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Integration of Text Mining, Railqual, Kano model, and Kansei Engineering for Train Service Excellence

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Abstract – **Customer satisfaction is insufficient. It applies to all service industries including train services. Apart from weather conditions and safety issues, the challenges faced by train services are improving passenger comfort, sense of well-being, and emotional satisfaction. How to understand and satisfy the customer emotional needs is critical. Conventional methods such as survey and interview sometimes bring shortcomings. Hence, this study proposes the integrated approach of text mining, Railqual, Kano model, and Kansei Engineering (KE) in train services. Text mining is inserted in the KE methodology to refine the more representative Kansei words and service attributes experienced. The finding shows that there were 8 final Kansei words, namely, clean, extraordinary, comfortable, spacious, modern, friendly, cool, and cheap. Related to critical train service attributes, there were 3 items i.e., comfortable temperature in train, politeness of staff, and good quality meals served in train. Surely, the continuous scheduled air conditioner maintenance, training "dealing with people" for staff, and food supplier evaluation should be prioritized.**

Keywords – **Text Mining, Kansei Engineering, Railqual, Kano, Train Services**

I. INTRODUCTION

If we talk about train services, we may be recalled by high-speed train Shinkansen in Japan or the Shanghai Maglev Train in China. They are known as the bullet train. The most dominant characteristic is that a high-speed train of 320 km/h carrying more than 500 passengers per day. Hence, the expected emotional needs (or Kansei words) were speedy, comfortable, and efficient.

Safety is always the basic need for any transportation mode, including the railway services. Technology-enabled features are hoped to be included in the service system, so that the trains run smoothly and correctly. As a result, the efficiency, safety, and reliability will be obtained. Surely, these are some service attributes highly expected by passengers. Once the number of service providers increasing, then the competition will be tightly increased as well. Moreover, the customer today is always much demanding.

This study is addressing the problem of state-owned railway service company located in Surabaya, Indonesia. It has huge challenges such as cost, comfort, speed, and safety compared to other transportation modes. In other words, those challenges lead to critical problems in the future. The effort to identify and fulfill what the customers concern is a must.

Capturing the essential needs of customers have been done intensively through survey, observation, or even social experiment. However, it is quite often that the respondents are constrained by the time of survey and there is no comfort for them. Consequently, the responses given are not representative and they seem to be short-lived answers or solutions. Moreover, it is very challenging to seek and dig the deepest layer of customer needs [1]. Hence, more sophisticated yet affordable approach is needed. According to study by Hartono et al. [2], due to customer dynamics, more representative customer needs especially the emotional needs are required. In addition, there has been little academic exploration and study in evaluating the importance of perceived railway passenger service quality on emotions. Hence, text mining on the exploration of customer emotional needs related to perceived passenger service quality on railway services is proposed.

Hence, this study aims to propose an integrative framework of Kansei Engineering, Kano model, and Railqual incorporating text mining methodology in refining the representative customer emotional needs and service attributes for the improvement of train service excellence. Both practical and theoretical implications are presented.

II. LITERATURE REVIEW

A. The Milestones of Kansei Engineering

Kansei Engineering (KE) has been evolving steadily since its first introduction in the 1970s. The KE application ranges from physical products to intangible services. As a general methodology, it starts from what emotional needs expected by customers (Kansei) and ends with design characteristics connected to the fulfilment of those Kansei. This study discusses the evolution of KE in services, which is focusing on the service quality of train service excellence. It might be the extension of KE in services in different service settings.

In general, KE methodology highlights the relationship between Kansei and perceived service/product attributes. Kansei is positioned to be a dependent variable, as a function of perceived service/product attributes (independent variables). The application of KE is very broad. It covers both physical and non-physical products or known as products and services [3]. KE is classified into type I, II, and III. Type I KE is a famous methodology

addressing the identification of design elements for creating new product. Type II KE uses the computer technologies such as neural network, genetic algorithm, and expert system. Type III KE is Kansei mathematical modeling, expanding the Kansei as the function of perceived product/service experience. It ranges from automotive, construction and housing, electrical device, houseware, to service design and development. This study focuses on service design for train/railway service excellence.

