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Design of Luxury Train Seat Integrating Emotional Perception and Local Wisdom Approaches

Afif Hakim [1], Bambang Suhardi [1,*], Pringgo Widyo Laksono [1], Mirwan Ushada [2], Jafri Mohd Rohani [3]

[1] Department of Industrial Engineering, Faculty of Engineering, Universitas Sebelas Maret, Indonesia

[2] Department of Agroindustrial Technology, Faculty of Agricultural Technology, Universitas Gadjah Mada, Indonesia

[3] Department of Mechanical and Industrial Engineering, Universiti Teknologi Malaysia, Malaysia

*Corresponding Author: bambangsuhardi@staff.uns.ac.id

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ABSTRACT

Although the physical ergonomics of seat design have been extensively studied, emotional comfort is still largely overlooked, especially in public transport. This study addresses this gap by incorporating passengers' emotional perceptions into the design of luxury train seats, in response to documented user discomfort which transcends physical dimensions. The aim was to design seats based on the emotional needs of users and the principles of Kansei engineering, incorporating elements of Javanese cultural values as a form of local wisdom. Emotional responses were captured using Kansei words derived from user interviews, online reviews, and from the expertise of local practitioners. The designs included batik and Javanese decorations. A statistical analysis using Quantitative Theory of Type I (QTT1) identified design elements corresponding to semantic differences between Kansei words. Analysis revealed that the dominant emotional dimension is creative, as indicated by the highest multiple of R-squared 0.9785. This dimension has been operationalized in 14 concrete design elements of the proposed seating concept. The innovative use of batik motifs on the seat backrests was a distinctive feature and underlined the fact that users perceived cultural integration as central to the creative dimension. The study concluded that the integration of emotional perception, represented by the creative dimension, and local wisdom, represented by the batik elements, is a viable strategy for the design of culturally distinct and emotionally attractive luxury train seats. It shows that the culturally rooted approach of Kansei Engineering contributes to the welfare of users.

Keywords: emotional perception, Kansei engineering, local wisdom, QTT1, batik motifs

INTRODUCTION

In Indonesia, rising competition among public transport operators has become increasingly visible, especially in long-distance land transportation, such as intercity buses and trains. Each mode of transportation had major comparable strengths and weaknesses, which became an important criterion for prospective passengers. Competition from trains and buses is distinctly visible through the products and facilities offered in a first-class market. Being in a highly competitive industry, train companies were encouraged to improve and develop their services to remain excellent and competitive. As the frontline of interaction with users, products served as one of the key instruments in achieving the company's strategic objectives [1].

After a further observation, the competition was rather subtler in the lower-class segment due to its relatively homogeneous nature. On the other hand, intense competition was more appealing in the luxury segment. Different

from any other customer behavior, in luxurious products, competition highlights not merely functional features but rather emotional perception and user experience. This was reflected in the numerous online reviews comparing luxury transportation services. Luxury trains are expected to represent the highest pinnacle of comfort and experience for their passengers by offering superior amenities and services compared to other classes. A growing demand for an active lifestyle is encouraging potential passengers to choose this mode of transportation for commuting. Comfort remains as a key factor influencing passenger preference for luxury train services. Among the various factors influencing the choice of transportation mode, comfort is considered the most important criterion [2].

However, according to a survey published by a railway service provider in Indonesia, it was reported that 17.6% of 68 respondents felt discomfort when using train services while sitting during the journey [3]. Discomfort when sitting is directly related to the seat used because most of the user's activities are on the seat. Seat discomfort is the only form of user dissatisfaction while in the train carriage. Seating comfort has a significant and positive influence on passenger satisfaction [4]. Comfort is not only limited to physical aspects; emotional comfort is a major concern in creating a truly pleasant travel experience. According to Kruithof et al. [5], the comfort was positively correlated with emotional components, but not necessarily with more physiological factors. Prasetyo [6] also emphasized the importance of considering emotional perceptions in determining the right combination of lighting design. Studies of physical comfort from an ergonomic perspective have been widely discussed in various previous studies, on the other hand, emotional comfort is often neglected and has not been widely explored.

According to the same survey, the Customer Satisfaction Index (CSI) results showed a different condition from what most people assume. The CSI results for executive class only obtained a score of 4.37. In contrast, commercial economy class actually achieved a higher score, namely 4.55. However, most people certainly assume that the CSI for executive class should be higher than economy class. This finding shows that the highest level of satisfaction actually comes from commercial economy class passengers, while executive class, which generally offers better facilities, actually recorded a lower satisfaction score. This phenomenon is closely related to consumer perceived value. Executive class users consider that the emotional experience of the facilities received is not commensurate with the ticket price they paid. Consequently, this view decreases their general satisfaction level. On the other hand, economy class passengers find the amenities and fare reasonable. This aligns with Zeithaml [7], who emphasized that satisfaction is assessed not only by the service provided but also by the perceived sacrifices made, including price.

In terms of luxury train, the necessity of ergonomic comfort is a given when considering the design parameters. Nevertheless, the comfort needs from an emotional perspective are also very important. This dimension is related to the emotional level of the travel experience and is derived from the user's satisfaction in the aesthetics of the seat, the personalization of the travel experience, and the emotional rapport that is built between the user and the overall design of the seat. Thus, designing seats on a luxury train must transcend the mere physical functionality of the seats and also strive to provide the user with an emotionally satisfying experience, which is characterized by the emotional functionality of the seats. Amidst the increasingly tight competition in the luxury class transportation market, luxury class trains are expected to be able to meet consumer expectations by eliciting positive emotional responses through appropriate seat designs. This is because purchasing decisions are not only based on product function, but are also influenced by perceptions of product benefits, ease of use, safety, price suitability, and emotions that arise when interacting with the product [8]. A study on luxury train services supports this view, showing that luxury amenities not only develop improvement on the physical perception but also create a deep emotional experience that enriches the entire journey, thus is expected to contribute positively to the customers' satisfaction and increase the preference for luxury train services [9].

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While research on luxury train services in Indonesia is still limited, a study by Yohanny et al. [10] offered some alternative designs for luxury compartments that address users' perceptions and emotional responses. However, another study by Arya [11] did not focus on the design process itself but compared the visual perception of first- and second-generation luxury train seats. However, until recently, a very limited amount of studies have placed users' emotional perceptions at the core of the design process for luxury train seats. This research gap highlighted the potential to further explore the design process of luxury train seating, where emotional comfort from the user's perspective should be prioritized over the physical features.

Various methods for product development, including QFD, TRIZ, and the Kano model, have been employed however these methods still concentrate on the functional technicalities and thus are less effective in systematically analyzing and converting the users emotional responses to the design. The method suggested in this study is Kansei Engineering. Kansei Engineering is considered to be more effective than other methods as it relates customer emotional needs to product design attributes [12], [13], [14]. This method emphasizes the analysis of the emotional user data and its merging with design in order to arrive at more effective design solutions [15]. In order to shape consumers' emotional perceptions of design attributes, Kansei Engineering employs a quantitative approach to map the relationship between product form, features, and emotional vocabulary [16].

