributes are delighters that exceed customer expectations and generate positive feelings. Indifferent attributes have no significant impact on satisfaction, regardless of their presence or absence. Reverse attributes are features that, if present, can actually lead to dissatisfaction (Sułkowski, Wolniak, 2015, 2016, 2018; Wolniak, Skotnicka-Zasadzień, 2008, 2010, 2014, 2018, 2019, 2022; Gajdzik, Wolniak, 2023; Swarnakar et al., 2023).

By analyzing customer preferences and perceptions across these categories, businesses can prioritize product development efforts, allocate resources efficiently, and tailor marketing strategies to better meet customer needs and expectations. Implementing the Kano model enables organizations to create products and services that not only fulfill basic requirements but also delight customers, fostering long-term relationships and sustainable competitive advantage in the marketplace (Wolniak, Grebski, 2018; Wolniak et al., 2019, 2020; Wolniak, Habek, 2015, 2016; Wolniak, Skotnicka, 2011; Wolniak, Jonek-Kowalska, 2021, 2022).

Table 1 contains description of Kano model key principles. This table outlines the main principles of the Kano model, categorizing product attributes based on their impact on customer satisfaction and perception.

Table 1.
Key principles of Kano model

Key principle	Description
Basic Attributes	Fundamental features or functionalities that customers expect as a minimum requirement. Their absence leads to dissatisfaction.
Performance Attributes	Features that correlate with customer satisfaction in a linear manner. Improving these attributes enhances satisfaction.
Delight Attributes	Unexpected features that go beyond customer expectations and evoke a positive emotional response, leading to increased loyalty.
Must-be Attributes	Basic features that are expected and result in dissatisfaction if absent but do not necessarily increase satisfaction when present.
One-dimensional Attributes	Performance features where an increase in functionality directly leads to increased satisfaction.

Cont. table 1.

Attractive Attributes	Delighters that exceed customer expectations and generate positive feelings, differentiating a product in the market.
Indifferent Attributes	Features that have no significant impact on satisfaction, regardless of their presence or absence.
Reverse Attributes	Features that, if present, can actually lead to dissatisfaction.

Source: (Almeida, Abreu, 2023; Jokovic et al., 2023; Khourshed, Gouhar, 2023; Maganga, Taifa, 2023; Liu et al., 2023; Yanamandra et al., 2023; Escobar et al., 2023; Bousdekis et al., 2023; Antony et al., 2023).

3. How Kano model method can be integrated with Industry 4.0 and Quality 4.0 concept

The relationship between the Kano model and Industry 4.0 lies in their shared focus on customer-centricity and innovation. By embracing Industry 4.0 technologies, organizations can gather vast amounts of data on customer behavior, preferences, and market trends in real-time. This data-driven approach aligns closely with the principles of the Kano model, allowing businesses to gain deeper insights into customer needs and preferences (Bousdekis et al., 2023). Moreover, Industry 4.0 enables companies to rapidly prototype and iterate product designs, facilitating the implementation of delight attributes that differentiate their offerings in the market. Furthermore, Industry 4.0 facilitates greater personalization and customization of products, which aligns with the concept of delight attributes in the Kano model. By leveraging advanced technologies such as AI and IoT, companies can offer tailored solutions that address specific customer needs and preferences, thereby enhancing customer satisfaction and loyalty (Alrabadi et al., 2023).

The integration of the Kano model method with Industry 4.0 and Quality 4.0 concepts represents a powerful approach to optimizing product development and enhancing overall quality management in the digital age (Maganga, Taifa, 2023).

Industry 4.0, with its emphasis on digitization, connectivity, and automation, provides a fertile ground for the application of the Kano model. By leveraging advanced technologies such as IoT sensors, AI-powered analytics, and digital twin simulations, companies can collect vast amounts of data on customer preferences, market trends, and product performance in real-time. This data-driven approach enables businesses to gain deeper insights into customer needs and expectations, aligning closely with the principles of the Kano model (Jonek Kowalska, Wolniak, 2021, 2022).