B. *Text Mining in Kansei Engineering for Train Service Excellence*

According to the previous study of KE in services considering more representative Kansei [2], it is still huge opportunity to extend the study into other different service settings. Since the issues on comfort and safety of transportation modes, it is a challenge to promote the modified KE methodology in the train services. We will utilize a more structured way to collect and finalize the Kansei words as representative of passenger emotional needs. Hence, text mining with sentiment analysis is used. This approach will refine the collected Kansei words due to interference of short-lasting and imprecise responses, different culture and background of subjects, traditional methods for data collection, and cognitive inertia. Social media tweets are deemed to be potential source of data of Kansei.

Recent studies on KE in services show that there is an opportunity to explore the study of KE mining for service excellence in various service settings.

III. METHODOLOGY, PROPOSED FRAMEWORK, AND DATA COLLECTION

Following the previous studies [1; 2], the research methodology starts with the objective of study, i.e., to promote excellent railway service experience for passengers. In complementing the previous KE studies in services, this current study proposes text mining for sentiment analysis. Regarding the service excellence for railway services, it has been usually conducted through conventional survey through questionnaires. However, this study introduces a new approach of text mining integrated with KE in order to refine the existing methodology.

Afterward, the methodology continues to the stage of text mining for sentiment analysis. It is to determine two major parts in the methodology, i.e., emotional attributes (Kansei words) and railway/train passenger service attributes. Generic model of Railqual – railway service quality is used to represent railway/train service quality which consists of 8 dimensions (i.e., tangible, reliability, responsiveness, assurance, empathy, comfort, connection, and convenience). The train/rail service attributes and Kansei words have been collected and finalized through two steps. First, they were collected and structured based on the result of sentiment analysis. The sentiment analysis process was carried out on all 918 reviews, resulting in a subjectivity value of 0.45 which means it is quite objective. The subjectivity of the review comes from the feelings, emotions, moods, opinions, and experiences of customers/visitors/passengers. Second, the determination of service attributes was also strengthened by previous research. The process of determining service attributes with a literature study was carried out to improve the sentence of a service attribute that has been compiled based on text mining output. More specifically, the refinement of Kansei words has been further strengthened by literature review on an enthusiast group called "Indonesian Railfans" on social media Facebook.

Following the previous study [2], Kano categorization and calculation of satisfaction score are done. Regarding the Kano categorization, this study focuses only on one dimensional (O) and attractive (A) as they are source of innovative improvement. After that, Kansei linear model is set (i.e., Kansei is a function of perceived railway service quality). This linear model will be reversed in order to identify and filter the most critical railway service attributes to be continued with the generation of improvement strategies using house of quality (HoQ). For details of methodology, please refer to Figure 1.

This study utilized the use of purposive sampling method and has collected 100 valid and reliable responses through online questionnaires. The participants rated their responses due to services provided by railway services of a state-owned company located in Surabaya, Indonesia, named as XYZ. User-generated content (UGC) on various social media is a driver for XYZ to understand customer needs more comprehensively. There has been an exponential increase in the number of reviews on several review provider platforms in recent years [4]. Therefore, text mining and sentiment analysis are used to determine the perception of long-distance train passengers. Both methods are considered superior to conventional methods such as surveys and interviews which are time-consuming and costly [5].

The sample criteria in this study were railfans (train enthusiasts) or railway enthusiasts in Indonesia, who have traveled by long-distance train 4 or more times in the last 2 years and boarded and/or disembarked from long-distance trains in one of the train stations in Surabaya. The results and discussion of the study are provided in Section IV.