The construction of the Kansei values principle is heavily influenced by local wisdom [17], [18], [19]. In other words, Kansei values were not formed universally but were strongly influenced by users' cultural backgrounds, social norms, and local living contexts. Local wisdom shaped consumers' emotions toward a product due to the understanding of the community over the environment, the social values, the aesthetics, the environment, and the values present in the community as a result of practices passed down through generations. In this context, Kansei represented expressions of feeling, symbolic meanings, and beauty as perceived by individuals based on their cultural experiences. Therefore, product designs that neglected cultural dimensions were likely to fail in meeting users' emotional expectations. Local wisdom can be operationalized through two primary dimensions: symbolic (philosophical) meaning and physical form. According to a symbolic perspective, a seat in Javanese culture is not only a functional object for sitting but also represents status, beauty, and dignity, reflecting the philosophical values that shape the Javanese perception of what a seat signifies [20]. In terms of form, local wisdom can be embodied through the application of batik motifs and traditional ornaments, which reinforce the visual identity and aesthetic character of the design. Accordingly, the people of Javanese culture, with self-actualization as a cultural background, can feel and affirm their own identity when a product is designed with these local wisdom orientations. The influence of local wisdom was essential in contemporary product development, as cultural components provided unique design inspirations and served as effective marketing approaches [21]. This cultural engagement aligned with luxury branding strategies, which emphasized that luxury encompassed quality and experience rather than quantity or ownership, with consumers engaging in luxury to express their culture, lifestyle, and personal preferences [22]. Consequently, the integration of Kansei Engineering and local wisdom was needed by the study. The main novelty contribution of this study is to incorporate emotional design through Kansei Engineering and to integrate the values of local wisdom of the Javanese to develop a holistic design of a seat. The objective of this approach is to design luxury seats through the emotional perception of the potential users and to strengthen users' sense of cultural identity along with the multicultural product acceptance of the product.

The design parameters resulting from the integration of emotional and local wisdom approaches were visualized through virtual reality technology. Utilizing virtual reality early in the design process was critical, as it allowed for design problems to be identified early and improved the quality of the resulting product while saving time and money in the development process [23]. This study focused the use of VR technology on the visualization of the design prototype, which will be in the final stage of the design development process. This stage is intended to provide a fully

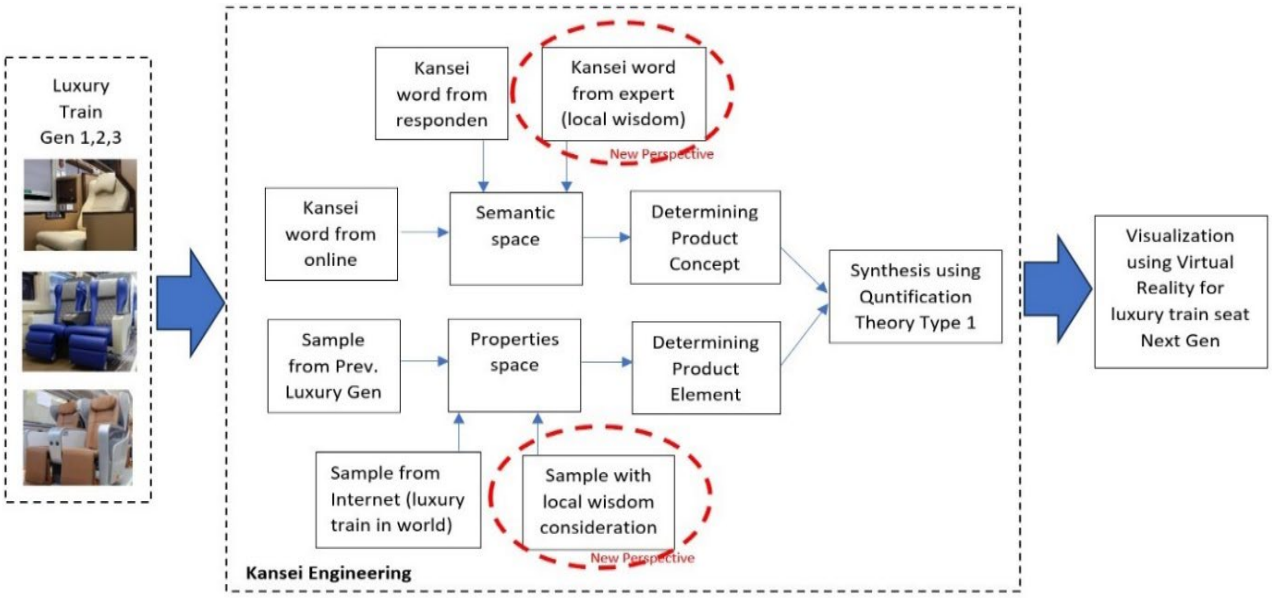

Figure 1. Research Framework

immersive tool to represent the Kansei interpretation, and allows one to gain a real insight into a new design idea and the intended perception. Nevertheless, further research is required to conduct evaluation and validation of the VR prototype, in order to ensure its alignment with users' emotional and cultural perceptions at a deeper level.

METHODS

As the primary customers belonged to the Javanese culture, this study combined Kansei Engineering techniques with local wisdom, especially Javanese cultural wisdom. Kansei Engineering separated the implementation process into two focal areas: defining the product concept and detailing the product attributes. Both perspectives involved the incorporation of local wisdom. The emotional responses and perceptions of the users formed the basis of the product concept, and these were obtained through the collection of kansei words. Most of these words were adjectives since they expressed feelings better, although at times, they could also serve as nouns [24]. The overall process and its integration with local wisdom are illustrated in Figure 1.

Kansei word derived from multiple sources pertaining to the context of the product. Magazines, journal articles, specialized literature, product test reports, user manuals, expert opinions, customer interviews, and user reviews are some examples of these sources [25]. In this study, Kansei words were obtained from three primary sources: user interviews, online reviews, and expert interviews on local wisdom. The intervention of local wisdom was implemented through the contributions of experts who viewed seating as a cultural artifact and articulated their perceptions using culturally meaningful words or phrases.

A set of representative product samples is required in order to identify product elements within the Kansei Engineering method. These samples could be conceptual prototypes, rival designs, or currently available commercial products. Existing products were a major source of reference for many previous studies. In the present study, the integration of local wisdom into the product element phase was achieved by incorporating conceptual product samples adorned with batik patterns and distinctive Javanese ornaments, reflecting aesthetics rooted in local wisdom. In addition to these culturally inspired prototypes, the sample set also includes examples of luxury train seats from other nations as well as Indonesia's first, second, and third generations. A sample range of 20 to 25 items was adequate to capture the variability and validity of emotional responses and perceptions in accordance with

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Kansei Engineering standards [26]. In this study, the phases of the Kansei engineering methodology are followed in determining the product concept and product elements. The procedures used in this study are outlined below.

