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Research Article

Systematic Review of Kansei Engineering Method Developments in the Design Field

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ABSTRACT

Kansei engineering is a critical method for designing products that meet functionality, usability, and pleasurability, essential elements for business success. Despite its significance, there is limited understanding of how this method has evolved in recent years. This study aims to analyze the development of Kansei Engineering research from 2018 to 2022 using the Scopus database. The research methodology involved stages of identification, screening, filtering, and inclusion, resulting in 41 articles for detailed analysis out of an initial 215. The results indicate that 85% of Kansei Engineering research focuses on tangible products, with 83% categorized as type 1 studies, and 56% not integrating other methods. Additionally, 88% of the studies use only Kansei words, and 41% visualize design results as 3D images, with 95% not considering unique aspects. This dominance of tangible product design and the lack of integration with other methods suggest a need for diversification in research approaches. Furthermore, the high reliance on Kansei words and 3D visualizations points to a potential area for innovation and expansion in research techniques. This review highlights a significant research gap in Kansei Engineering studies, emphasizing the need for more diversified approaches. By identifying these gaps, the study provides a clear direction for future research, recommending that Kansei Engineering should explore beyond the predominant trends and consider integrating with other methods and unique aspects. This can enhance the method's application in industrial engineering and lead to more comprehensive and innovative product designs. Future research should aim to fill these gaps, ensuring that Kansei Engineering continues to evolve and contribute effectively to the field of product design and development.

Keywords: Kansei engineering, product design, systematic review, usability, pleasurability

INTRODUCTION

User-based product development is essential to satisfy customers who seek ease of use and to keep manufacturers competitive in the market [1]. The initial impression that a product creates can be immediately felt by the user, and this impression may persist, leading to repeated use. Therefore, the product is crucial to the continuity of the business process. The more products that are absorbed by the market, the greater the profit the company receives. To achieve this, products must be meticulously designed and developed to meet the needs and desires of users. Product development is an interdisciplinary activity requiring contributions from various company functions, including marketing, design, and manufacturing teams [2].

Each user interacts with the product they use, and the results of this interaction are captured in the user's emotions and expectations [3]. Jordan divides user needs into three aspects: functionality, usability, and pleasurability [4]. The impression that a product leaves on a customer influences their decision-making process. This includes considerations of functionality, usability, safety, affordability, and the emotions or feelings triggered by the product [5]. Therefore, alongside functionality and usability, pleasurability must also be pursued to ensure the product leaves a deep emotional impression on customers. This is inevitable because users increasingly view products not just as tools but as memorable life objects that should function well and evoke positive emotions. This presents a challenge related to the human factor [4]. More and more customers base their purchases on subjective impressions of a product [6]. Analysis of these studies shows that product aspects can be divided into two categories: engineering aspects and psychological aspects. The engineering aspects include functionality, usability, and safety, while the psychological aspects relate to pleasure and emotions. However, some companies neglect the psychological aspects in product design, focusing solely on engineering aspects, which results in products being less acceptable to the market. This review underscores the importance of considering psychological aspects in product design.

The Kansei engineering technique, introduced by Nagamachi, a professor at Hiroshima University in Japan, is a design tool that incorporates the user's emotions into design elements [7]. "Kansei" is a Japanese term that encompasses feelings gathered through sight, hearing, smell, and taste [8]. In a broader sense, Kansei includes feelings, sensitivity, affection, emotion, desire, and need. The primary goal of Kansei engineering is to discover and translate the affective and emotional needs of customers. It is considered one of the best-structured methodologies globally for translating Kansei needs into new product attributes, characteristics, and functions [9]. Kansei can be measured in several ways, including EEG, EMG, attitude-behavior, and words [8].

A notable success of Kansei engineering is the Mazda Miata car, which became popular worldwide due to its aesthetic, structural, and functional design, all decided emotionally using Kansei engineering techniques [10]. This technique has been widely applied in various industries, including the clothing sector. Takatera concluded that Kansei engineering is crucial for designing in the clothing industry to achieve different levels of customer satisfaction [11]. Additionally, Kansei engineering can be applied to robot design. Coronado et al. found it to be a suitable paradigm for robot design, opening new opportunities and challenges for the future [12]. Schutte and Marco-Almagro developed the Kansei food model, successfully used in the Japanese food industry, which builds on the general Kansei engineering model while adhering to its basic principles [13]. The studies mentioned above demonstrate that Kansei engineering is a promising method for future product design, combining engineering and psychology. Product design is a significant part of the industrial engineering body of knowledge. Kansei engineering can capture customers' emotional needs as inputs for the pleasure aspect, optimizing the design process and improving its efficiency. The pleasurability aspect is crucial for the sustainability of products in the future.

Lokman [14] classifies Kansei engineering into eight types based on its application principles: Type 1: Category Classification, Type 2: KE System, Type 3: KE Modeling, Type 4: Hybrid KE, Type 5: Virtual KE, Type 6: Collaborative, Type 7: Concurrent KE, and Type 8: Rough Set KE [14]. However, most researchers do not specify the type of Kansei their research falls under. Over time, the implementation of Kansei engineering has expanded beyond designing tangible manufacturing products to include intangible services and work systems. Research on Kansei implementation in the service sector includes logistics services, where 13 service elements emerged from 13 service attributes [15]; hotel services, which produced guidelines for service development [16]; and airport services, which generated practical guidelines for the airport management team to continuously improve services, considering resource constraints, innovative ideas, and emotional satisfaction [17].