Moreover, Industry 4.0 facilitates greater agility and flexibility in the product development process, allowing companies to rapidly prototype, iterate, and customize products to meet evolving customer demands. By integrating the Kano model into the design and development phases, organizations can prioritize features and functionalities based on their impact on

customer satisfaction, thereby ensuring that resources are allocated effectively to deliver maximum value to customers. Furthermore, the integration of Quality 4.0 concepts, which focus on leveraging digital technologies to enhance quality management practices, complements the application of the Kano model and Industry 4.0. Quality 4.0 enables companies to implement advanced quality control techniques such as predictive analytics, real-time monitoring, and automated defect detection to ensure product consistency and reliability throughout the production process (Antony et al., 2023; Escobar et al., 2023; Antony et al., 2023; Salimbeni, Redchuk, 2023).

By integrating Quality 4.0 principles with the Kano model, organizations can proactively identify potential quality issues and address them before they impact customer satisfaction. For example, predictive analytics algorithms can analyze data from IoT sensors to anticipate product failures or performance issues, allowing companies to take preemptive measures to rectify the underlying causes. Moreover, the Kano model can help prioritize quality attributes based on their perceived importance to customers, guiding organizations in allocating resources to areas that have the greatest impact on overall customer satisfaction. By combining the insights from the Kano model with Quality 4.0 technologies, companies can establish a proactive quality management framework that not only meets but exceeds customer expectations, driving long-term loyalty and competitive advantage in the marketplace (Jonek-Kowalska, Wolniak, 2021, 2022, 2023; Rosak-Szyrocka et al., 2023; Gajdzik et al., 2023; Jonek-Kowalska et al., 2022; Kordel, Wolniak, 2021, Orzeł, Ponomarenko et al., 2016; Stawiarska et al., 2020, 2021; Stecuła, Wolniak, 2022; Olkiewicz et al., 2021).

The integration of the Kano model method with Industry 4.0 and Quality 4.0 concepts represents a synergistic approach to product development and quality management. By leveraging advanced technologies and data-driven insights, organizations can create innovative products that not only meet customer needs but also deliver exceptional quality and value, positioning themselves for success in the digital era.

Table 2 is listing examples of integration of Kano model method with Industry 4.0. This table outlines the integration of the Kano Model with Industry 4.0, highlighting the benefits and key considerations for manufacturers looking to leverage both frameworks to enhance customer satisfaction and competitiveness in the digital age.

Table 2.
Kano model integration with industry 4.0

Aspect	Description
Kano Model Overview	The Kano Model is a theory developed by Professor Noriaki Kano in the 1980s, used to prioritize customer needs and preferences into categories: basic, performance, and excitement. It assesses how different product features influence customer satisfaction.
Industry 4.0 Overview	Industry 4.0 refers to the fourth industrial revolution, characterized by the integration of digital technologies such as IoT, AI, big data, and automation into manufacturing processes. It emphasizes the use of cyber-physical systems to create smart factories that are more efficient, flexible, and interconnected.

Cont. table 2.

Integration Benefits	By applying the Kano Model within Industry 4.0, manufacturers can better understand and prioritize customer preferences, leading to the development of products and services that align with market demands. Industry 4.0 technologies enable mass customization by integrating customer feedback directly into the manufacturing process, allowing for the creation of personalized products tailored to individual preferences. The Kano Model facilitates agile development methodologies by categorizing features based on their impact on customer satisfaction, allowing manufacturers to quickly adapt to changing market needs and preferences.
Data Integration	Industry 4.0 relies heavily on data collection and analysis from various sources, including sensors, machines, and customer feedback channels. Integrating the Kano Model with Industry 4.0 involves incorporating customer satisfaction data into the manufacturing process, enabling real-time adjustments and improvements based on customer preferences.
Predictive Analytics	By leveraging predictive analytics algorithms within Industry 4.0 systems, manufacturers can anticipate customer preferences and trends based on historical data. Integrating the Kano Model with predictive analytics allows for the proactive development of features that are likely to excite customers, leading to competitive advantages in the market.
Continuous Improvement	Industry 4.0 promotes a culture of continuous improvement through technologies like IoT and AI, which provide real-time insights into production processes. By integrating the Kano Model with Industry 4.0, manufacturers can continuously monitor customer satisfaction metrics and iterate on product features to maintain or enhance customer satisfaction levels over time.
Real-Time Feedback	Industry 4.0 enables the collection of real-time feedback from customers through various channels, such as social media, online reviews, and IoT-enabled devices. Integrating the Kano Model with real-time feedback mechanisms allows manufacturers to promptly identify and address emerging customer needs and preferences, fostering greater customer loyalty and market competitiveness.
Product Lifecycle Management	The Kano Model can be integrated into product lifecycle management (PLM) systems within Industry 4.0 frameworks, enabling manufacturers to track and manage customer satisfaction metrics throughout the entire product lifecycle. This integration facilitates data-driven decision-making at every stage, from product design and development to post-sales support and service, ensuring that customer needs are consistently met and exceeded.

