A child-friendly design for sustainable urban environment: a case study of Malang city parks

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Abstract. A child-friendly city environment contains elements of security, health and comfort, especially in the midst of the current pandemic. This paper aims to study the child-friendly designs in urban public spaces, especially city parks. The study objective was to find the level of performance and importance of child-friendly design in the case study of Indonesian city parks. The research stages include aspects of perceptions and expectations by users as well as development proposals based on expert opinions. Importance Performance Analysis (IPA) technique is used to determine the level of suitability, performance and importance of child-friendly design elements in the case study of city parks. The case study used is Trunojoyo Smart Park, Malang City. Analysis Hierarchy Process (AHP) technique is used for the proposed development of sustainable improvement of child-friendly spaces. The level of suitability of garden elements has the highest value above the average of 116.73%. While the pedestrian path element has the highest performance value and importance with scores of 169 and 156 respectively. The child-friendly design element that has the lowest performance is the sand game vehicle (132). Two child-friendly design elements that become development priorities for both users and experts are safe spaces and play equipment which have a suitability rate of 113.92% and 108.90%, respectively, and the experts' priority values are 0.117 and 0.083, respectively.

1. Introduction
Services for all ages tend to be out of balance with the rapidly growing urban environment. One solution to ensure the sustainability of the city's environment is a child-friendly city program with the main consideration that children are part of the city's residents who are obliged to achieve good service. The child-friendly city program is a development system based on the fulfillment of children's rights through the continuous integration of government, community and business commitments in policies, programs and activities [1]-[2]-[3]. The form of the child-friendly city program is the availability of child-friendly city open spaces, especially city parks as a place to play.

The open space of the city is a place where children learn to be independent, love the natural environment and have strong social relationships [4]. The open space model of the city varies greatly and depends on the policies and social conditions of the community. City open space as a child-friendly space summarizes four main criteria, i.e.: the value of play [5], accessibility [6], integration [6]-[7] and safety [8]-[9]. A child-friendly space is composed of design elements that suit the needs of its users.
The design elements of child-friendly spaces according to [10] are based on multidisciplinary and complex considerations. Based on previous research, it is formulated that the design elements of child-friendly spaces are: location [11]-[12], safe room [13]-[14]; entrance access [15]-[16], walkway [17]-[12], marker [12]-[15], seating [16], guardrail [11], playground equipment [11]-[12], lighting facilities [17], trees and plants [18], parks and gardens [11], sand games [19] and water games [12]. The summary of elements and criteria for child-friendly spaces in urban open spaces can be summarized in Table 1.

### Table 1. Elements and criteria for child-friendly spaces in urban open spaces [10-19].

| No | Elements/criteria | Play value | Accessibility | Integration | Safety |
|----|-------------------|------------|---------------|-------------|--------|
| 1  | Location          | Children feel safe and want to play | Within walking distance | Improve local character | Visible from all directions |
| 2  | Safe space        | Improve health and well-being | Promoting independent mobility of children | Connected via access from the road | Adequate barriers and lighting |
| 3  | Entrance          | Social meeting room | Location close to transportation facilities | Clarity of arrival and departure points | Give clear directions |
| 4  | Pedestrian pathway| Various types of paths for various activities | Can be used by people with special needs | Ease of circulation | Clear markings and pathways |
| 5  | Markers           | Designed for play purposes | Correct height, color, image | Image is open to all | Benefits for information or announcements |
| 6  | Seating           | Encourage interaction among children. | Design for all | Integration of functions and interactions | Comfortable and safe |
| 7  | Guardrail         | Provides a sense of security for activities | There is an open space around the entrance | Integration between users | Evacuation and security facilities |
| 8  | Play equipment    | Physical health and social interactions | Accessible for all ages | Shared use | Child protection |
| 9  | Lighting facilities| Safe and aesthetic atmosphere. | Access to supporting facilities | The beauty of the playing environment | Safety at night |
| 10 | Trees and plants  | Motivation to explore and discover | The low tree is accessible to all | Interactive play opportunities between children | Harmless/poisonous types |
| 11 | Parks and gardens | Development of fine motor skills | Always updated and accessible to all users | Group activities and community engagement. | Altitude and density |
| 12 | Sand boxes        | Creative play media | Accessible for users with disabilities | Motivate children to play interactively. | Presence of a protective coating |
| 13 | Pools             | Multisensory character | Accessible to all | Support interactive play | Water level and quality |