Kansei Engineering has evolved significantly in methodology, both in capturing Kansei as input and processing data into design elements. The development of the Kansei route now involves using sensory biological signals, such as electroencephalography (EEG) and eye tracking, to capture user emotions when interacting with products. For instance, EEG can detect human brain signals to determine whether a user feels pleasure related to a product. Using sensory biological signals provides more precise Kansei data compared to traditional methods like interviews. These devices, such as EEG and eye tracking, help avoid the uncertainties associated with subjective evaluations through Kansei words [18]. Some research even combines these tools with Kansei words [19].

In terms of data processing, artificial intelligence algorithms like artificial neural networks [20] and machine learning [21] are now utilized. These embedded AI programs process Kansei data to generate design elements more quickly. To present a representation of design results, recent studies employ virtual reality technology, offering a more optimal and realistic prototype description [22]. Additionally, several studies have linked user Kansei with the uniqueness and identity of specific communities that are the target market, enhancing product acceptance. For example, Liu S et al. [23] considered local cultural aspects in designing the Mazu crown, while Daud N et al. [24] integrated Islamic aspects in designing Kansei engineering-based websites. Kansei Engineering fosters sustainable industry and

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innovation, aligning with the Sustainable Development Goals (SDGs). The innovation lies in designing products that adapt to changing customer desires. If a product continuously meets customer needs, it will remain viable in the market, thereby maintaining industry stability.

The explanation above highlights the various developments in Kansei Engineering, including its application to different design objects, integration with other methods, advancements in Kansei routes, visualization of Kansei design outcomes, and consideration of unique aspects. However, there is no current literature review that comprehensively discusses these developments from multiple perspectives. Therefore, this literature review aims to examine the development of Kansei Engineering research from 2018 to 2022 using the Scopus database. The review will address the following six research questions:

Question 1: What are the primary objects of design addressed using Kansei Engineering?

This question seeks to uncover the specific domains where Kansei Engineering has been applied most prominently. Understanding the prevalent design objects will shed light on the practical applications and potential future directions of Kansei Engineering in various fields of product design, user interface development, etc.

Question 2: Which types of Kansei Engineering are predominantly utilized?

Understanding the prevalence of different types of Kansei engineering provides valuable insights into the dominant approaches and practices within the field. Each type represents distinct methodologies and frameworks for capturing and interpreting human affective responses. By identifying which types have been most frequently employed in previous studies, researchers can discern trends in methodological preferences over time. This insight not only reflects the current landscape of Kansei engineering research but also indicates evolving methodologies that may shape future research directions and innovations.

Question 3: To what extent are other methodologies integrated with Kansei Engineering?

This question explores the integration of Kansei Engineering with complementary methodologies such as user experience research, usability testing, and cognitive psychology. By examining these interdisciplinary connections, researchers gain insights into how multiple methodologies enrich and validate Kansei-driven insights. Understanding the depth of integration enhances the reliability and applicability of findings, offering a holistic approach to understanding user preferences and behaviors.

Question 4: What are the most commonly employed Kansei Engineering route?

By identifying which routes are most frequently employed, researchers can evaluate the effectiveness and reliability of these various methods in different contexts, guiding future research and application. Moreover, understanding the distribution and popularity of these routes can highlight gaps in current methodologies and encourage the adoption of innovative approaches that may provide deeper insights into user emotions and preferences. This, in turn, can lead to more nuanced and effective design solutions that better meet user needs.

Question 5: How are Kansei Engineering results typically visualized?

Visualization is a powerful tool for interpreting and communicating complex data. Kansei Engineering involves capturing and analyzing affective responses. This allows researchers to quickly grasp the emotional responses and design implications derived from Kansei studies. By evaluating how results are visualized, researchers can identify best practices that enhance clarity, comprehension, and the overall impact of their findings.

Question 6: What additional factors beyond traditional considerations impact Kansei Engineering studies?

This question investigates the diverse factors beyond traditional factors like usability and functionality that researchers incorporate into their studies to enrich the understanding and applicability of Kansei-driven design solutions in real-world contexts.

METHODS

In The methodology employed in this research is the systematic literature review (SLR) method, utilizing metadata sources by searching for specific keywords in the Scopus database. The Scopus database served as the primary source for articles in this literature review due to its status as the most extensive journal indexing database internationally and a significant resource for researchers.

A systematic review is defined as a methodology that relies on the availability and accessibility of previous studies by establishing certain criteria [25]. It aims to provide an overview of past research and indicate possibilities for future research [26]. The SLR method used in this study was adapted from Moher [27]. The Moher method is suitable for answering research questions because it follows systematic stages from general to specific, encompassing the research question comprehensively. The adaptation of the Moher method in this literature review is explained as follows:

1. Identification

At this stage, the keywords used to search for references in the Scopus database are specifically focused on "Kansei engineering." The search parameters were limited to titles and abstracts containing the term "Kansei engineering." This approach aimed to gather a comprehensive collection of articles, both directly and indirectly related to the topic. The search covered articles published over the past five years, from 2018 to 2022, to ensure the inclusion of recent yet relevant research on Kansei engineering.

To maintain the credibility of the sources, only journal papers published by reputable publishers were selected, while papers in the form of proceedings were excluded. Consequently, the keywords for the search were formulated and entered into Scopus Advanced Search as follows:

> TITLE-ABS-KEY ("Kansei engineering") AND (LIMIT-TO (DOCTYPE, "ar")) AND (LIMIT-TO (PUBYEAR, 2023) OR LIMIT-TO (PUBYEAR, 2022) OR LIMIT-TO (PUBYEAR, 2021) OR LIMIT-TO (PUBYEAR, 2020) OR LIMIT-TO (PUBYEAR, 2019) OR LIMIT-TO (PUBYEAR, 2018))

2. Screening

At this stage, the title and abstract of each article identified in the previous step were carefully reviewed. Each article had an equal opportunity to be considered based on its abstract, which provides a concise summary of the paper's content, including the background, methodology, and results.