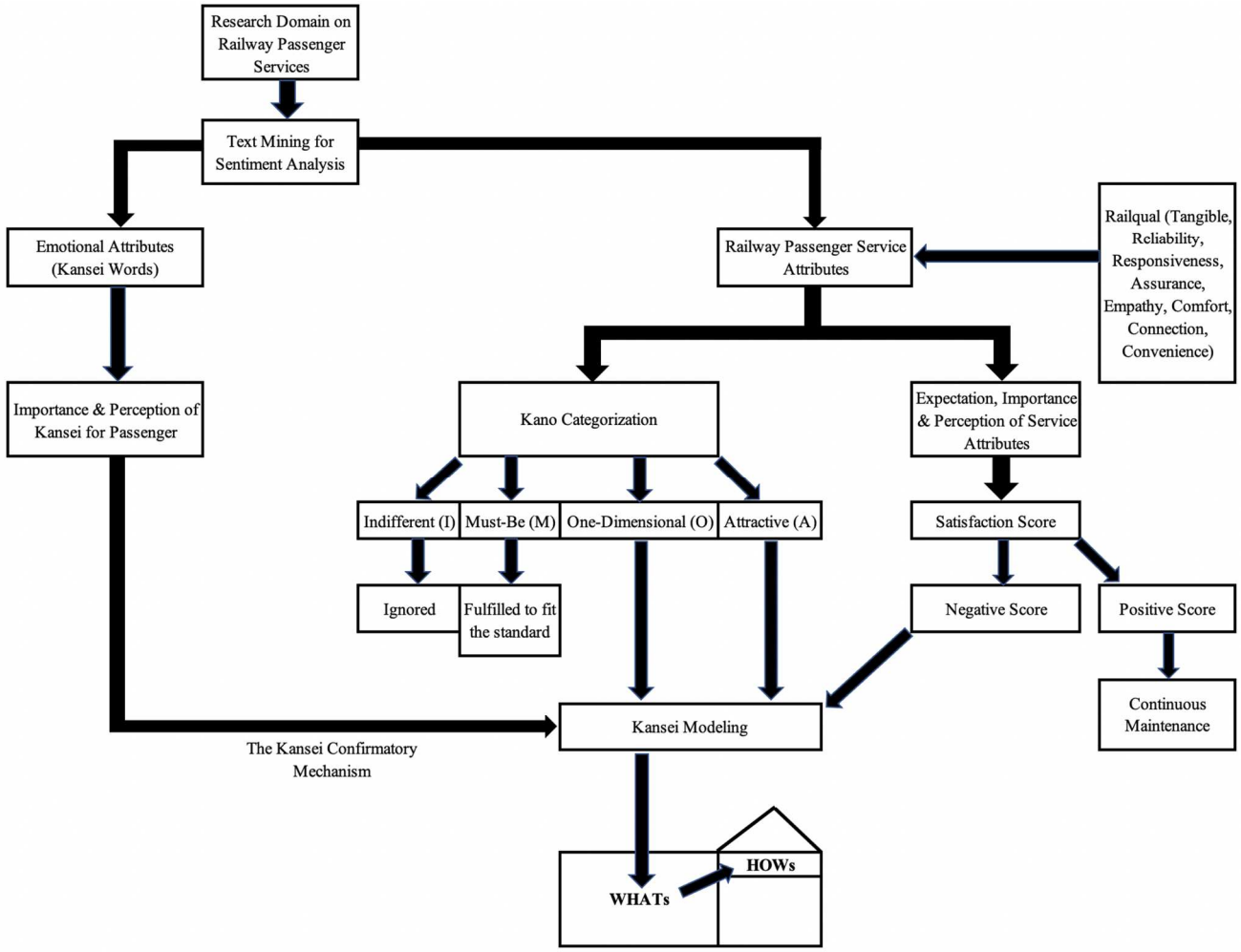

Fig. 1. The modified integrative model of Text Mining, Railqual, Kano, and Kansei Engineering for railway passenger service excellence

IV. RESULTS AND DISCUSSION

A. Kansei words to represent customer emotional needs for train services

The review data obtained from Google Maps Review at major stations in Surabaya were then processed using the Pandas library, Vader, with Textblob using the Python programming language. The process includes text corpus (document review from Google Maps), preprocessing (case folding, tokenizing, lemmatizing, stopwords removal), representation (bag of words or word frequencies), and knowledge discovery (sentiment analysis). The word frequencies that have been obtained are used in the preparation of 21 service attributes and 9 emotional needs in the form of Kansei words. In addition, the sentiment analysis of 917 data reviews categorized 41% as negative reviews and 59% as positive reviews and obtains a subjectivity value of 0.45 (quite objective). The emotional needs (Kansei words) of long-distance train passengers that have been validated are clean, extraordinary, comfortable, spacious, modern, friendly, cool, and cheap.

