Product design with integration of Kansei engineering and TRIZ to promote sustainable tourism

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Product Design with Integration of Kansei Engineering and TRIZ to Promote Sustainable Tourism

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Abstract. In the last few decades, tourism has grown and developed yet it brings negative impacts on the environment and society, especially related to garbage problems that strongly depend on human behavior. The present study aimed at identifying factors that trigger tourist to litter and to preserve cleanliness, namely negative attributes and positive attributes. Important attributes were obtained through Pareto diagram and used to generate product design. To specify the design, Kansei Engineering Type I and TRIZ were applied. Important negative attributes (NA1, NA2, and NA3) and positive attributes (PA1, PA2, PA3, PA4, PA5, PA6, and PA7) generated attractive product design, i.e., trash bin and appeal board that will attract the tourist because of the uniqueness and moving objects. Furthermore, the collected Kansei words, i.e., unique, innovative, safe, and noticeable, which were applied to develop the specification of the product. Lastly, TRIZ was applied to solve the contradiction between shape and durability, hence principle 26 and 25 were employed.

BACKGROUND

Introduction

In the last few decades, tourism has been growing rapidly and considered as a solution to many economic and socio-cultural problems. Specifically, tourism begins to affect numerous aspects in the society, including its function as an agent of development and in creating jobs and increasing people's income. Nevertheless, despite tourism has contributed significantly to economic development and made differences in many regions, it has failed to meet some expectations [1]. Moreover, there is a serious concern that tourism potentially has a negative impact on the environment and society [2]. The negative impact of tourism is actually found in several mountains and national parks in Indonesia, for instance the piles of garbage carried by climbers. It was reported by BBC.com [3], there is approximately 250kg of garbage was brought to Mount Semeru by 200-500 climbers, every day. This problem encourages the implementation of tourism projects to devise a plan related to sustainable tourism.

According to Yu et al., [4] has defined sustainable tourism as the effort to improve the wellbeing of local people, to improve the quality of the tourist's experiences, and to preserve the environment for both visitors and the local community.

The present study focuses more on improving sustainable environmental conditions, especially related to garbage issues which strongly associated to human behavior, i.e., local people and tourists. By promoting environmental preservation, it is expected that the quality of life of the local people and the quality of the tourist's experiences will be improved. As a consequence, there is a need to identify the gap between tourist's perception and expectation as well as factors that encourage tourists to prevent littering action. The finding will be used to design the proposed products whose specification will be explored using Kansei Engineering (KE) and TRIZ. Recently, KE is considered to have advantages among similar methods, since it has the ability to translate customers'' emotional needs into real design parameters through certain techniques [5]. Meanwhile, TRIZ can be applied in the design of products and

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services as it has the ability to eliminate contradictions and find innovative solutions [6]. By employing these methods, it is expected that the present research will generate a product to make tourists more concerned about the environment, especially for not littering while visiting tourist attractions. Later, this product can be applied in all tourist attractions in Indonesia.

Problem Formulation and Research Objective

Problem formulation is described in two questions below:

1. What are the factors that trigger tourists to litter and to preserve cleanliness in tourist attraction?
2. From the identified factors, what kind of product can be designed to achieve sustainable tourism?

The present study aimed at identifying factors that encourage tourist either to litter or to preserve cleanliness. The identified factors are used to design a product which prevents the tourist for littering in tourist attraction. Kansei Engineering (KE) and TRIZ were employed to develop the specification of the product as well as find innovative solution. It is expected that the product will be able to encourage tourist to be more concerned about tourism environment and promote sustainable tourism.

RESEARCH METHODS

The present study uses questionnaire to identify the GAP between perception and expectation and factors that trigger people for either littering or preserving cleanliness. Subsequently, Kansei Engineering will be applied to specify the design. Type of sampling used is convenience sampling with sample size of 143 domestic tourists.

GAP analysis is adopted from Servqual [7], which is done by comparing the perception and expectation of tourists for certain attributes, including the cleanliness of tourist attractions, tourist behavior, and the effectiveness of existing appeals.

The present study also attempts to find and analyze factors which cause littering habits as negative attribute as well as factors which cause tourist for preserving cleanliness in tourist attraction as positive attribute. The developed attributes are shown in Table 1. These attributes are obtained from references and in-depth interview.