The exclusion criteria applied to determine whether an article would proceed to the next stage were as follows:

- The Kansei method must be the primary method used in design, which is the main focus of this literature review, particularly in the field of design. Articles where Kansei engineering is used solely for analysis or is not the main method discussed were excluded.
- The article must describe the creation of a product, at least at the concept design stage, as this is a necessary output in design-focused research.
- The article must be an original paper and not a literature review.

3. Filtering

In this stage, the full text of each article was carefully read. The criteria for passing this filtering process were as follows:

- The articles must be fully accessible to ensure that their contents can be thoroughly reviewed.
- The full articles must be written in English.
- The Kansei method must be the primary method used in the design. While this criterion was initially applied during the abstract screening stage, it required verification through a detailed reading of the full content.

4. Data extraction and Analysis

This stage constitutes the core of the study. Articles that have passed the filtering process are now subjected to meta-analysis. The process confirmed that the 41 articles met the established criteria, the subsequent step involved extracting pertinent data from these articles to address the research questions. This data encompassed author identity, year of publication, type of Kansei utilized, design object, analysis method, visualization design, and consideration of uniqueness. Subsequently, the data was organized, quantitatively summarized, and subjected to analysis to derive meaningful insights. All the above process is summarized in Figure 1.

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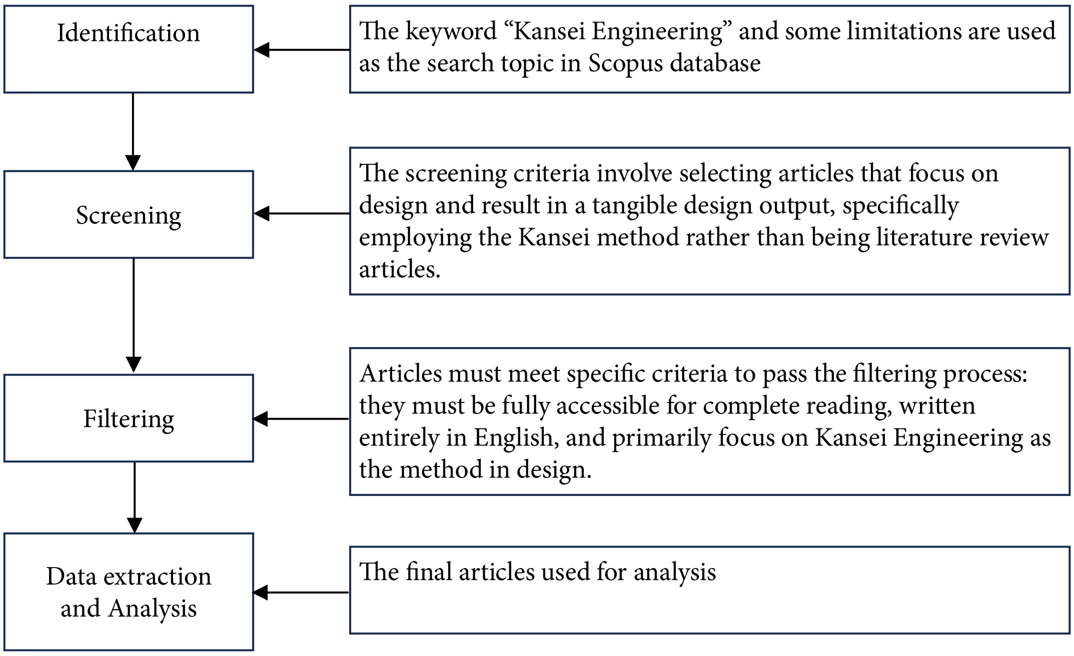

Figure 1. The stages of the proposed literature review

RESULT AND DISCUSSION

Number of Articles Reviewed

With the predefined search keywords and limitations in the research methodology, a total of 215 articles were identified in the Scopus database. This exceeds the scope of previous literature reviews, such as that conducted by Lopez et al. [5], which initially identified 154 articles using different keywords. Figure 2 shows that China has made the most significant contributions to Kansei Engineering techniques, particularly in product design and system evaluation, followed by Indonesia, Japan, and Malaysia. This indicates that while Japan pioneered Kansei engineering, China has emerged as the leading country in advancing research and applications across diverse fields related to Kansei engineering. This trend is illustrated graphically, where China exhibits the highest concentration of research points compared to other countries involved in Kansei engineering initiatives.