Source: (Almeida, Abreu, 2023; Jokovic et al., 2023; Khourshed, Gouhar, 2023; Maganga, Taifa, 2023; Liu et al., 2023; Amat-Lefort et al., 2023; Alrabadi et al., 2023; Singh et al., 2023; Barsalou, 2023; Antony et al., 2023; Saihi et al., 2023; Sureshchandar, 2023; Swarnakar et al., 2023; Gimerska et al., 2023; Salimbeni, Redchuk, 2023; Yanamandra et al., 2023; Escobar et al., 2023; Bousdekis et al., 2023; Antony et al., 2023).

Table 3 is describe the advantages Kano model approach usage in industry 4.0. This table illustrates how the integration of the Kano Model with Industry 4.0 offers numerous advantages for manufacturers, ranging from improved customer satisfaction and product development to enhanced agility, customization, and competitive positioning in the market.

Table 3.
The advantages of Kano model integration with industry 4.0

Advantage	Description
Enhanced Customer Satisfaction	By integrating the Kano Model with Industry 4.0, manufacturers can gain deeper insights into customer preferences and priorities. This leads to the development of products and services that better meet customer needs, ultimately enhancing satisfaction levels and fostering greater brand loyalty.

Cont. table 3.

Improved Product Development	Industry 4.0 technologies enable rapid prototyping and iterative product development cycles. By incorporating the Kano Model into this process, manufacturers can prioritize features based on their impact on customer satisfaction, resulting in more focused and efficient product development efforts. This leads to the creation of products that resonate more strongly with target markets, driving sales and profitability.
Agile Response to Market Dynamics	Industry 4.0 facilitates agile manufacturing processes, allowing companies to quickly adapt to changing market conditions and customer preferences. By integrating the Kano Model, manufacturers can identify emerging customer needs in real-time and respond promptly with innovative product features or modifications. This agility enables companies to stay ahead of competitors and maintain a competitive edge in dynamic market environments.
Customization and Personalization	Industry 4.0 enables mass customization through flexible manufacturing systems and digital technologies. Integrating the Kano Model with these capabilities allows manufacturers to tailor products to individual customer preferences, delivering personalized experiences that drive customer satisfaction and brand differentiation. This customization enhances perceived product value and fosters stronger customer relationships.
Data-Driven Decision Making	Industry 4.0 generates vast amounts of data from various sources throughout the product lifecycle. By integrating the Kano Model with data analytics tools, manufacturers can extract actionable insights from this data, informing strategic decision-making processes. These data-driven decisions lead to more informed product design, marketing strategies, and resource allocations, resulting in improved overall business performance and profitability.
Continuous Improvement and Innovation	Industry 4.0 promotes a culture of continuous improvement and innovation through iterative design processes and real-time feedback loops. By integrating the Kano Model, manufacturers can systematically track customer satisfaction metrics and iteratively improve product features to meet evolving market demands. This fosters innovation and ensures that products remain competitive and relevant in the long term.
Competitive Advantage	The integration of the Kano Model with Industry 4.0 provides companies with a significant competitive advantage in the marketplace. By aligning product development efforts with customer preferences and leveraging digital technologies for agile manufacturing, companies can differentiate themselves from competitors, attract more customers, and capture greater market share. This sustainable competitive advantage drives long-term business success and growth.

Source: (Almeida, Abreu, 2023; Jokovic et al., 2023; Khourshed, Gouhar, 2023; Maganga, Taifa, 2023; Liu et al., 2023; Amat-Lefort et al., 2023; Alrabadi et al., 2023; Singh et al., 2023; Barsalou, 2023; Antony et al., 2023; Saihi et al., 2023; Sureshchandar, 2023; Swarnakar et al., 2023; Gimerska et al., 2023; Salimbeni, Redchuk, 2023; Yanamandra et al., 2023; Escobar et al., 2023; Bousdekis et al., 2023; Antony et al., 2023).