Product Concept Determination

Identification of Kansei Words

Finding and assembling a thorough collection of Kansei words that represent users' emotional impressions was the first step in the process. The study used three distinct methods to accomplish this: user interviews, online reviews, and local cultural experts. Each approach was treated equal so that no single source overly shaped the results. This approach ensured that the final collection of Kansei words represented a wide and balanced range of emotional expressions. The contribution of each source is outlined below.

- *User interview*. Kansei words were collected through interviews. There was no precedent for the minimum number of participants required; therefore, a total of 30 respondents was involved. All participants had taken at least one luxury train trip. Eligible respondents were randomly selected using a convenience sampling approach.
- *Online review*. Kansei words were collected by analyzing comments on YouTube videos reviewing luxury trains. There was no limit to the number of videos used as data sources; therefore, the four most-watched YouTube videos, each with over 100 comments, were selected. While focusing on the most-watched videos allows for effective identification of dominant emotions, it may reduce the depiction of diverse user experiences represented.
- *Local wisdom expert*. Kansei words were also derived from insights provided by experts in Javanese cultural wisdom, with a focus on linguistic and symbolic meanings. The local culture referenced is Javanese culture, particularly its linguistic elements. The expert team for this study consisted of two people. The first was an academic of Javanese cultural studies whose work, including the publication "Kursi Kekuasaan Jawa", explores how legitimacy of power, philosophy, and symbolism are embedded in seating forms. The second expert was a practitioner in product design. The expert's role in this study focused on interpreting symbolic meanings and validating the semantic relevance of Kansei words in relation to local cultural values, not as a statistical respondent. The experts did not take part in the quantitative survey. The arrangement of the data involved the use of cultural theory to complete the collection of data through the use of semi-structured interviews. From these interviews, a number of Kansai words were collected for future analysis. The symbolic meanings of the interviews were transformed into a number of candidate words of Kansei, which were subsequently evaluated in the next stage of the study. One example is the Javanese culture of seats, which experts say are not merely for resting or seating but also symbolize power, luxury, the sacred, and the mystical.

Evaluation of Kansei Words Using the First Semantic Differential

Since the selected Kansei words worked as research instruments, it was necessary to assess their measurement validity and reliability as well. An initial semantic differential questionnaire was administered to assess their suitability. To assess validity and reliability, 30 participants were chosen randomly, aligning with the minimum sample size stipulated for exploratory research [27]. Each of the Kansei words was placed on a bipolar scale, with the right side containing positive words and the left side containing negative words, and a five-point scale was utilized for quantitative measurement. For this validation test, Pearson Product Moment correlation was chosen, with the alpha set at 0.05. For the pair of Kansei word items to be accepted as valid, the SPSS 25 significance output for recalculated had to be greater than *R*-table; otherwise, the observation was non-valid. On the other hand, the reliability of the test was calculated using Cronbach's Alpha. If the obtained value of Cronbach's Alpha was greater than 0.6, all items in the questionnaire were declared to be reliable.

Extraction of Kansei Words Through Factor Analysis

Exploratory factor analysis was implemented within the Kansei Engineering framework to reduce the original variables into a series of new, derived factors. This analysis consolidated Kansei word variables into a limited number of synthetic constructs and identified new dimensions within the semantic space, following their evaluation through the semantic differential technique. The procedure of exploratory factor analysis could be conducted with a minimum of 50 respondents [28]. Although this number satisfies the minimum sample requirement for exploratory factor analysis, future research involving a larger number of respondents could enhance the generalizability of the results. To perform the exploratory factor analysis procedure, two requirements had to be fulfilled, namely:

- Kaiser-Meyer-Olkin (KMO) Sampling Adequacy Test
  The sampling adequacy was considered sufficient and could be proceeded to Factor Analysis if the value of the KMO Measure of Sampling Adequacy (KMO MSA) was greater than 0.5 and the significance value of Bartlett's Test of Sphericity was less than 0.05.
- Correlation among Variables with Anti-Image Correlation
  A strong correlation among variables was indicated if the Measure of Sampling Adequacy (MSA) in the Anti-image Correlation for each variable was greater than 0.5. If any variable had an MSA value below 0.5, the variable was removed, and the first requirement was re-examined.

Once both requirements had been satisfied, the procedure of factor analysis was subsequently carried out.

Product Element Determination

Product Sample Collection

At this stage, reference products were gathered to inform the analytical process. A total of 20 sampels are compiled, consisting of concept designs with traditional Javanese batik motifs and ornaments, seats from earlier generations of Indonesian luxury trains, and examples from various international luxury train interiors. Javanese batik motifs and ornaments was included in a considerate manner, as these local traditions strongly reflect the identity of the Javanese people, who comprise as majority of luxury train users in Indonesia. An equivalent number of samples was sourced from the following references:

- Samples of existing luxury train seat generations are Generation 1, Generation 2 and Generation 3 (3 samples).
- Samples obtained from internet sources in the form of images of luxury train seats from various countries worldwide (11 samples). Samples obtained from another country aim to appeal a broader emotional perception among various socio-cultural upbringings and market maturity levels. The selection included China, Japan, Thailand, Australia, Saudi Arabia, Turkey, Russia, Switzerland, and Canada to balance Eastern, Middle Eastern, and Western design traditions, climatic requirements, and travel profiles.
- Samples that include local cultural elements (6 samples).

Definition of Items and Categories

After compiling design patterns for luxury train seats, the next step was to identify relevant elements and categories as design criteria for the product development process. Finding a structured combination matrix for every developing design sample is part of this step. Each pattern from the element-category table was mapped to the appropriate items and category once it was ready. An organized analysis of the design sample elements was made possible by this mapping.

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Item-Category Evaluation Using the Second Semantic Differential

Each product and its Kansei words were assessed using a second questionnaire that employed a semantic differential. Each product was rated by respondents using the provided Kansei descriptors. This second semantic differential evaluation's main goal was to investigate each product's relationship to the emotional impressions that the Kansei words represented. The same five-point rating system that was employed in the initial survey was utilized. Each Kansei word's average score was determined in order to analyze the gathered data.

In total, 30 people joined the study—15 men and 15 women. Previous studies showed that a Kansei structure persisted across 30 people and at 60, 90, and 120 respondents, and so the number 30 was settled on. As a consequence, it emphasized that identifying effective design components was not largely influenced by the total number of the design people [29]. For this reason, a minimum sample size of thirty participants would be enough for this research.