Pareto analysis will be applied to decide important factors based on negative and positive attributes in order to solve the formulated problems. It is carried out based on the observation that the operational results and economic wealth are not distributed evenly and that some inputs contribute more than others. It is referred to as the "80/20 rule," a nomenclature which has popularized a complex economic concept introduced by Vilfredo Pareto, a nineteenth-century Italian economist [8].

TABLE 1. The Developed Negative and Positive Attributes

Negative Attributes Modified from Juvan and Dolnicar [9]	• Because littering is not too bad, there will also be cleaning by employee (denial of consequences) • Others behave worse, I am better at behaving at tourist attractions (Downward comparison) • It is not my responsibility (Denial of responsibility) • I actually want to throw garbage in trash bin, but don't have much time or trash bin is too far so I don't do it (Denial of control) • Usually I throw garbage in trash bin. Holidays are special so sometimes it has no problem to litter (Exception handling) • I do good more than bad, one of which I pay for the economic growth of tourist attractions (compensation through benefits)
Positive Attributes	• Special education about preserving cleanliness [10] • There are strict regulations on the tourist sites (There are fines, etc.) • The existence of CCTV so that tourist behavior can be monitored [11] • There are many trash bins [12] [13] • Unique and interesting trash bins [14] [15] • There are appeal board "prohibited littering" • The existence of an appeal should be more attractive as there are images that can move, it might be more effective • Better appeals contain stabbing words • Better appeals contain funny words • By throwing garbage in the trash, there will be applause/voice thank you.

Awareness and positive intentions do not automatically lead to non-littering behavior, because littering is habitual and hard to refrain of. Therefore, several approaches can be done, namely: a) to disturb the wrong behavior by unconscious norm-activating interventions, and b) to make the desirable behavior easy by simplifying the target behavior. Measures should be adjusted to the target group in the context of the built environment [16]. Thus, the developed negative and positive attributes can be used to propose a product design. Furthermore, Kansei Engineering will be applied to specify the design. Kansei is able to translate technology from a consumer's interest and expectation of a product into design elements [17].

In addition, Kansei words will be collected by interviewing the tourists and doing literature review. The present study will apply Kansei Type I where a product is broken down into tree structures to obtain the design details and to classify the zero level concept to the sub concepts, that is, 1^{st}, 2^{nd},. . . . . and nth sub concept until the design specifications are obtained [17].

The Teoriya Resheniya Izobreatelskikh Zadatch (TRIZ) is applied to produce various alternative and innovative solutions that are adjusted to the contradictory elements in order to achieve a win-win solution. There are 40 innovative principles used to make conceptual solutions about the technical and physical contradictions [18]. Another tool in TRIZ is Contradiction Matrix comprising of 39 interrelated technical parameters and is used to determine innovative principles that are appropriately applied to overcome technical contradictions [19].

Furthermore, the portal http://www.triz40.com/TRIZ_GB.php is used to ease setting in contradiction and to propose the principles to solve the contradictions.

RESULTS AND DISCUSSION

The current study found that the high GAP between tourist's perception and expectation for some attributes as explained in Table 2. Questionnaire has been claimed to be valid and reliable with the smallest to biggest attribute value of .573 to .738, Cronbach's Alpha value of .912 and r table (df=141; α= 5%) of .1642.

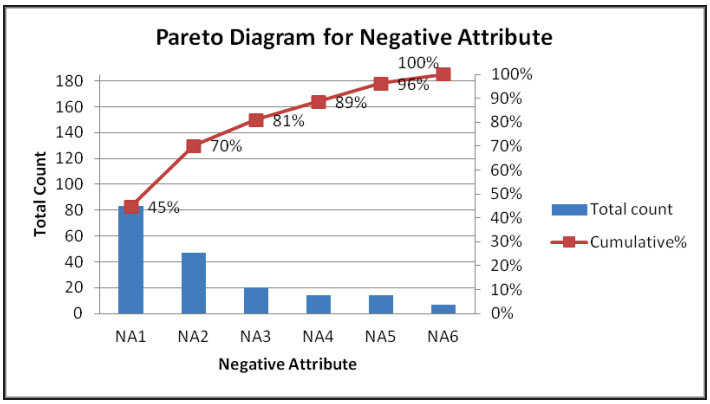
TABLE 2. Gap between perception and expectation

No	Attribute	*Gap*
1	Cleanliness of tourist attractions	-1.24476
2	Tourist behavior in preserving the cleanliness of tourist attractions	-1.62238
3	The appeals or information provided in tourist attraction have educated tourist for not littering	-0.67832
4	The appeals or information have attracted and educated tourists	-1.18182

The result showed that improvement is required in the tourist attraction. To obtain such information, negative and positive attributes were developed and followed by Pareto analysis in order to decide important factors used to solve the problem. The result of Pareto analysis for both negative and positive attributes are shown in Fig. 1 and Fig. 2, respectively.