B. Finalized Railqual dimensions and service attributes to represent train service items

Railqual (Railway Service Quality) is a method developed from SERVQUAL (service quality) by adding new dimensions, namely comfort, connection, and convenience [6]. These three dimensions are closely related to the measurement of service quality in rail transportation services.

A service is said to be of quality if the offering meets the demands or expectations of customers. Therefore, service quality is the difference between customer expectations of service and the service received by customers. Customer dissatisfaction arises when the expectations of a service exceed the expectations of the service itself. This study finalized 21 railway service attributes as follow (available in Table 1), attached with service gap, satisfaction, significance of statistical test for service gap, and Kano category for each service attribute. Again, a set of 21 railway service attributes was adopted from Prasad & Shekar's RAILQUAL model with a modification based on the context in Indonesian railway services.

Table 1. The finalized service attributes of Railqual and their statistics *

Code	Attribute	P	E	I	Gap	*p*	S	Kano
Tangible								
Tan-1	The area is clean	4.07	4.10	4.63	-0.03	0.769	-0.14	I
Tan-2	The train is clean	3.80	4.21	4.64	-0.41	0.000	-1.90	M
Tan-3	The station building is modern	3.36	4.17	4.41	-0.81	0.000	-3.57	O
Tan-4	The meal is of good quality	3.15	4.14	4.59	-0.99	0.000	-4.54	O
Reliability								
Rel-5	The departure and arrival is on time	3.98	4.19	4.66	-0.21	0.038	-0.98	M
Rel-6	The staff is skillful in handling problem	3.68	4.19	4.37	-0.51	0.000	-2.23	O
Responsiveness								
Resp-7	The staff is responsive in helping passenger	3.70	4.23	4.38	-0.53	0.000	-2.32	O
Resp-8	The number of staff is sufficient	3.59	4.16	4.30	-0.57	0.000	-2.45	O
Assurance								
Assu-9	The staff is knowledgeable	3.76	4.20	4.45	-0.44	0.000	-1.96	O
Assu-10	The condition in station and train is safe	4.07	4.29	4.74	-0.22	0.051	-1.04	I
Assu-11	The staff in station is polite	3.27	4.25	4.61	-0.98	0.000	-4.52	O
Assu-12	The staff in train is polite	3.76	4.22	4.71	-0.46	0.000	-2.17	O
Empathy								
Emp-13	The staff acknowledges passenger need	3.57	4.20	4.33	-0.63	0.000	-2.73	O
Emp-14	The staff communicates well	3.74	4.21	4.37	-0.47	0.000	-2.05	O
Comfort								
Comf-15	The seat is comfortable for long-hour trip	3.03	4.38	4.68	-1.35	0.000	-6.32	M
Comf-16	The temperature in train is comfortable	3.08	4.20	4.63	-1.12	0.000	-5.19	O
Comf-17	Legroom is spacious	3.29	4.16	4.64	-0.87	0.000	-4.04	O
Connection								
Conn-18	The schedule fits to passenger need	3.31	4.24	4.48	-0.93	0.000	-4.17	O
Conn-19	Transportation options from/to station	3.45	4.15	4.44	-0.70	0.000	-3.11	O
Convenience								
Conv-20	Public facilities at station are adequate	3.97	4.16	4.60	-0.19	0.095	-0.87	I
Conv-21	Mechanism to buy or cancel ticket is easy	3.84	4.18	4.41	-0.34	0.001	-1.50	O

*Note: *P=Perception, E=Expectation, I=Importance, Gap=Perception-Expectation, p=significance value, S=Satisfaction=(P-E)xI*

Based on the results in Table 1 above, there were 15 service attributes (with Kano's category O – One Dimensional) selected to be linked with each Kansei word. After conducting the linear mathematical model using linear regression (with a defined Y is particular Kansei word, and defined Xs are perceived service attributes), the importance of weight (called as IW) for each significant service attribute was calculated. It is critical to provide which service attribute(s) is/are prioritized for continuous improvement. The details of the importance of weight (IW) for each significant service attribute is provided in Table 2.