Synthesis

In this study, Quantification Theory Type I (QTT1) was employed as the synthesis method. This approach enabled the direct identification of product elements significantly associated with the selected Kansei words. The synthesis stage in Kansei Engineering essentially aimed to integrate the product concept with product elements, based on the respondent evaluation results obtained from the second semantic differential questionnaire. The mean scores of each product sample in relation to each Kansei word, derived from respondent evaluations in the second semantic differential questionnaire, were used as input data for the QTT1 analysis. Data processing was conducted using R in the primary base environment of R, version 4.4.1, which is one of the most common statistical programming languages used by researchers, the data processing task was conducted. For the purposes of this study, a bespoke function was created. This was modified from ordinary multiple regression, as well as the techniques for quantifying categories in the base R environment, with the optional use of the MASS library for matrix inversion via the ginv () function.

Visualization

In the last phase, a three-dimensional model of the design prototype produced by the QTT1 analysis is created and displayed in a virtual reality setting. The study's last stage involved using virtual reality (VR) technology to visualize the suggested design outcomes. In order to give users and stakeholders a realistic digital experience of the product concept, the synthesized Kansei attributes are translated into an immersive three-dimensional representation during this phase. This study's scope is restricted to the visualization phase. To evaluate the VR representation based on user feedback and to determine whether Kansei perception and the visual experience offered are aligned, more research is required. The results of this evaluation will form the basis for the development of a physical prototype in the next research phase.

RESULT AND DISCUSSION

Product Concept Determination

This study aimed to explore emotional perceptions by identifying Kansei words that represented emotional responses to the design of luxury train seats. The collection process combined three main sources namely passenger reviews from user interview, online reviews, and the opinions of local cultural experts. Customer needs and desires were identified by analyzing as many Kansei words as possible that represent users' emotional reactions and perceptions

Table 1. Selected Kansei Words

Sources	Selected Kansei Words
Respondents interview	Special, Deluxe, Safe, Favorite, Cool, Comfortable, Superior, Traditional, Privacy, Soft, Like
Online reviews	Aesthetic, Elegant, Trendy, Happy, Simple, Steady, Interesting, Impressed, Addictive, Unique, Calm, Suitable for traveling, Clean, Creative, Neat, Quality
Opinions of local wisdom experts	Authority symbol, Majesty symbol, Wealth symbol, High position symbol, Strength symbol

regarding these seats. This approach aimed to obtain a comprehensive representation enriched with emotional nuances, both from the actual experiences of users and from cultural perspectives. Initially, 47 Kansei words were collected. Nevertheless, a Kansei words are likely to overlap semantically, this is due to its subjective nature. Hence, a later evaluation was established to refine its relevance. The re-evaluation was done through a semantics analysis to assess similarities among terms, allowing synonymous or closely related words to be grouped. The list was narrowed to 32 validated Kansei words to be later analyzed (Tabel 1).

These 32 words were continued as the research instrument. Initially, validity and reliability tests were performed to ensure that the terms were appropriate for further analysis. A semantic differential questionnaire was distributed to 30 participants, A prerequisite for participation was that respondents had traveled on luxury trains two times least. The selected Kansei words were divided into two opposing groups: a right-wing (positive) and a left-wing (negative) group. Respondents were asked to rate their preference for the seating concept on luxury trains based on their perceptions and desires using the selected Kansei words on a five-point scale. Scale 1 indicated a very negative impression (strongly disagree), and 5 indicated a very positive one (strongly agree). A total of 30 participants were involved in this evaluation. An item was considered valid if the calculated r value exceeded the r table value. For N = 30 at a significance level of 0.05, the r table value was 0.361.

Align with the validity test principal, a sample is only valid if the calculated r-value is bigger than the r table value. With N = 30 and $\alpha = 0.05$, the table r-value was 0.361. Results from the first validation round showed that two Kansei pairs shall be eliminated, “Lowly symbol–Majesty symbol” (r = 0.135) and “Low Position Symbol–High Position Symbol” (r = 0.173). These items were removed, leaving 28 Kansei words for further use. In the second round of validity testing, all 28 Kansei words were confirmed to be valid. Reliability was assessed using Cronbach’s Alpha. An Alpha value greater than 0.60 indicated acceptable internal consistency, whereas values below this threshold reflected unreliability. Figure 2 shows a Cronbach’s Alpha value of 0.842, which exceeded the minimum standard, thereby confirming that all items in the instrument were generally considered reliable.

Kansei word extraction was carried out using the Exploratory Factor Analysis (EFA) approach. This analysis essentially aimed to reduce a large number of variables or factors into a smaller set of variables. The results of the factor analysis were focused on the objective space, and the items as well as product design categories were determined according to the customer’s image or feelings expressed through Kansei words. These words were subsequently reused in the second semantic differential assessment. To apply factor analysis, the Measure of

Reliability Statistics

Cronbach's Alpha	N of Items
,842	30

Figure 2. Output of Reliability Test

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KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,761
Bartlett's Test of Sphericity	Approx. Chi-Square	948,809
	df	378
	Sig.	,000

Figure 3. Output of KMO and Bartlett's Test

Sampling Adequacy (MSA) value had to exceed 0.50 to ensure that the variables were suitable for prediction and further analysis. Variables with MSA values below this threshold were considered inadequate and were therefore removed from the dataset. The analysis revealed two variables with MSA values below 0.50: "Old–Trendy" (MSA = 0.467494) and "Inferior–Superior" (MSA = 0.461297). Therefore, another two variables shall be removed, remaining 26 samples of Kansei words for later to be analyzed.

In the second round of MSA testing, all 26 Kansei words surpassed the minimum scores of 0.50, resulting in none of the items being removed and confirming their suitability for factor analysis. To further verify whether the dataset was suitable for exploratory factor analysis (EFA), two additional benchmarks were applied: Kaiser-Meyer-Olkin (KMO) score above 0.50 and a Bartlett's test significance level of less than 0.05 (Figure 3). The analysis yielded a KMO score of 0.761, and a Bartlett's test significance level of 0.000, thus successfully surpassed the significance requirements. These results confirmed the adequacy of the data for conducting factor analysis. Both KMO and MSA values served as the basis for confirming the feasibility of using EFA in this study [30].

Confirming both KMO and MSA criteria were fulfilled, factor analysis was performed using SPSS version 22. The technique retrieved seven principal components of the 28 Kansei words. A Kansei word pair with the highest correlation values was chosen and aligned with each component as its descriptor. This process produced seven representative pairs as factors to reflect each component: "Uncreative–Creative," "Trivial Symbol–Authority Symbol," "General–Unique," "Poor Quality–Quality," "Shabby–Elegant," "Messy–Neat," and "Unpreferred–Favorite," as shown in Table 2. Each factor describes one of the aspects of how users feel about the seats. Uncreative–Creative factor describes the feelings of the users about the innovation and originality of the design. Trivial Symbol–Authority Symbol describes the feelings of the users to the symbolic value of the seat that represents a certain status, level of power, or importance. General–Unique relates to how distinct or exclusive the design feels. Poor Quality–Quality represents judgments linked to workmanship and material standards. Shabby–Elegant represents aesthetic refinement, including balance, proportion, and visual harmony. Messy–Neat describes the clarity and organization perceived in the overall design composition. Unpreferred–Favorite expresses the overall likability or attractiveness of the seat. These seven Kansei word pairs were subsequently used to evaluate the seat samples through the semantic differential method.