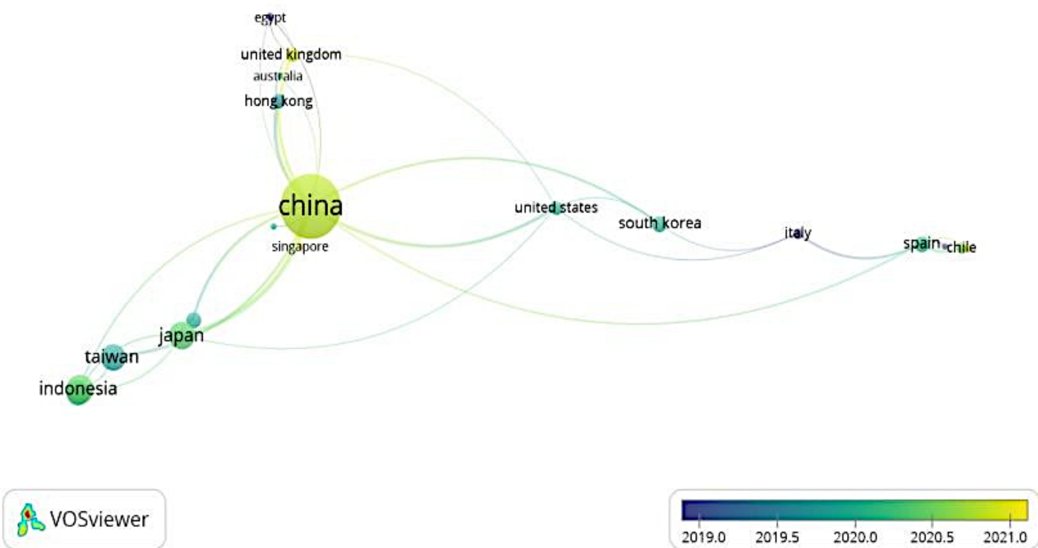

Figure 2. The most contributed country to Kaisei Engineering Study

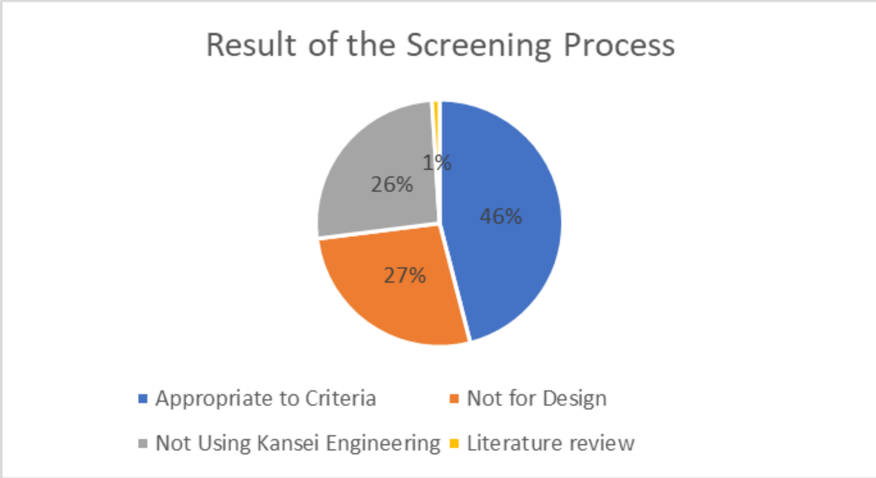

Figure 3. Evaluation of Screening Process

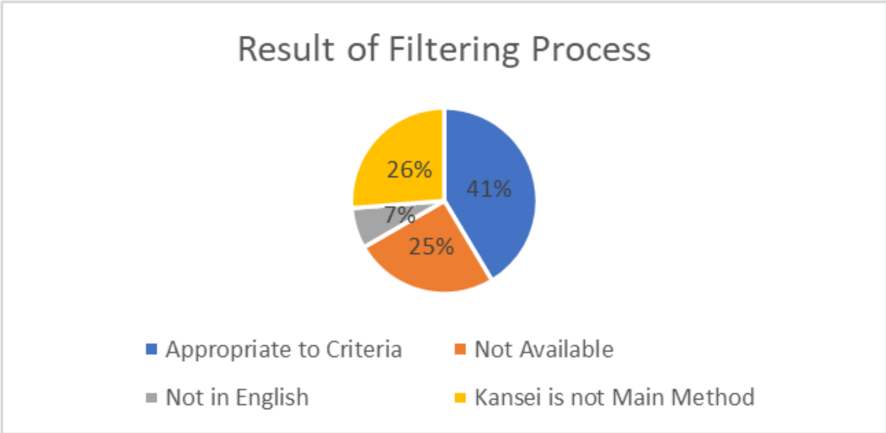

Figure 4. Evaluation of Filtering Process

Screening and Filtering

After the initial screening process, 99 articles met the criteria and proceeded to the filtering stage. This transition is illustrated in Figure 3, representing the distribution of these articles in percentage form. Subsequently, a detailed review of the article content narrowed down the selection to 41 articles that passed the filtering process. In reflecting on the initial pool of 215 articles, only 19% successfully navigated through the screening and filtering stages to become eligible for analysis. Figure 4 illustrates this percentage in relation to the number of articles that passed the screening stage, emphasizing the rigorous process of narrowing down the search to articles with comprehensive information relevant to the research objectives. The outcomes of the 41 selected articles are detailed in the Appendix and analyzed in alignment with predefined research questions. This structured analysis aims to derive insights and conclusions from the compiled data, contributing to a comprehensive understanding of Kansei Engineering applications.

The Objects of Design Using Kansei Engineering

As depicted in Table 1, Kansei Engineering primarily focuses on designing tangible products, accounting for 85% of the applications studied. This dominance underscores the clarity and feasibility associated with designing physical products, where design elements are more tangible and easier to define. Conversely, the utilization of Kansei Engineering in designing services constitutes 12%, highlighting a lesser but significant application in enhancing service experiences. Work systems, comprising 2% of the applications, indicate a niche area with ample room for

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Table 1. Mapping based on designed object