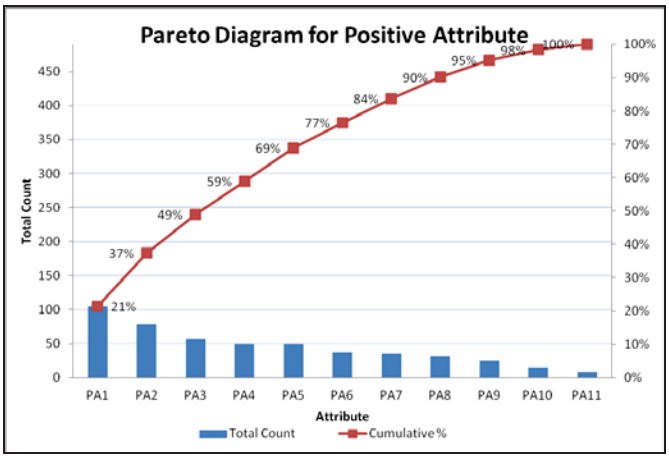
In Fig. 1, attributes NA1, NA2, and NA3 were taken as important factors for negative attributes as a cause for littering (total three attributes are 81% in accordance with the Pareto's rule). Attributes PA1, PA2, PA3, PA4, PA5, PA6, and PA7 in Fig. 2 were considered as important factors for positive attributes, which is preserving cleanliness in tourist attraction (total seven attributes are 84% in accordance with the Pareto's rule).

Furthermore, Crosstabs analysis was conducted between education and negative attributes, and between frequency of visiting tourist attraction and negative attributes. The result showed that there was insignificant association between education and negative attributes as indicated by asymptotic significance (Asymp. Sig.) 0.517. Likewise, insignificant correlation was also found between frequency of visiting tourist attraction and negative attributes as indicated by Asymp. Sig. 0.244.



No.	Attributes
NA1	I actually want to throw garbage in trash bin, but don't have much time or trash bin is too far so I don't do it
NA2	Because littering is not too bad, there will also be cleaning by employee
NA3	Others behave worse, I am better at behaving at tourist attractions
NA4	It is not my responsibility
NA5	Usually I throw garbage in trash bin. Holidays are special so sometimes it has no problem to litter
NA6	I do good more than bad, one of which I pay for the economic growth of tourist attractions

FIGURE 1. Pareto diagram for negative attributes



No.	Attributes
PA1	There are many trash bins
PA2	There are strict regulations on the tourist sites. (There are fines, etc.)
PA3	Special education about preserving cleanliness
PA4	Unique and interesting trash bins
PA5	There are appeal board "prohibited littering"
PA6	The existence of an appeal should be more attractive as there are images that can move, it might be more effective
PA7	The existence of CCTV so that tourist behavior can be monitored
PA8	By throwing garbage in the trash, there will be applause or voice thank you.
PA9	Better appeals contain funny words
PA10	Better appeals contain stabbing words
PA11	Other

FIGURE 2. Pareto diagram for positive attributes

Proposed product design is considered by analyzing significant negative and positive attributes. The wrong behavior i.e., trash bin is too far (cannot be seen), there will also be cleaning by employee, and thought that others behave worse, as derived from important negative attributes can be disturbed by unconscious norm-activating interventions and by making the desirable behavior easy by simplifying the target behavior. In this case, product design should be created as attractive as possible, e.g., remarkable trash bin or appeal board will attract the tourist to take picture with it.

In positive attributes, the first thing to understand is the availability of trash bins (facility). Moreover, this facility should be unique and the presence of moving object to attract the tourist's attention.