As far as the creation of urban open spaces is concerned, the Malang City government carried out a child-friendly city program and managed to get awards in 2015 and 2017. This can be seen in the development and revitalization of urban open spaces in the form of thematic city parks such as: Taman ...
Cerdas Trunojoyo, Taman Singha Merjosari, Hutan Malabar City and Ijen Boulevard Park. As thematic city parks grow, a more in-depth study is needed on how the performance and importance of child-friendly spaces are based on user perceptions and development proposals by experts.

2. Materials and methods

2.1 Research objects and data
The research material consists of the object of the park itself, the number of respondents and the number of experts. The selected park object is Trunojoyo Smart Park, one of five thematic parks in Malang City. The number of respondents in this case is the number of park users using the Sample Linear Time Function formula until the minimum number is 36 people. In the Trunojoyo Smart Park case study, the number of respondents was 41 people. The research sample was taken using the probability sampling method. The IPA questionnaire design was used to analyze the level of importance and service performance according to user perceptions. The assessment of the level of importance consists of: very important (weight 5), important (weight 4), neutral (weight 3), not important (weight 2) and very unimportant (weight 1). The performance assessment starts from very satisfied (weight 5), satisfied (weight 4), neutral (weight 3), dissatisfied (weight 2) and very dissatisfied (weight 1).

The design of the AHP questionnaire is focused on child-friendly design elements in city parks whose criteria are play value, accessibility, integration and safety. Each criterion consists of thirteen elements of child-friendly design as used in the science questionnaire. In each AHP questionnaire, each element is compared with each other and arranged in pairs with a numerical value between 1 to 9 [20]. The number of experts consists of five people representing child observers, architects, landscape experts, lecturers and government officials. The main consideration for the selection of experts is domiciled in the city of Malang and involved in the development and construction of the Trunojoyo city park.

2.2 Analysis techniques
IPA analysis is used to determine user perceptions related to the level of suitability of child-friendly spaces at Trunojoyo Smart Park. Based on the perception results, it can be seen the level of performance and the level of importance of the thirteen child-friendly design elements and the direction of their development. The first step in the IPA method is to determine the level of conformity by comparing the performance score with the importance score, then calculating the average value of each perceived element. The mean level of importance (Y) and performance (X) of the elements will be the limit in the quadrilateral diagram. AHP analysis is used to determine development priorities according to experts based on the direction of development of the results of the IPA. The proposal for the development of Trunojoyo Smart Park is based on consideration of the results of the AHP analysis and the results of the IPA analysis in the performance section. The results of the IPA analysis that have been grouped by quadrant will be prioritized based on the AHP analysis. This is so that the resulting analysis is right on target in accordance with the performance of park management.

3. Results and discussion

3.1. Environmentally friendly elements in trunojoyo smart park, Malang City
The location of Trunojoyo Smart Park is located on Trunojoyo Street and is west of the Kota Baru Train Station, Malang City. The condition of city park elements based on child-friendly space elements can be seen in Figure 1 and Table 2.
Figure 1. Visual condition of Trunojoyo Smart Park, Malang City.

### Table 2. The condition of the child-friendly elements of the Trunojoyo Smart Park, Malang City.

| Element                  | Condition                                                                 |
|--------------------------|---------------------------------------------------------------------------|
| Location & size          | Bordered by a road with a north-south shape                                |
| Safe space               | Garden space covered with fence                                           |
| Entrance                 | There is only one entrance                                                |
| Pedestrian pathways      | A seven-and-a-half-centimeter-wide pedestrian path that connects all play facilities with paving and brick pavements |
| Markings                 | Most of them are in the form of prohibition signs and regulations for using parks as well as place markers |
| Seating                  | A variety of round seating, displaying wood, iron and concrete materials  |
| Railings or barriers     | The fence borders the road with a height of one meter equipped with forty centimeters of shrubs |
| Play equipment           | Various types of seesaw, swing, agility, slide with usage signs.           |
| Lighting facilities      | There are 59 lamps scattered throughout the area and various types of lamps |
| Trees and plants         | There are several large trees that give a shady impression                |
| Garden and vegetables    | There is only an ornamental plant garden                                  |
| Sand boxes               | There is a circular sand pool and is equipped with a place to clean yourself |
| Pools                    | A circular fountain with multiple sprayers of different heights and alternating spray times |
In general, the condition of the child-friendly design elements in Trunojoyo Smart Park, Malang City is complete with various conditions for each element. An aspect of the location that is too close to the road and the condition of the playing equipment is a major concern. While the elements of trees, rides and entrances still need to be improved.