Design Object	Authors	Number of Articles
Tangible products	Yang et al. [18]; Zhou et al. [19]; Lin et al. [20]; Lian et al. [21]; Fu et al. [22]; Liu et al. [23]; Daud et al. [24]; Wu et al. [28]; Gong et al. [29]; Chen & Cheng [30]; Akgül et al. [31]; Fithri et al. [32]; Lai et al. [33]; Liu et al. [34]; Wang et al. [35]; Lee and Han [37]; Huang Y., Pan Y. [38]; Jasmy F.A. [39]; Jia and Tung [40]; Erol and Basar [41]; Kang and Qu. [42]; Gan et al. [43]; Dong et al. [44]; Wang et al. [45]; Li et al. [46]; Liang et al. [48]; Chen and Cheng [49]; Xue et al. [50]; Akgül et al. [51]; Li and Zhu [52]; Redzuan et al. [53]; Baroroh et al. [54]; Wang and Zhang [55]; Prakoso and Purnomo [56]; Kisanjani and Purnomo [58]	35 articles
Service	Restuputri et al. [15]; Hartono [17]; Chen et al. [19]; Masudin et al. [36]; Yan and Li [47]	5 articles
Work System	Hsu and Hsiao [57]	1 article

exploration and development, suggesting both opportunities and challenges for future Kansei research. The broader applicability of Kansei Engineering beyond product design is evident, suggesting its potential expansion into optimizing work systems for enhanced operational efficiency.

Several studies exemplify the application of Kansei Engineering in tangible product design. Lin et al. [29], for instance, integrated Kansei Engineering with artificial neural networks to optimize the design of electric shavers based on consumer emotional responses to sound. Gong et al. [29] employed a Kansei Engineering-Design Thinking integration to create a bamboo pen holder, aligning designer-user perceptions effectively. Lee and Han [37] explored user preferences to enhance soccer shoe design, achieving an average customer satisfaction rate of 87%.

In the context of service design, Masudin et al. [36] investigated customer emotional satisfaction with logistics services during the Covid-19 pandemic, highlighting the impact of customer commitment on loyalty. Chen et al. [19] developed guidelines for hotel services using Kansei techniques and data mining, aimed at aligning service offerings with customer desires. Hartono [17] employed an integrated approach to assess the emotional impact of attractive service attributes and formulate sustainable service innovations at airports. Additionally, Hsu & Hsiao [57] focused on client-centered health scape design to enhance green dentistry supply chains, emphasizing positive client emotions and loyalty enhancement strategies. These studies collectively highlights the diverse applications of Kansei Engineering across tangible product design and service system, while also illuminating its potential for broader implementation in optimizing work systems and service experiences.

The most utilized Kansei Engineering Type

To address the second research question regarding the classification of Kansei Engineering types, Lokman [14] provides a framework that categorizes these types, yet researchers often do not explicitly specify which type they utilize in their studies. Upon closely examining the 41 selected articles and applying the principles outlined by Lokman [14], the distribution of Kansei Engineering types was identified. The analysis reveals that Type 1 of Kansei Engineering predominates, encompassing 83% of the studies. This type focuses on categorical classifications, indicating its widespread application in research. Type 2, Type 3, Type 7, and Type 4 follow with smaller proportions, comprising 5%, 5%, 5%, and 2% respectively. This distribution underscores the significant preference for Type 1, which facilitates relatively easier implementation compared to other types. However, it also highlights the potential for exploring more challenging types in future Kansei research endeavors. The distribution of these Kansei Engineering types is visually depicted in Figure 5, offering a clear representation of their utilization across

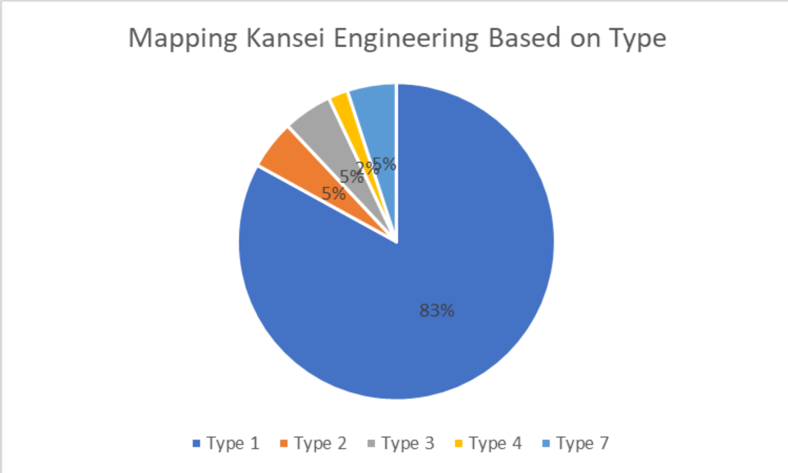

Figure 5. Kansei Engineering Mapping by Type

the analyzed studies. This classification provides insights into the varying type used and potential research directions within the field of Kansei Engineering.

Other methodologies integrated with Kansei Engineering

An examination was conducted to determine whether Kansei Engineering remains a standalone methodology or has evolved through integration with other relevant methods (the third research question). Initially introduced as a distinct methodology, Kansei Engineering has indeed evolved significantly by incorporating and integrating various other methods. Among the methodologies integrated with Kansei Engineering, notable advancements include artificial intelligence algorithms such as artificial neural networks [20] and machine learning [21]. These integrations are classified under KE Type 4, which involves applying mathematical modeling and inferential logic within computer systems [10].