Nevertheless, some of positive attributes, i.e., PA2, PA3, and PA7, cannot be linked to the current design since these positive attributes are associated with the management of tourist attractions as well as educational curricula and practices.

In addition, Kansei words will be collected by interviewing the tourist and by conducting literature review for then being re-questioned to the respondents. Kansei words and the level of importance (grand mean) based on respondents are provided in Table 3.

Questionnaires for Kansei words has been declared to be valid and reliable with the smallest to biggest attribute value of .739 to .881, Cronbach's Alpha value of .93 and r table (df=141, α= 5%) of .1642.

Kansei words which were greater than grand mean (4.2075) are: unique, innovative, safe and easy to see, will be analyzed further using affinity diagram on Kansei Type I. The affinity diagram is rotated into a hierarchy diagram to identify the senses employed to elicit the life style words. Afterwards, this diagram is used to identify product

features such as systems, design element and quality characteristics, components, and performance levels to be considered as critical to portraying the most valued lifestyle images [20].

TABLE 3. Kansei words and meaning

Attributes	Mean	Description
Unique	4.21	It contains funny and entertaining sentences (76.9%)
Beautiful	4.04	
Innovative	4.43	Images can move sideways (65%)
Natural	3.94	
Modern	4.14	
Safe	4.38	It is not easily fallen or damaged by rain (86.7%)
Simple	3.94	
Easy to see	4.58	Located near the trash bin (56.6%); the size is large and it can be seen at a distance of 10 meters (63.6%)
GRAND MEAN	**4.2075**	

The affinity diagram is shown in Fig. 3. It is started with Kansei Domain level 0 which is the general idea of the product that will be designed and continued by Kansei words that have been previously obtained (Level 1). On the next level (level n), Kansei words would be described more detail, thus it will be easier to manifest them in physical form than level 1, e.g., font, color, product weight, and so forth. The level n must be seen by the most influential senses for then being translated to physical domain. The first domain is the system of the product (part of the product), continued by the design element, i.e., characteristics and dimension. The final physical domain is the specification of the proposed product.