Product Element Determination

As part of the design exploration stage in Kansei Engineering, a collection of design samples resembling the research object, namely seats in luxury-class trains, was carried out. A total of 20 design samples were obtained from three primary sources: (1) three seat design samples from previous generations of luxury trains in Indonesia, (2) eleven seat design samples from luxury trains across various countries worldwide, and (3) six seat design samples that incorporated elements of local wisdom, primarily through the application of batik patterns and traditional Javanese ornaments. Based on the results of expert discussions conducted with design and cultural specialists, it was concluded that the incorporation of local cultural elements into seat design could be implemented through visual

Table 2. Result of Factor Analysis

Factor	Corr. value of variables	Code	Instrument Items	Group	Interpretive Meaning
1	0.346036	KK03	Regular-Deluxe	Uncreative-Creative	Innovativeness
	0.513611	KK08	Complicated-Simple		
	0.723943	KK10	Shaky-Steady		
	0.526144	KK14	Annoying-Impressed		
	0.537021	KK22	Not suitable for traveling-Suitable for traveling		
	0.674779	KK24	Dirty-Clean		
	0.813984	KK25	Uncreative-Creative		
	0.577256	KK30	Poor symbol-Wealth symbol		
	0.618836	KK32	Weakness symbol -Strength symbol		
2	0.776815	KK02	Ugly-Aesthetic	Trivial symbol-Authority symbol	Symbolic Power
	0.785951	KK18	Modern-Traditional		
	0.838544	KK28	Trivial symbol-Authority symbol		
3	0.418890	KK07	Sad-Happy	General-Unique	Uniqueness
	0.561464	KK11	Bad-Cool		
	0.735796	KK15	Just Once-Addictive		
	0.858401	KK19	General-Unique		
	0.483783	KK23	Rough-Soft		
4	0.458039	KK04	Danger-Safe	Poor quality-Quality	Perceived Quality
	0.626835	KK17	Disturbed-Comfortable		
	0.764337	KK27	Poor quality-Quality		
5	0.608346	KK01	Ordinary-Special	Shabby-Elegant	Elegance
	0.858066	KK05	Shabby-Elegant		
6	0.574576	KK12	Boring-Interesting	Messy-Neat	Orderliness
	0.640316	KK21	Noisy-Calm		
	0.768561	KK26	Messy-Neat		
7	0.734316	KK09	Unpreferred-Favorite	Unpreferred-Favorite	Perceived Attractiveness
	0.476552	KK13	Dislike-like		
	0.577538	KK20	Open-Privacy		

features such as ornaments, batik patterns, traditional carvings, or a combination of these. For the design category with cultural interventions, the samples used were still in the form of conceptual sketches that had been consulted with experts. All of these design samples were subsequently employed in the second semantic differential questionnaire, which aimed to measure users' affective perceptions of the proposed design samples. This section, as shown in Figure 4, only presented the six samples representing local wisdom as the central focus of the analysis.

Figure 4. Samples of Luxury Seats with Local Wisdom Intervention on the Backrest and Armrests

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The determination of item categories was a crucial stage in the application of Kansei Engineering, as this step served as the foundation for formulating the target specifications to be embodied in the designed product concept. Choosing representative and pertinent item categories guarantees that the final product design can successfully incorporate all of the emotional elements that users expect effectively. In this study, 20 seat design samples were observed to determine item categories. The seat design was identified and broken down into five main components by looking at how each seat was constructed: the backrest, seat base, headrest, armrest, and footrest. In addition to being analysed partially according to its subsystems, the seat was also considered as an integrated system as a whole. As a result of this procedure, the observed variations were obtained into 14 items and 30 categories, which are shown in Appendix.

After identifying the item categories, the analysis proceeded by hybridizing each item category based on coherent design features by visual clustering and supplementary descriptive information, thereby allowing each element to be examined comprehensively. This step was not merely a technical grouping but a process of defining each feature using explicit design-based criteria to reduce subjective interpretation. The resulting groups served as the foundation for more detailed explanations that highlighted the parallels and discrepancies between each design option. As a result, the information acquired during this phase helped the subsequent step of analysis in a more structured manner. This classification provides a general grasp of the various ways that each design pattern appears in the same product context; the following table provides an overview of these patterns.

The second Semantic Differential questionnaire focused on evaluating each design sample from the perspective of the Kansei words that were previously clustered through factor analysis. This approach focused on measuring the respondents' emotional responses toward design attributes from a more refined and deeper level by considering the psychological aspect of the user experience. For the completion of this questionnaire, 30 respondents assessed the 20 design samples that had been prepared (Table 4). To provide an overview of the respondents' design sample evaluation, this table comprehensively summarizes the definition of each item, the mean scores of the respondents

Table 4. Item-Category Implemented to the Samples and Result of Second Semantic Differential

No.	X1 to X14	Creative	Authority symbol	Unique	Quality	Elegant	Neat	Favorite
1	12221111111111	2.33	3.47	3.17	3.07	2.67	3.40	3.20
2	21221111111112	2.87	3.57	3.00	3.20	2.57	3.47	3.23
3	12321122121112	3.13	3.60	3.07	3.13	2.73	3.43	3.40
4	12221112121112	3.10	3.20	3.13	3.50	3.27	3.20	3.03
5	11221122121112	2.87	3.47	3.37	3.17	2.57	3.73	3.37
6	12121112122112	2.90	3.43	3.20	3.10	2.73	3.47	3.27
7	12321121121112	3.10	3.30	3.17	3.10	2.73	3.83	3.37
8	12121112121112	3.20	3.27	3.33	3.03	2.63	3.60	3.20
9	12122122122112	3.33	3.50	3.33	3.23	2.73	3.40	3.57
10	12112112122122	3.10	3.27	3.07	3.17	2.70	3.63	3.40
11	22221112121122	2.83	3.30	3.40	3.30	2.80	3.07	3.53
12	12221212122122	3.20	3.23	3.10	3.60	2.90	3.37	3.23
13	12221111211112	3.33	3.53	3.27	3.03	2.57	3.03	3.47
14	21221111211122	3.40	3.33	3.17	3.30	2.97	3.53	3.00
15	32222121111212	2.83	3.57	3.23	3.07	3.00	3.07	3.03
16	32222121111212	3.30	3.10	3.17	2.70	3.07	3.83	3.63
17	32222121111212	2.90	3.47	3.10	3.10	2.73	3.47	3.23
18	32222121121212	3.10	3.33	3.00	3.47	2.97	3.40	3.13
19	32222121121212	3.13	3.17	3.17	3.37	3.00	3.63	3.23
20	32222121121212	3.30	3.17	3.30	3.27	2.90	3.83	3.20