From the analysis of 41 selected articles, it was observed that a majority of studies, approximately 56%, predominantly employed the pure Kansei methodology without additional integrations. However, significant developments were identified where Kansei Engineering was combined with other methodologies. This integration included neural network algorithms in 12% of the articles, followed by combinations with Kano/TRIZ/AHP (10%), fuzzy set theory (7%), rough set analysis (5%), design thinking (5%), deep learning (2%), and data mining (2%), as illustrated in Figure 6. These findings suggest that while the foundational principles of Kansei Engineering suffice for designing

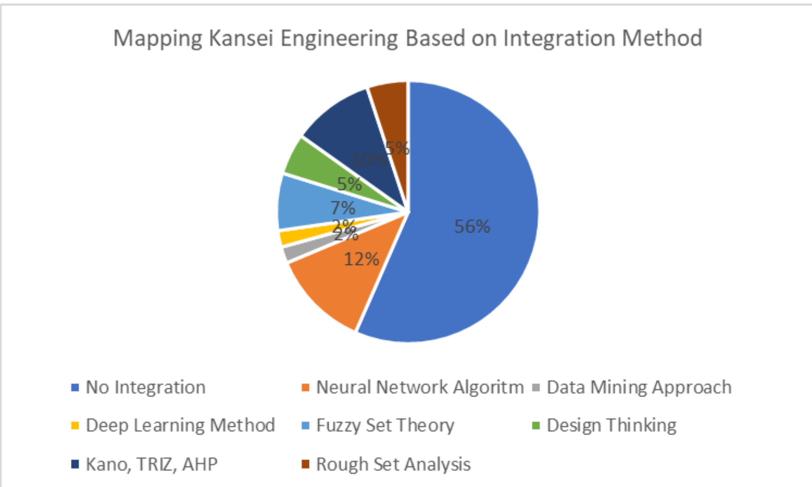

Figure 6. Integration of Other Methodologies with Kansei engineering

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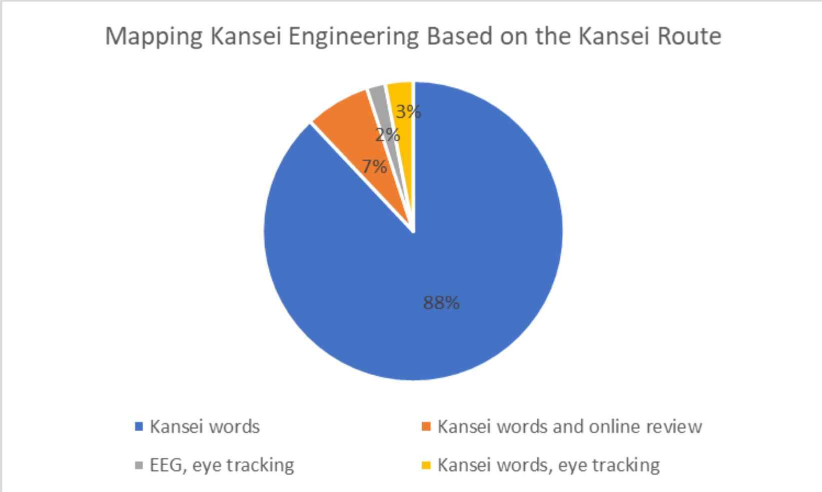

Figure 7. Kansei Engineering Mapping based on the Kansei Route

products based on user preferences, there is substantial potential for further exploration and innovation through integrating Kansei with diverse methodologies. The open opportunities and challenges posed by integrating Kansei Engineering with other methods underscore its adaptability and potential for enhancing product design and user satisfaction. This ongoing development encourages future research endeavors to explore and expand the integration of Kansei Engineering with cutting-edge methodologies, thereby advancing its applicability and impact across various domains.

The most Employed Kansei Engineering Route

Kansei can be obtained through various methods, including EEG, EMG, attitude-behavior analysis, and Kansei words [8]. The tools for Kansei data collection have become increasingly diverse and sophisticated. In recent studies, sensory biological signal capture tools such as electroencephalography (EEG) and eye tracking have been utilized to capture the user's Kansei, aiming to avoid the uncertainties associated with subjective evaluation by Kansei words [18]. Some research also combines these tools with Kansei words [19]. To answer the fourth research question, the majority of Kansei-based research predominantly relies on Kansei words to gather data from respondents, accounting for 88% (as depicted Figure 7). Kansei words sourced from online reviews make up 7%, while EMG and eye tracking are used in 2% of the research. Additionally, 2% of the studies combine Kansei words with eye tracking. This indicates that most Kansei Engineering research uses Kansei words due to their relative affordability compared to other methods. Although using EEG, EMG, or other sensory devices yields more accurate data, these methods are significantly more expensive than relying on Kansei words. Consequently, research utilizing these advanced devices is still limited, presenting a potential opportunity for future studies.

Visualization of Kansei Engineering Design

To provide a more optimal and realistic prototype description, recent research has employed virtual reality technology to display design representations. For instance, Fu et al. [22] effectively managed design elements within a virtual reality (VR) environment based on Kansei engineering, offering an advanced evaluation method for the design process. Similarly, Ishihara [59] utilized VR to visualize garden designs based on Kansei analysis, facilitating better collaboration between designers and customers. These studies fall under KE type 5, where Kansei engineering is combined with virtual reality, enabling customers to examine products in a virtual space [10].

In response to the fifth research question, the 41 selected articles were reviewed to assess how design results were visualized. The findings reveal that 41% of the design results were presented as 3D images, 37% had no visualization, 17% used 2D images, 2% combined 2D and 3D images, and 2% utilized virtual reality for visualization (Figure 8). Researchers typically visualize their design outcomes in various ways, with three-dimensional shapes being the most common representation in Kansei engineering. Although using virtual reality for design visualization is still limited,