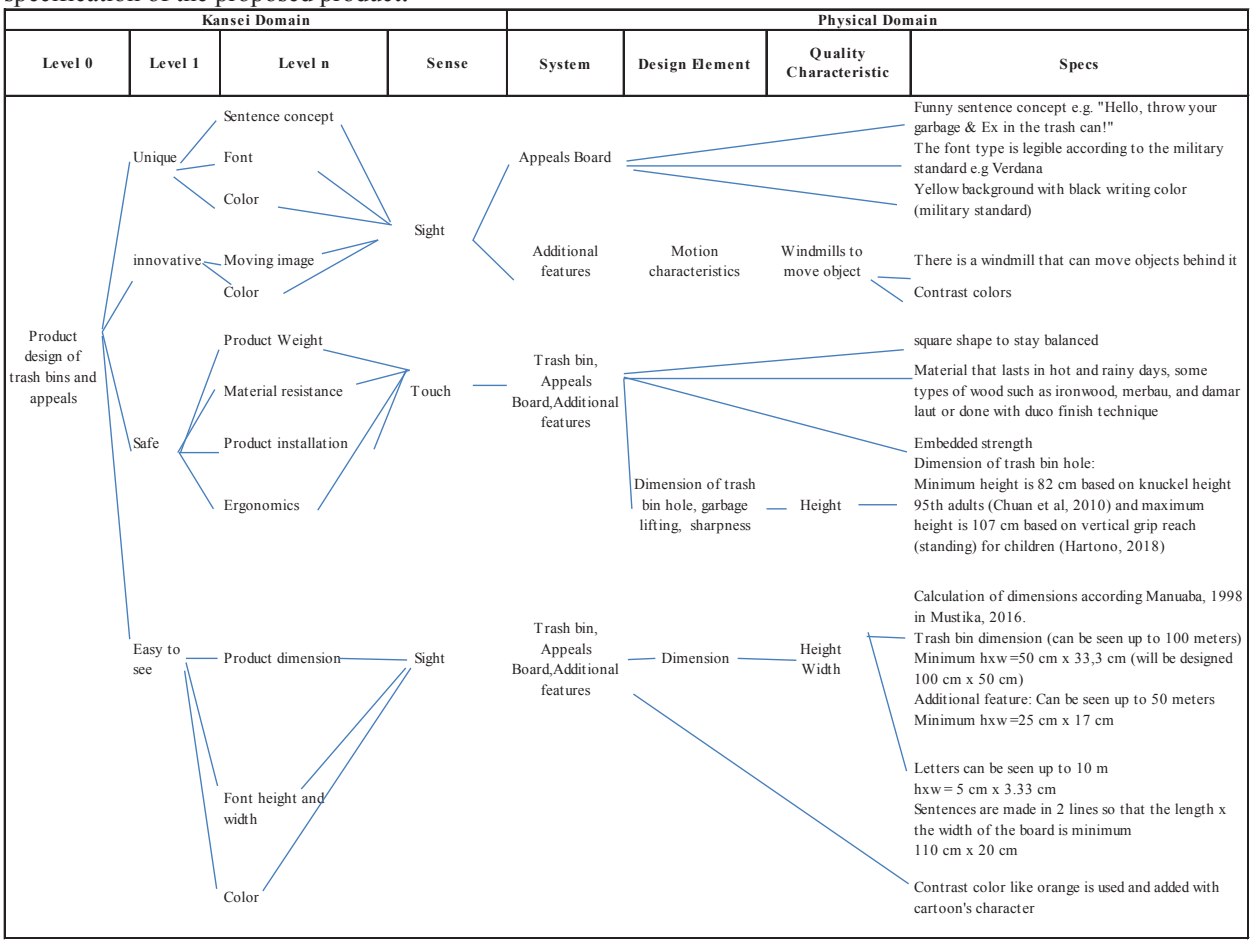


FIGURE 3. Kansei Engineering Type I

The proposed product is a trash bin accompanied by an appeal board and additional features. Trash bin has square shape (box) with materials that are resistant to hot and rainy days, for instance using some types of wood (e.g., ironwood, merbau, and damar laut) or Duco finish technique. Dimension of trash bin hole, minimum height is 82 cm based on knuckle height 95th adults [21] and maximum height is 107 cm based on vertical grip reach (standing) for children [22]. The calculation of the trash bin, attractive board, additional feature and the letters dimension according to Manuaba in Mustika et al., [23] are depended on reading distance.

Height of the letter or picture (mm)	= reading distance (mm)/200	(1)
Width of the letter or picture (mm)	= 2/3 x Height	(2)
Distance between 2 letters	= 1/5 x height	(3)
Distance between 2 words	= 2/3 x height	(4)
Distance between 2 lines of sentences	= 1 x height	(5)
Width of the letter	= 2/3 x height	(6)
Thickness of the letter	= 1/6 x height	(7)

Trash bin can be seen up to 100 meters, thus the recommended of minimum height x width = 50 cm x 33.3 cm. The trash bin will be designed 100 cm x 50 cm in size regarding the quantity of the waste in tourism attraction. It also has contrast colors, e.g., orange color and cartoon's characters.

Attractive board has funny sentence concept e.g. "Hello, throw your garbage & Ex in the trash can!". It has yellow background with black color font. Letters can be seen up to 10 m, hence the minimum height x width = 5 cm x 3.33 cm. Sentences are made in 2 lines hence the length x the width of the board is 110 cm x 20 cm in minimum.

Additional feature is windmill, which can be seen up to 50 meters. Minimum height x width = 25 cm x 17 cm. This windmill can move the objects behind it. Sound can also be added from the sound of a can, making it more attractive to the tourists.

The problem arises concerning with the shape of the product which comprises of three components (box, attractive board, and additional feature) and its durability when lifted into a garbage cart (shape vs durability). This problem can be solved with TRIZ through principle 26 (copying), which is by replacing the content of the box with cheaper item, e.g., plastic bag (endeavored to be environmentally friendly), or self service (principle 25) by placing waste substances (used drums/used materials) inside the box. The detail of the proposed product using TRIZ is shown in Table 4.