Table 5. Multiple R-Squared of Kansei Words

No.	Kansei Words	Multiple R-squared	Result
1	Uncreative-Creative	0.9785	Worthy
2	Trivial symbol-Authority symbol	0.9502	Worthy
3	General-Unique	0.7923	Worthy
4	Poor quality-Quality	0.9729	Worthy
5	Shabby-Elegant	0.9393	Worthy
6	Messy-Neat	0.8487	Worthy
7	Unpreferred-Favorite	0.9582	Worthy

toward each of the design categories, overall depiction of respondents' preferences and evaluation tendencies toward the tested designs, while it also enables the identification of patterns of the emotional preferences. This approach was expected to support the interpretation of findings in a more systematic and in-depth manner.

The next stage involves synthesis using Quantification Theory Type I (QTT1). Data analysis with QTT1 was performed using R software. The multiple R-squared coefficient in the QTT1 output indicates the degree of fit of the estimated model to the observed data; a higher multiple R-squared value reflects a better model fit. Therefore, the Kansei word pair with the highest double R-squared value was selected as the design recommendation. In Kansei engineering assessment, a multiple R-squared value above 0.6 is considered acceptable. Table 5 shows that the multiple R-squared values for all Kansei word pairs are above 0.6; therefore, they are all considered valid. The Kansei word pair selected for the luxury train seat design was "Uncreative–Creative," as it demonstrated the highest multiple R-squared value, which was 0.9785. The subsequent output from R Studio displayed the multiple R-squared values for the Kansei word pair "Uncreative–Creative."

The Kansei word pair "Uncreative–Creative" was selected as it demonstrated the highest multiple R-squared value in Quantification Theory Type I (QTT1). The result in Figure 5 indicates that it had the strongest explanatory power in connecting users' emotional impressions with the evaluated seat designs. This word pair was considered to represent the primary emotional dimension, namely "creativity," which consistently emerged from user feedback and cultural expert input. Therefore, this pair was adopted as the main reference for formulating and refining the design elements proposal.

```
Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  2.01167    0.41233   4.879   0.0165 *
x12         -0.22833    0.30474  -0.749   0.5081
x13          0.11167    0.24203   0.461   0.6759
x22         -0.34000    0.18517  -1.836   0.1637
x32         -0.10000    0.13094  -0.764   0.5006
x33          0.50000    0.29278   1.708   0.1862
x42          0.75833    0.46139   1.644   0.1988
x52          1.00000    0.29278   3.415   0.0420 *
x62          0.44167    0.33168   1.332   0.2751
x72         -0.57000    0.26187  -2.177   0.1177
x82          0.03000    0.13094   0.229   0.8335
x92          0.57167    0.20355   2.808   0.0674 .
x102         0.31167    0.08452   3.688   0.0346 *
x112        -0.30000    0.13094  -2.291   0.1058
x122        -0.43500    0.11339  -3.836   0.0312 *
x132        -0.04167    0.24203  -0.172   0.8743
x142         0.42833    0.20355   2.104   0.1260
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.09259 on 3 degrees of freedom
Multiple R-squared:  0.9785,    Adjusted R-squared:  0.8636
F-statistic: 8.518 on 16 and 3 DF,  p-value: 0.05142
```

Figure 5. Multiple R-squared Values for the Kansei Words "Uncreative-Creative"

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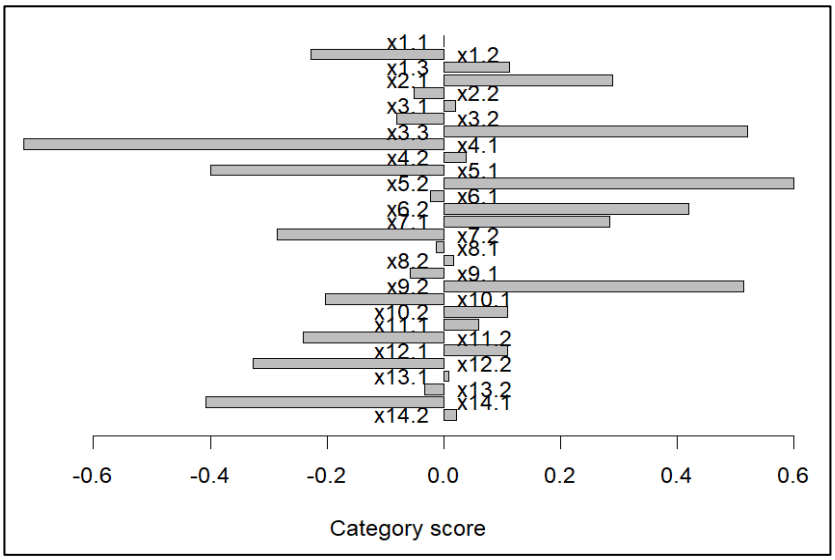

Figure 6. Selected Ccategories for the "Uncreative-Creative" Kansei Word Pair

Figure 6 indicates that the recommended categories consistently appear as a longest bar on the right-hand side (the positive side). These results support the use of the selected design concept as an embodiment of the Kansei word "creative," which was identified as the main emotional descriptor. Although the final design direction was determined based on the highest R-squared value associated with the Kansei word "creative," this selection was not made solely on statistical grounds but also reflects a conceptual connection to the local wisdom that forms the central focus of this study. It is acknowledged that in the quantitative analysis, the Authority Symbol dimension representing notions of status, honor, and legitimacy of power in Javanese culture did not emerge as a dominant factor. Nevertheless, these cultural values, particularly those related to form, are implicitly accommodated within the interpretation of the word "creative." In this sense, creativity is not only in the new ideas to be brought forth but also in the formal innovation that integrates distinctive local visual elements. For this reason, the backrest of the seat is adorned with a batik motif, which serves as a cultural identity marker and an aesthetic symbol. Accordingly, although the Kansei word chosen was more general, local wisdom in its essence is presented in the choice of design details through the formal and visual expressions embodied in the design.