3.2. The level of conformity of the child-friendly space according to Trunojoyo Smart Park users, Malang City

Based on the results of the questionnaire, it can be seen that the most visit time is in the morning on weekends at 75.61%. Meanwhile, on weekdays, the highest number of visits is in the afternoon, which is 24.39%. This can be caused by the existence of non-formal educational institutions that operate in the afternoon until the evening. In addition, there are supporting food vendors who are able to attract visitors around the Trunojoyo Smart Park area.

The child-friendly design element that has the highest importance value is the pedestrian path element and the marker element with the same score of 156. This is because the pedestrian path is designed regularly and the use of good paving variations. Likewise, the available markers are quite adequate although there are some that are less attractive, such as at the entrance. The element that has the highest performance value is the road path, with a score of 169. This is because the design of the pedestrian path provides access around and is arranged in all directions, especially towards the play area. The element of the sand game vehicle has the lowest performance value (132) due to its limited area and the non-functioning of facilities for self-cleaning. The level of suitability, performance value and importance of child-friendly design elements in Trunojoyo Smart Park can be seen in table 3.

Table 3. Weighting the performance value and importance level of Trunojoyo Smart Park, Malang City.

| Child friendly design elements | Performance (x) | Interest (Y) | Conformity level (%) | Performance (x) | Interest (Y) |
|-------------------------------|----------------|-------------|----------------------|----------------|-------------|
| Location                      | 158            | 154         | 102.93%              | 3.86           | 3.75        |
| Safe place                    | 168            | 147         | 113.92%              | 4.09           | 3.59        |
| Entrance                      | 162            | 147         | 107.84%              | 3.96           | 3.59        |
| Pedestrian pathways           | 169            | 156         | 110.37%              | 4.11           | 3.81        |
| Markers                       | 157            | 156         | 100.16%              | 3.82           | 3.81        |
| Seating                       | 167            | 154         | 108.43%              | 4.08           | 3.76        |
| Guardrails                    | 162            | 149         | 108.75%              | 3.94           | 3.62        |
| Play equipment                | 156            | 143         | 108.90%              | 3.80           | 3.49        |
| Facilities and lighting       | 149            | 144         | 103.48%              | 3.63           | 3.51        |
| Trees and plants              | 160            | 154         | 103.90%              | 3.90           | 3.76        |
| Parks and gardens             | 155            | 133         | 116.73%              | 3.79           | 3.24        |
| Sand boxes                    | 132            | 141         | 93.10%               | 3.21           | 3.45        |
| Pools                         | 141            | 141         | 99.82%               | 3.43           | 3.43        |
| Average                       | 157            | 156         | 148%                 | 3.60           | 3.82        |

The distribution of child-friendly design elements in the quadrant of the level of performance and importance of the Trunojoyo Science Park can be explained as follows: first, the "keep up the good work" quadrant. In this quadrant, the design elements have good performance qualities and are important as the basis for gardening. The design element is a garden with the highest level of suitability (116.73%), followed by pedestrian paths (110.37%), fences (108.75%), seating (108.43%), location (102.93%) and markers (100.16%). Gardens are considered appropriate, and should therefore be maintained, because flower gardens are in accordance with the area of Trunojoyo Park. The path is considered appropriate and can be maintained because the path has been arranged according to the needs in Trunojoyo Park. The use of paving is also appropriate because it can provide space for water
absorption. The fence is considered appropriate and can be maintained because it covers the entire area of Trunojoyo Park. In addition, the fence has also been covered with shrubs. The fence can increase safety because the location is around the main road and is dense with vehicles. Seating, judged appropriate because the design and function has been adequate. The location is considered appropriate and should be maintained because the location is located in the city center and is close to the train station so that it can be an attraction for people from inside and outside the city of Malang. Markers, considered appropriate and can be maintained, although the presence at the entrance is still less attractive.