TABLE 4. Applied TRIZ

No	Contradiction Technique	Matrix Coordinate	Innovative Principles	Notes
1	Weight/Shape	1x12	10. Preliminary action ; 14. Spheroidality - Curvature; 35. Parameter Changes; 40. Composite materials	not yet applicable
2	Weight/Durability	1x15	5. Merging; 34. Discarding & Recovering; 31. Porous Materials	not yet applicable
3	Shape/Durability	12x15	14. Spheroidality – Curvature	not yet applicable
			26. Copying	Replacing the content of the box with cheaper item, such as plastic bag (endeavored to be environmentally friendly)
			9. Preliminary anti action	not yet applicable
			25. Self service	Use waste substances (used drums/used materials)

The final proposed product design is shown in Fig. 4 and Fig. 5**.** These figures are the integration of the Kansei Engineering and TRIZ as explained previously to preserve cleanliness in tourist attractions. Hence, it can influence tourist's perspective towards sustainable tourism.

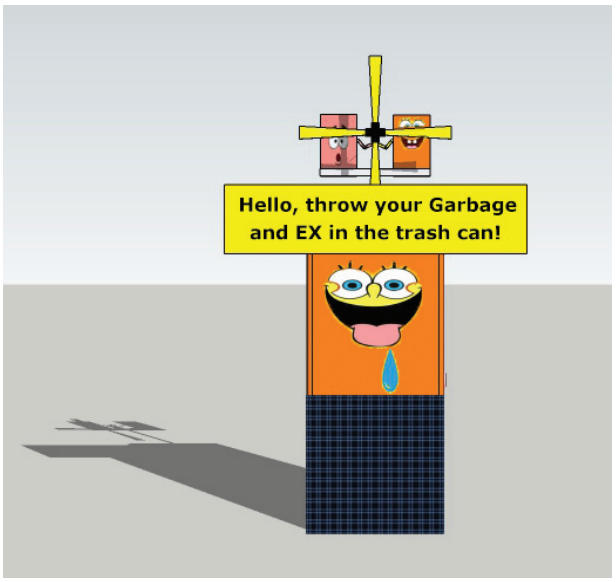


Figure 4. Perspective 1 (front)

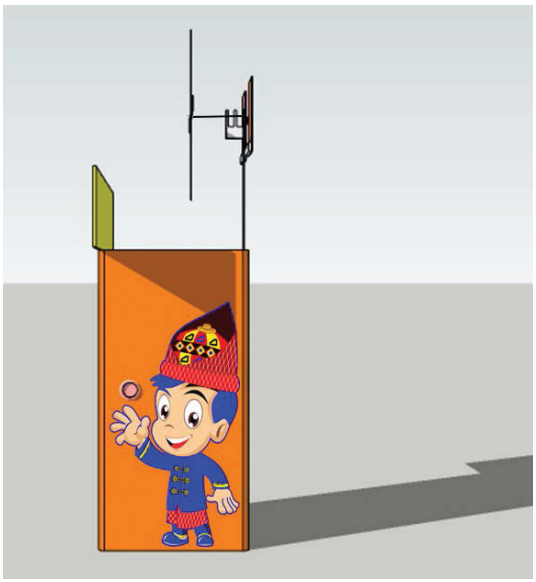


Figure 5. Perspective 2 (side)

The dimensions of the product can be altered. The most important thing is the minimum size regarding with ergonomics field. The size can be bigger depending on the weight of the trash that can be produced by tourists. As a consequence, every tourist attraction will not be the same. The size of the box (trash bin) can be only designed for one type of waste, i.e., organic waste or an-organic waste. If the box is bigger, it can be provided a partition between organic and an-organic waste. The utilization of other materials placed inside box should also be considered environmental friendly, for instance using plastic that can be recycled easily or degraded easily.

CONCLUSION

Pareto analysis has been used for determining important attributes in the present study. Moreover, NA1, NA2, and NA3 are considered as important negative attributes or the reasons for littering, while PA1, PA2, PA3, PA4, PA5, PA6, and PA7 are considered as important positive attributes as the cause for preserving cleanliness. Based on these attributes, design products are developed, namely unique trash bin and attractive board with moving objects. Kansei words, i.e., unique, innovative, safe, and easy to see, have been used to obtain the specification of the product. It is related to funny texts on attractive board, font size which can be seen from a distance and moving objects as additional features, e.g., a windmill that is able to move the images behind it. The word ‘safe’ is related to installation. Meanwhile, the noticeable shape of the product is relied on the dimension that has been measured before. It should be noted that the proposed dimension is a minimal dimension that can be enlarged to the specified size. This will be corresponded to the quantity of the waste and the required cost. The improvement based on TRIZ is to add another component inside the trash bin so that it is not necessarily lifted to the garbage cart because of its related durability. There is also a need to select certain material to produce the trash bin.