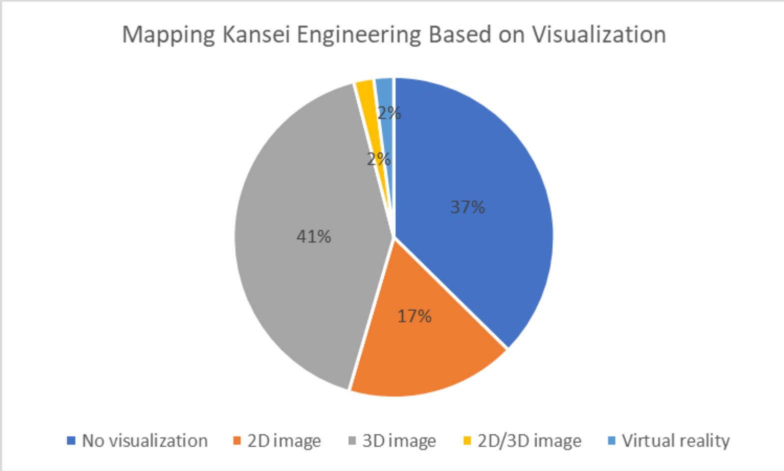

Figure 8. Kansei engineering mapping based on visualization

it is highly recommended for future research due to its potential benefits. Camburn et al. [60] emphasized the importance of using virtual reality in the initial design phase. They noted that VR helps detect design problems early, improves product quality, and reduces both development time and costs. This underscores the value of integrating VR into Kansei engineering for more effective and efficient design processes.

Additional factors impact Kansei Engineering studies

To answer the sixth research question, an in-depth review was conducted to determine if there are any other factors to consider in the Kansei Engineering method. The review found that some studies have linked user Kansei with the uniqueness or identity of specific communities that are the target market, enhancing product or service acceptance. For instance, Liu et al. [23] considered local cultural aspects in designing the Mazu crown, while Daud et al. [24] incorporated Islamic elements in designing Kansei engineering-based websites.

From the identification results, it was found that the majority of Kansei Engineering research did not account for any particular uniqueness, with 95% of studies falling into this category (Figure 9). Only 5% of the research considered certain unique aspects. This suggests that there is significant potential for future Kansei research to explore connections with the uniqueness of target market communities, such as local cultural characteristics. Ushada [61] concluded that Kansei value is influenced by local wisdom, underscoring the importance of integrating cultural and community-specific elements into Kansei Engineering research. This approach can help create products and services that resonate more deeply with their intended audiences.

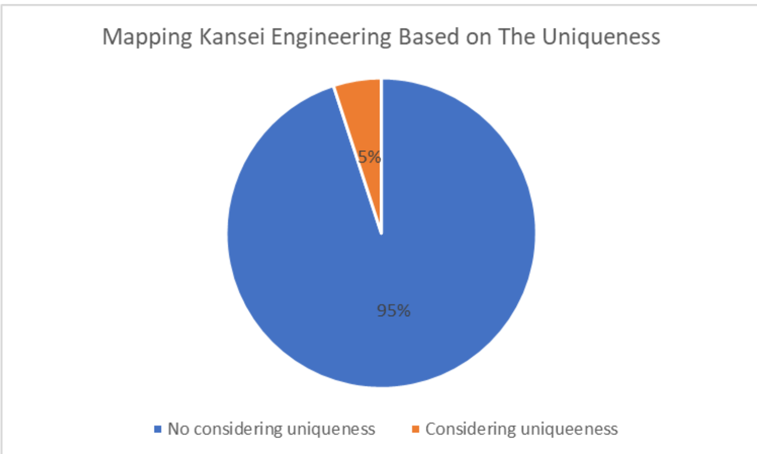

Figure 9.Other Factors Considered in Kansei engineering

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CONCLUSION

This research provides the comprehensive analysis of Kansei Engineering highligting its expansive potential for development across various dimensions. The broad development of Kansei Engineering can be achieved through improvements in three key aspects: input, process, and output. In terms of input, there are opportunities to expand the scope of design objects beyond tangible products to include work systems and potentially other fields beyond design. Additionally, advancements in obtaining Kansei through the latest technologies, such as sensory biological signal tools, can provide more sohisticated results. Regarding the process, the integration of Kansei Engineering with other relevant methods can enhance the creation of design elements, making the process faster and more accurate. Incorporating unique features of a community, such as cultural or religious considerations like Islam and local wisdom, can further refine the process. For the output, the focus is on improving the visualization of design results. While visualizing with 2D or 3D images is common, leveraging virtual reality technology can offer a more engaging and attractive experience. Virtual reality allows for a more immersive visualization, enhancing the appeal and understanding of the design. Future Kansei Engineering research should avoid focusing on aspects with the greatest percentage, as these areas have been extensively explored. Instead, research should target aspects with the smallest percentage in each answer of research question. Therefore, recommendations for further Kansei research include studying work systems, exploring Kansei types other than type 1, integrating with other methods, using sensory devices for Kansei data collection, employing virtual reality for design visualization, and associating Kansei with community uniqueness. Kansei Engineering also has the potential to contribute to achieving the Sustainable Development Goals (SDGs), particularly in sustainable innovation. By continually promoting the development of product designs that meet user expectations, Kansei Engineering supports the creation of sustainable and user-centered innovations.

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CONFLICT OF INTEREST

The author declares that there are no conflicts of interest regarding the authorship or publication of this research.

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APPENDIX

Result of Systematic Literature Review

No.	Authors	Year	Type of KE	Kansei Route	Research Object			Methods of Analysis	DV *	Uniqueness
					TP *	S *	WS *			
1.	Lin et al. [20]	2022	1	Kansei Words	Electric shaver	-	-	Cluster Analysis and Factor Analysis	-	-
2.	Wu et al. [28]	2022	1	Kansei Words	Industrial robot module	-	-	Conjoint Analysis	3D image	-
3.	Gong et al. [29]	2022	1	Kansei Words	Bamboo pen Holder	-	-	Cluster Analysis	3D image	-

Result …. (cont.)