Table 2. The importance of weight of significant service attribute for prioritized improvement**

Code	Attribute	|S|	KW	Kansei Mean	Significant Kansei	IW
Comf-16	The temperature in train is comfortable	5.19	2	3.59	Extraordinary, comfortable, modern, spacious, cool, cheap	223.6
Assu-11	The staff in station is polite	4.52	2	3.77	Comfortable, spacious	204.4
Tan-4	The meal is of good quality	4.54	2	3.51	Cheap	191.4
Tan-3	The station building is modern	3.57	2	3.42	Modern, cool	146.6
Emp-13	The staff acknowledges passenger need	2.73	2	3.35	Cool	109.7
Rel-6	The staff is skillful in handling problem	2.23	2	3.98	Clean	106.4
Assu-9	The staff is knowledgeable	1.96	2	3.98	Clean	93.5
Emp-14	The staff communicates well	2.05	2	3.49	Modern	86.0
Conn-18	The schedule fits to passenger need	4.17	2	-		8.3

Comf-17	Legroom is spacious	4.04	2	-	8.1
Conn-19	Transportation options from/to station	3.11	2	-	6.2
Resp-8	The number of staff is sufficient	2.45	2	-	4.9
Resp-7	The staff is responsive in helping passenger	2.32	2	-	4.6
Assu-12	The staff in train is polite	2.17	2	-	4.3
Conv-21	Mechanism to buy or cancel ticket is easy	1.50	2	-	3.0

*Note: **|S|=Absolute Satisfaction, KW=Kano weight, IW=Importance of Weight = |S| x KW x Kansei Mean x Number of Significant Kansei*

In order to prioritize which significant train service attributes to be improved, the Pareto diagram is used as shown in Figure 2. It is shown that there were three service attributes deemed as critical, i.e., Comf-16, Assu-11, and Tan-4.

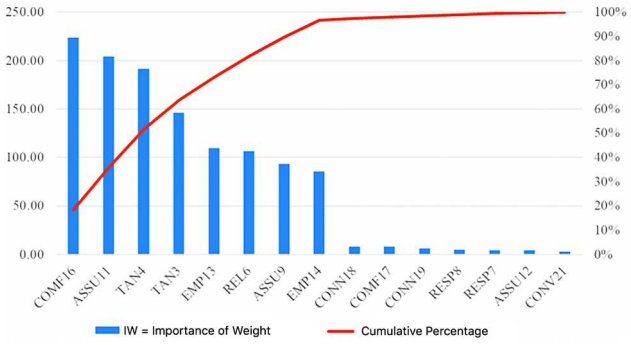

Fig. 2. The Pareto diagram for prioritization of improvement

Through focus group discussion (FGD) with enthusiasts, respondent feedbacks, and literature reviews, the proposed improvement strategies were formulated. They consisted of i) Regular check, provision of air conditioner, and ensuring the air conditioner is always on with temperature of 24-degree Celsius (i.e., the comfortable temperature), ii) Regular training and campaign for staffs regarding "dealing with people", and (iii) Provision of self-service kiosk for meals and drinks.

V. CONCLUSION

The integration of Kansei Engineering-based mining, Kano model and SERVQUAL has shown its applicability to propose the prioritized improvement for excellent train service quality. It is not just identifying and finalizing what emotional needs (Kansei) are critical to customer/user, but also filtering the more representative Kansei. Even though some studies highlight that Kansei is dynamic, this study may offer a distinctive attribute of Kansei package which is more relevant to certain service encounter. At least, the Kansei package will last longer. Hence, this model produces more efficient resources in terms of what the exactly emotional needs of customer are, and how to prioritize the formulated solutions.

For further research, it is surely dealing with Kansei dynamics and potential discussion in other service settings using the same KE methodology. More relevant approaches are highly expected. A confirmatory factor analysis using Structural Equation Modeling (SEM) is potentially conducted.

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