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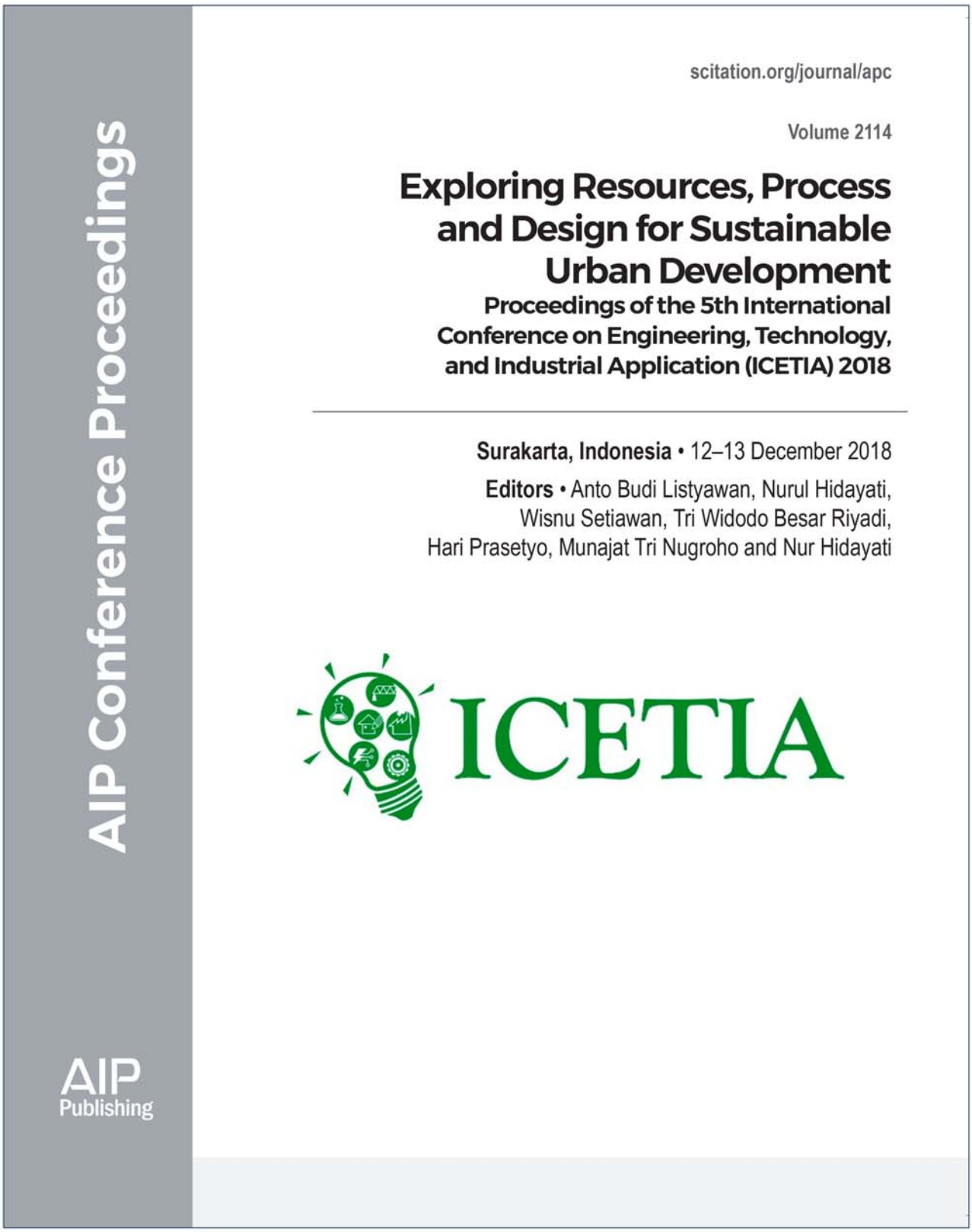

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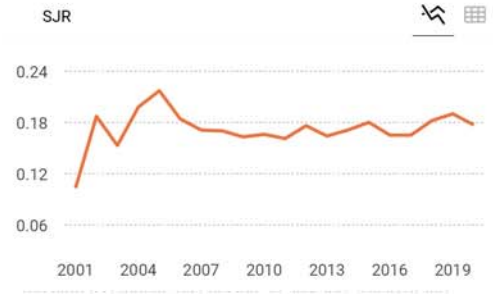