No.	Authors	Year	Type of KE	Kansei Route	Research Object			Methods of Analysis	DV *	Uniqueness
					TP *	S *	WS *			
4.	Chen & Cheng [30]	2022	3	Kansei Words	T-shirt pattern	-	-	Factor Analysis	2D image	-
5.	Akgül et al. [31]	2022	4	Kansei Words	Cradles design	-	-	Genetic Algorithm	3D image	-
6.	Fithri et al. [32]	2022	1	Kansei words	Traditional food packaging	-	-	Factor Analysis	2D image	-
7.	Lai et al. [33]	2022	1	Kansei words from the internet	Electric car exterior	-	-	SEM	3D image	-
8.	Liu et al. [34]	2022	1	Kansei Words (Online Review)	Smartphone	-	-	TF-EPA	-	-
9.	Wang et al. [35]	2022	1	Kansei words	MARs product	-	-	PCA	3D image	-
10.	Lian et al. [21]	2022	3	Kansei words	CNC lathe	-	-	Factor Analysis	-	-
11.	Masudin et al. [36]	2022	1	Kansei words	-	Logistic service	-	SEM-PLS	-	-
12.	Lee and Han [37]	2022	1	Kansei word	Soccer shoes	-	-	Factor Analysis, QT1	3D image	-
13.	Huang and Pan [38]	2021	1	Kansei words, eye tracking	Zhuang brocade weaving	-	-	Factor Analysis	2D image	Yes
14.	Jasmy [39]	2021	2	Kansei words	AR-based mobile learning	-	-	PCA, Factor Analysis, QT3	-	-
15.	Jia and Tung [40]	2021	1	Kansei words	Wrist wearables	-	-	Factor Analysis	2D image	-
16.	Erol and Basar [41]	2021	1	Kansei words	Tulip glass	-	-	Factor Analysis, PCA	2D image	-
17.	Kang and Qu. [42]	2021	1	Kansei words	Hybrid car exterior	-	-	Factor Analysis, PCA	3D image	-
18.	Gan et al. [43]	2021	1	Kansei words	Social robot design	-	-	Regression analysis	3D image	-
19.	Dong et al. [44]	2021	1	Kansei words	SUV car	-	-	Factor analysis, Fuzzy clustering	-	-
20.	Zhou et al. [19]	2021	1	Kansei words, EEG, Eye movement	Medical nursing bed	-	-	Experimental analysis with Matlab	-	-
21.	Wang et al. [45]	2021	1	Kansei word	Portable air purifier	-	-	Factor analysis	3D image	-

Result …. (cont.)

No.	Authors	Year	Type of KE	Kansei Route	Research Object TP *	S *	WS *	Methods of Analysis	DV *	Unique-ness
22.	Li et al. [46]	2021	3	Kansei words	Hand drill	-	-	PD-GAN architecture	3D image	-
23.	Yan and Li [47]	2021	1	Kansei Words	-	Service behavior	-	PLS method	-	-
24.	Fu et al. [22]	2020	1	Kansei Word	VR interface task	-	-	QT1, Multiple regression	VR	-
25.	Hartono [17]	2020	1	Kansei words	-	Airport service	-	Qualitative analysis	-	-
26.	Liang et al. [48]	2020	1	Kansei word	Car Interior	-	-	Factor analysis, QT1	-	-
27.	Yang et al. [18]	2020	1	EEG, Eye Tracking	Smartphone	-	-	Time-frequency analysis, ERP Analysis	-	-
28.	Chen and Cheng [49]	2020	1	Kansei words	Women vest	-	-	Correlation analysis	2D image	-
29.	Xue et al. [50]	2020	1	Kansei word	Train seat	-	-	Grey relation analysis - Fuzzy logic, QT1	3D image	-
30.	Akgül et al. [51]	2020	7	Kansei words	Baby Cradle	-	-	Cost-Based MCDTRS	3D image	-
31.	Li Y., Zhu L. [52]	2020	7	Kansei words	Car profile	-	-	Multi-objective optimization model, Taguchi	2D image	-
32.	Restuputri et al. [15]	2020	1	Kansei words	-	Logistic service	-	PLS-SEM	-	-
33.	Liu et al. [23]	2019	1	Kansei word	Mazu crown	-	-	Triangular fuzzy number, Factor analysis	3D image	Yes
34.	Chen et al. [19]	2019	1	Kansei words (from online review)	-	Hotel service	-	Link Analysis	-	-
35.	Redzuan et al. [53]	2019	2	Kansei words	AR-based mobile learning	-	-	Factor analysis, PCA, PLS	-	-
36.	Daud et al. [24]	2019	1	Kansei word	Islamic knowledge website	-	-	Factor analysis, PCA	-	-
37.	Baroroh et al. [54]	2019	1	Kansei word	Electric motorcycle	-	-	Factor analysis, QT1	2D/3D image	-
38.	Wang and Zhang [55]	2019	1	Kansei words	Tractor engine	-	-	PCA	3D image	-
39.	Prakoso and Purnomo [56]	2019	1	Kansei words	Rocking horse toy and folding chair	-	-	Faktor analysis	3D image	-

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Result …. (cont.)

No.	Authors	Year	Type of KE	Kansei Route	Research Object			Methods of Analysis	DV *	Unique-ness
					TP *	S *	WS *			
40.	Hsu and Hsiao [57]	2019	1	Kansei word	-	-	Dental care	Factor analysis	-	-
41.	Kisanjani and Purnomo [58]	2019	1	Kansei words	Shopping trolley with scooter	-	-	Factor analysis	3D image	-

*) TP = Tangible Product; S = Service; WS = Work System; DV = Design Visualization

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