The luxury train seat design concept, inspired by user emotions and local wisdom across 14 items, was effectively developed (Table 6). The proposed design was visualized within a web-based virtual reality environment to enhance

Table 6. Design Concept Recommendation

No.	Item	Category Notation	Selected Categories	No.	Item	Category Notation	Selected Categories
1	Backrest pattern	X1.3	Local batik motifs	8	Headrest area	X8.2	Sunken
2	Backrest texture	X2.1	Textured	9	Headrest position	X9.2	Flexible (separate)
3	Rear backrest body area	X3.3	Sunken	10	Headrest shape	X10.2	Oval
4	Backrest tilt angle	X4.2	Flexible	11	Armrest area	X11.1	Flat
5	Backrest covering material	X5.2	Non-leather materials	12	Armrest texture	X12.1	Not ornate
6	Seat area	X6.2	Sunken	13	The presence of a footrest	X13.1	Available
7	Headrest thickness	X7.1	Thick	14	Design concept	X14.2	Open

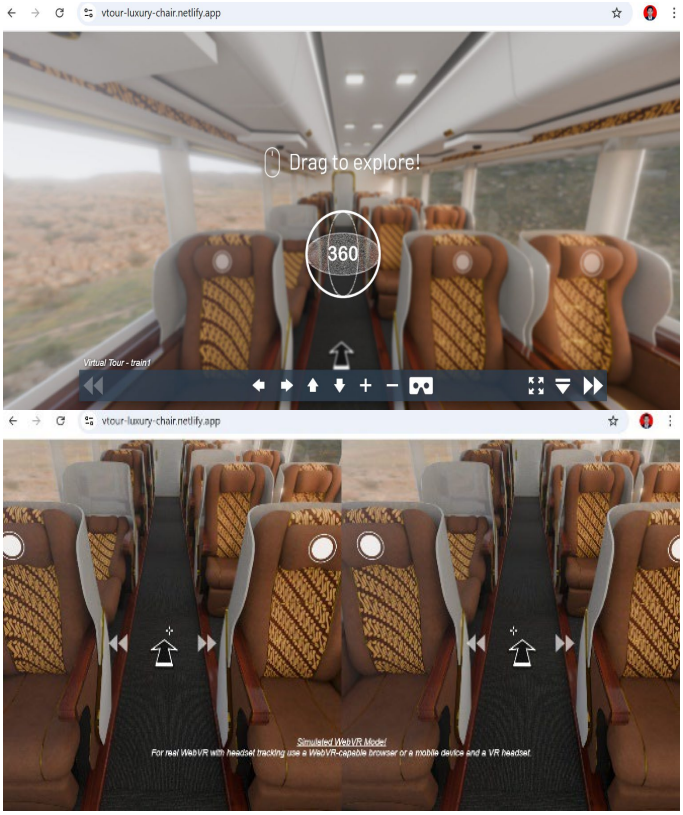

Figure 7. Image of Design Recomendation in Virtual Reality

realism (Figure 7). In this study, all of the proposed 14 design elements were comprehensively visualized and incorporated in the Virtual Reality (VR) environment that was used to create an immersive and realistic 360-degree user experience. However, the VR environment still had limitations in interactivity. For example, users were not able to adjust the seat depth and inclination in real time. Despite the constraints of interactivity, the VR experience was extremely useful inthe early phase of the design in capturing the users' emotions with the integrated design features. At this stage, the VR application was restricted to design visualization with the intent to showcase the end result of the Kansei design in an immersive environment. To understand the gap in the VR experience and user perceptions with the design, direct feedback on the visuals and emotions evoked through the VR needs to be collected for further research. The findings of such future studies are expected to strengthen the validity of VR as a tool for verifying Kansei perception and to support its integration into subsequent stages of design testing and development.

There were a few major differences between the proposed design adjustments and the previous generation of luxury train seat designs. Table 7 showcases a comparison between the recommended designs of the next luxury train seat and the designs of its predecessors. Table 7 compared the proposed design elements with the existing luxury train seats of Generations 1, 2, and 3. The analysis confirmed the proposed design introduced four new features never implemented before: a batik-patterned backrest reflecting local cultural wisdom, non-leather upholstery to enhance sustainability, a sunken seat surface for improved ergonomic support, and an adjustable headrest to accommodate user preferences. Thus, these new proposed designs were significant, indicating a shift toward culturally integrated and user-centered solutions and also increasing the likelihood of acceptance culturally. The four newly introduced design elements demonstrated a strong association with the Kansei words identified through the factor analysis, especially the backrest batik motif design that strongly represented the primary embodiment Kansei word "Creative" while also reflecting the dimensions of "Unique" and "Authority Symbol", which conveyed strength and local cultural identity. Meanwhile, the non-leather upholstery, such as velvet, is aligned with the Kansei words "Elegant" and "Neat"

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Table 7. The Comparisons of Luxury Train Seat Design in Indonesia

No.	Item	Proposed design	Luxury Gen 1	Luxury Gen 2	Luxury Gen 3
1	Backrest pattern	Local batik motifs	Plain solid color (one color)	Solid color blend	Plain solid color (one color)
2	Backrest texture	Textured	Not Textured	Textured	Not Textured
3	Rear backrest body area	Sunken	Slightly sunken	Slightly sunken	Sunken
4	Backrest tilt angle	Flexible	Flexible	Flexible	Flexible
5	Backrest covering material	Non-leather materials	Leather/synthetic leather	Leather/synthetic leather	Leather/synthetic leather
6	Seat area	Sunken	Flat	Flat	Flat
7	Headrest thickness	Thick	Thick	Thick	Thin
8	Headrest area	Sunken	Flat	Flat	Sunken
9	Headrest position	Flexible (separate)	Fixed at the top of the backrest	Fixed at the top of the backrest	Fixed at the top of the backrest
10	Headrest shape	Oval	Box	Box	Oval
11	Armrest area	Flat	Flat	Flat	Flat
12	Armrest texture	Not ornate	Not ornate	Not ornate	Not ornate
13	The presence of a footrest	Available	Available	Available	Available
14	Privacy	Open	Closed	Open	Open

which relate to refinement and neatness, all while maintaining a sense of luxury. In addition, the implementation of a sunken seat surface and an adjustable headrest was associated with the Kansei word "Quality", as both features were aimed at improving ergonomic comfort and providing a more personalized and relaxing sitting experience. Thus, these four features not only represented functional innovations but also emotionally conveyed aesthetic perception, comfort, and cultural elements that formed the core of the Kansei approach and local wisdom integration.

This study, which focuses on the design of luxury train seats using Kansei Engineering, aligns with various literature that suggests that the perception of luxury, as within vehicle interiors, is strongly related to and influenced by emotional factors and users' perceived value [31], as well as by design styles capable of evoking specific emotional responses [32]. The findings indicate that the batik motif applied to the backrest was the most preferred element among users, as it represents a form of local cultural identity. This result supports Yardım and Pedgley [33] that design cues reflecting cultural identity function as status or identity symbols that enhance the luxury experience while simultaneously serving as a means of product differentiation. Furthermore, Zhang et al. [34] argued that when local culture is integrated into a product and mapped through emotional imagery, it increases user acceptance and increases the distinctiveness of the product. Thus, this study not only reaffirms the significance of emotional dimensions in luxury transportation interior design but also expands the existing literature by introducing local wisdom as a new, context-specific variable that is highly relevant to Javanese community. The implications suggest that the design of premium services should incorporate local wisdom elements as an effective strategy for achieving product differentiation and improving user satisfaction.