Table 4 is describe the problems of Kano model approach usage in Industry 4.0 and methods to overcome them. Addressing these problems requires a strategic and thoughtful approach, involving a combination of technological solutions, organizational change management, and ongoing adaptation to evolving industry standards and practices.

Table 4.
The problems of Kano model integration with industry 4.0

Problems	Description of Problem	Overcoming Strategies
Lack of understanding of Industry 4.0 concepts	Many organizations struggle to fully comprehend the intricacies and implications of Industry 4.0, making it challenging to integrate the Kano model effectively within this framework.	1. Education and Training: Provide comprehensive training programs to employees and management on Industry 4.0 concepts and how they relate to the Kano model. 2. Collaboration: Foster partnerships with experts in Industry 4.0 to gain insights and guidance on integrating the Kano model within this context. 3. Pilot Projects: Initiate small-scale pilot projects to experiment with the integration of the Kano model and Industry 4.0, allowing for iterative learning and adjustment.
Data Integration Challenges	Industry 4.0 relies heavily on data-driven processes, and integrating the Kano model within this environment requires overcoming challenges related to data collection, analysis, and utilization.	1. Data Architecture: Develop a robust data architecture that facilitates seamless integration of Kano model data with other Industry 4.0 systems and processes. 2. Data Quality Assurance: Implement measures to ensure the accuracy, consistency, and reliability of data used in conjunction with the Kano model in Industry 4.0 applications. 3. Advanced Analytics: Employ advanced analytics techniques such as machine learning and artificial intelligence to derive meaningful insights from Kano model data within Industry 4.0.
Scalability Issues	As organizations grow and evolve within the context of Industry 4.0, scalability becomes a crucial concern for integrating the Kano model effectively across diverse products and services.	1. Modular Approach: Design the integration of the Kano model with Industry 4.0 systems in a modular fashion, allowing for scalability and adaptability to changing business needs. 2. Standardization: Establish standardized processes and methodologies for applying the Kano model across different product lines and business units within the Industry 4.0 framework. 3. Scalable Technologies: Invest in technologies that can scale efficiently alongside the growth of Industry 4.0 initiatives, ensuring compatibility with the integrated Kano model.

Source: (Almeida, Abreu, 2023; Jokovic et al., 2023; Khourshed, Gouhar, 2023; Maganga, Taifa, 2023; Liu et al., 2023; Amat-Lefort et al., 2023; Alrabadi et al., 2023; Singh et al., 2023; Barsalou, 2023; Antony et al., 2023; Saihi et al., 2023; Sureshchandar, 2023; Swarnakar et al., 2023; Gimerska et al., 2023; Salimbeni, Redchuk, 2023; Yanamandra et al., 2023; Escobar et al., 2023; Bousdekis et al., 2023; Antony et al., 2023).

4. Conclusion

The integration of the Kano model with Industry 4.0 presents a promising approach to enhancing product development, customer satisfaction, and overall competitiveness in the digital era. By combining the structured approach of the Kano model with the advanced technologies and principles of Industry 4.0, organizations can unlock numerous benefits and overcome various challenges.

The Kano model offers a systematic framework for understanding and categorizing customer preferences, distinguishing between basic, performance, and delight attributes. This model helps businesses prioritize product features and allocate resources effectively, leading to enhanced customer satisfaction and loyalty. On the other hand, Industry 4.0 revolutionizes manufacturing processes through digitization, connectivity, and automation, enabling companies to achieve higher levels of efficiency, flexibility, and responsiveness to customer demands. However, integrating the Kano model with Industry 4.0 is not without its challenges. One significant issue is the lack of understanding of Industry 4.0 concepts among organizations, hindering effective integration efforts. To address this, strategies such as education and training, collaboration with industry experts, and initiating pilot projects can help bridge the knowledge gap and facilitate smoother integration.

Another challenge is data integration, as Industry 4.0 relies heavily on data-driven processes, and integrating the Kano model requires overcoming challenges related to data collection, analysis, and utilization. Developing a robust data architecture, ensuring data quality assurance, and leveraging advanced analytics techniques can help address these challenges and derive meaningful insights from Kano model data within Industry 4.0 applications. Scalability issues also arise as organizations grow within the context of Industry 4.0, making it crucial to design the integration of the Kano model in a modular fashion, establish standardized processes, and invest in scalable technologies.

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