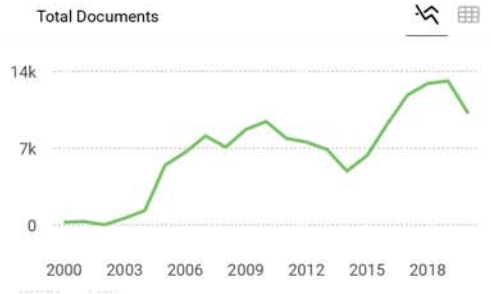

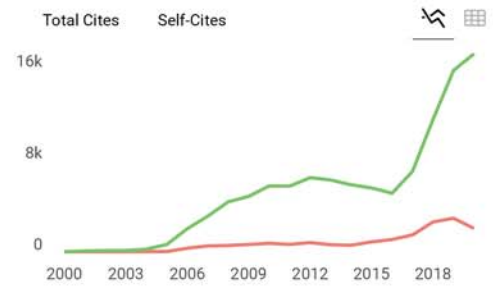

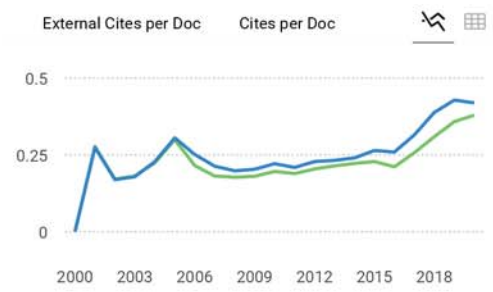

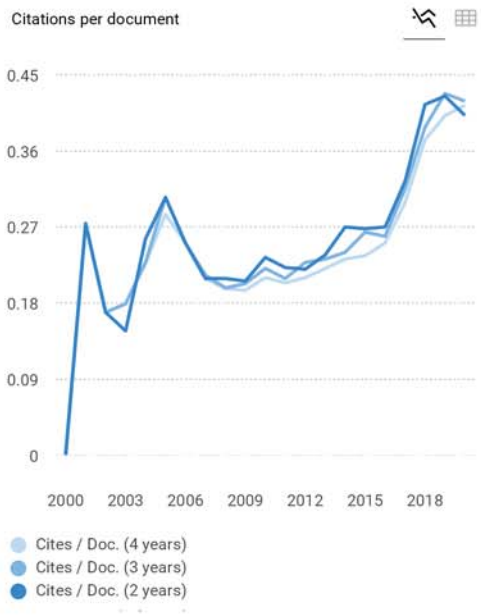

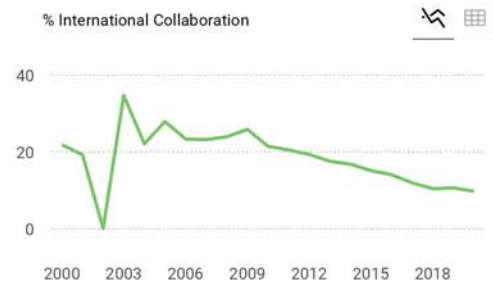

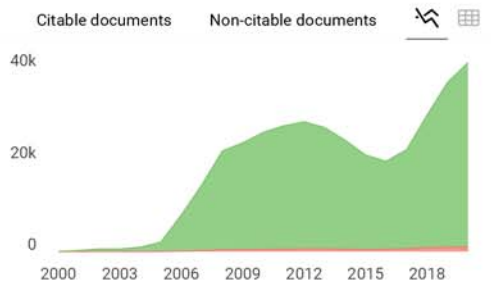

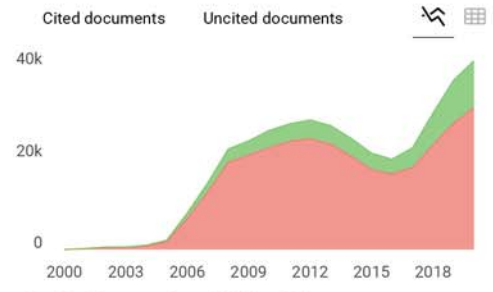

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