Although the use of batik motifs is strongly supported by users in Java, generalization to support from other ethnic groups still needs to be investigated. Future studies on designs with this kind of cultural integration would be beneficial for applications to other ethnic groups in Indonesia. Furthermore, in-depth studies are needed that aim

to address challenges in pattern standardization, feasibility of mass production, and alignment with industrial manufacturing constraints. Incorporating these considerations will ensure that culturally rich designs maintain emotional resonance and operational feasibility.

CONCLUSION

This study illustrates how Kansei Engineering can be effectively integrated with local wisdom by utilizing user interviews, online reviews, and cultural expert insights as inputs for the Kansei process. Cultural elements such as batik and Javanese ornaments were thoughtfully incorporated into design samples to ensure authentic cultural representation. Through the application of Quantification Theory Type I (QTT1), the final design proposal successfully combined emotional aspects with design elements for product development. Recommendations for luxury train seat designs that evoke emotional responses through Kansei Engineering and local wisdom were developed using semantic differential evaluation, which identified the most influential Kansei pair as the foundation for design element combinations. This process led to the integration of numerous design elements into the proposed product. The resulting design introduces four innovative features not present in previous luxury train seats: (1) a backrest adorned with batik patterns representing local cultural identity, (2) upholstery made from non-leather materials, (3) a sunken seating surface to enhance ergonomic comfort, and (4) an adjustable headrest position based on user preferences. Although the chosen Kansei term "Creative" is broad, the essence of local wisdom remains evident through the form and visual expression of the design, particularly the batik motif on the backrest, which reinforces cultural identity. These recommendations were visualized using virtual reality technology, enabling users to experience an immersive representation of the final design. The findings confirm that integrating local wisdom—especially batik motifs—effectively conveys the Kansei perception of "Creative" in luxury train seat design, and users demonstrated a strong preference for cultural attributes such as batik in the backrest area, highlighting the importance of products rooted in cultural identity. Nevertheless, this study is limited by a small sample size and its focus on Javanese culture, which may not represent other regions of Indonesia. Furthermore, the design remains conceptual and has only been visualized virtually. Future research should involve real user testing to validate ergonomic comfort and technical aspects, conduct cost-benefit analysis for selected forms and materials, and apply the methodology to other cultural contexts to achieve broader and more practical results.

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CONFLICT OF INTEREST

All authors declare that they have no conflict of interest.

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DATA AVAILABILITY STATEMENT

Due to privacy restrictions, the data are not publicly available. De-identified data may be available from the corresponding author upon reasonable request.

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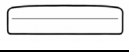
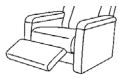
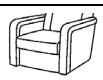
APPENDIX

Seat Design Item and Category

Part	Item			Category			Visual Illustration
	No.	Name	Code	No.	Name	Code	
Backrest	1	Backrest pattern	X1	1	Plain solid color (one color)	X1.1	
				2	Solid color blend	X1.2	
				3	Local batik motifs	X1.3	
	2	Backrest texture	X2	4	Textured	X2.1	
				5	Not Textured	X2.2	
	3	Rear backrest body area	X3	6	Flat	X3.1	
				7	Slightly sunken	X3.2	
				8	Sunken	X3.3	
Backrest	4	Backrest tilt angle	X4	9	Fixed	X4.1	
				10	Flexible	X4.2	
	5	Backrest covering material	X5	11	Leather/synthetic leather	X5.1	
				12	Others (polyester, nylon, etc.)	X5.2	
Seat	6	Seat area	X6	13	Flat	X6.1	
				14	Sunken	X6.2	

Seat Design Item and Category (cont.)

Part	Item			Category			Visual Illustration
	No.	Name	Code	No.	Name	Code	
Headrest	7	Headrest thickness	X7	15	Thick	X7.1	
				16	Thin	X7.2	
	8	Headrest area	X8	17	Flat	X8.1	
				18	Sunken	X8.2	
	9	Headrest position	X9	19	Fixed at the top of the backrest	X9.1	
				20	Flexible (separate)	X9.2	
	10	Headrest shape	X10	21	Box	X10.1	
				22	Oval	X10.2	
Armrest	11	Armrest area	X11	23	Flat	X11.1	
				24	Curved	X11.2	
	12	Armrest texture	X12	25	Not ornate	X12.1	
				26	Decorated with Javanese ornaments	X12.2	
Foot rest	13	The presence of a footrest	X13	27	Available	X13.1	
				28	Not available	X13.2	
Overall	14	Design concept	X14	29	Closed	X14.1	
				30	Open	X14.2	

AUTHORS BOGRAPHY

Afif Hakim is currently a PhD student in the field of industrial engineering at Sebelas Maret University. He also holds the head of Institute for Research and community services at the University of Buana Perjuangan Karawang. His research interests include halal supply chain, quality management, product design, and manufacturing systems. He can be contacted at email: afif.hakim@student.uns.ac.id

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Bambang Suhardi worked as a Professor at Industrial Engineering, Sebelas Maret University. His research expertise was in work design and systems, ergonomics, and environmental management. Prof. Bambang leads research groups at the Sebelas Maret University, in the fields of ergonomics engineering, work systems, and environmental management. He can be contacted at email: bambangsuhardi@staff.uns.ac.id

Pringgo Widyo Laksono is currently a Lecturer and a Researcher in the Industrial Engineering Department at Sebelas Maret University. His research interests include production development system engineering, intelligent machine, system and control engineering. He leads the Center for Research in Manufacturing Systems (CRiMS), a research group at the Sebelas Maret University. He can be contacted at email: pringgowidyo@staff.uns.ac.id

Mirwan Ushada worked as a Professor at the Department of Agro-industrial Technology, Faculty of Agricultural Technology, Gadjah Mada University, Indonesia. His research interests include affective engineering and design, Kansei engineering, production systems, and agro-industrial technology. He also leads the Research Directorate at Gadjah Mada University. He can be contacted at email: mirwan_ushada@ugm.ac.id

Jafri Mohd Rohani is an Associate Professor of Material, Manufacturing, and Industrial Engineering. He lectures in Department of Industrial and Mechanical Engineering, Faculty of Mechanical Engineering, Universiti Teknologi Malaysia. He holds a B.Sc. in Industrial Engineering and a B.Sc. in Mathematical Statistics from New Mexico State University, USA. He also holds an M.Sc. in Industrial and Systems Engineering from Ohio University, USA, and a Ph.D. in Statistical Process Control from Universiti Teknologi Malaysia, Skudai, Johor. Email: jafrimr@utm.my

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