Second, the "low priority" quadrant has a performance value and importance that is lower than the average value. The design elements with the lowest level of suitability are sand games (93.10%) and water rides (99.82%). The sand box area is considered too small and the facilities for cleaning the body are not well maintained. Similarly, visitors rarely use water rides.

Third, the “concentrate here” quadrant, which is considered to have poor value, but is very important so that it is prioritized in the arrangement of environmentally friendly designs. The order of the suitability values of the elements is: safe room (113.92%), playground equipment (108.90%) and entrance (107.84%). A safe space is a very important and primary element of child-friendly design for children. The location of the park in a strategic position can lead to criminal action and the use of hard materials in some play areas can cause serious injuries when children fall to play. Playground equipment plays an important role in the child-friendly element and is a priority for adding a variety of types of games and improving their condition. The entrance door, as an important design element in exiting and entering the garden area, has been placed in an area that is not crowded with vehicles but is still too small and not aesthetically appealing.

3.3. Proposed development of child friendly space according to experts

The proposed development is carried out according to the design elements contained in the quadrant that has poor value but is very important and the quadrant with low performance value and importance. Based on the selection of the elements, a strategy for developing a child-friendly garden is described based on the considerations of experts. The order of development proposals according to the experts in the AHP analysis is: development based on the child's developmental stage (0.500), game elements (0.333) and design considerations (0.167). This development proposal was chosen taking into account the relatively narrow area of the park, so that as far as possible all elements of the existing park can be a means of children's play that can increase children's imagination and creativity. The proposal for developing the value of child-friendly design in Trunojoyo Smart Park is based on the elements that have the highest priority value in the following order: safe space (0.117), playground equipment (0.083), trees (0.07), sand playground (0.067), water rides (0.055) and entrances (0.043) (table 4).

### Table 4. The condition of the child-friendly elements of the Trunojoyo Smart Park, Malang City.

| Element              | Priority Value | Development based on the child's developmental stage |
|----------------------|----------------|------------------------------------------------------|
| Safe space           | 0.117          | a. Enhancing safe and functional play spaces for all age groups.  
b. The use of bright and diverse colors that can increase children's attention.  
c. Eliminating smoking rooms and replacing them with playgrounds.  
d. Adding walking paths to play elements that can be accessed in more than one way to improve a child's motor skills |
| Play Equipment       | 0.083          | a. Addition of traditional toys  
b. The need for symbolic play  
c. Designing games that can safely improve children's sensory and motor skills |
| Trees and plants     | 0.073          | a. Arrangement of trees, plants to stimulate exploring, and discovering behavior so that children's activity and motor levels increase.  
b. Tree and plant arrangements that encourage children's playful fantasy |
and imagination.
c. The addition of fruit trees, flowers, vegetables so that children's knowledge increases.

| Sand Playground | 0.067 | a. Expansion of the sand play area to improve children's activities and motor skills.  
b. Improve the condition of the sand to become looser so that creativity increases. |
|-----------------|-------|----------------------------------------------------------------------------------------------------------------------------------|
| Water Games     | 0.055 | a. Maintenance of floor and water cleanliness so that it can support functional, constructive and symbolic game elements.  
b. Setting the water level, spray quality, and water circulation to stimulate children's multisensory character |
| Entrance        | 0.043 | a. The addition of symbolic elements so that children can quickly find out where the entrance and exit are.  
b. The need for the use of different colors that support the aesthetic value, creativity and grasping power of children. |

4. Conclusions

The conclusion of this study concerns two things, i.e.: the performance and importance value of child-friendly design elements based on visitor perceptions which is strengthened by field observations and development proposals based on the priority order of experts. Child-friendly design elements that include conditions that should be maintained in order of the performance and importance value according to suitability level are gardens with the highest level of suitability, followed by walking paths, fences, seating, location and markers. While the child-friendly design elements that are considered to have poor the performance and importance value, but are very important so that they become a priority according to the suitability value of the elements are: a safe room, play equipment and entrance doors. The child-friendly design elements in Trunojoyo Smart Park that have low performance values and importance so that the suitability level is lower than the average value are sand games and water games. The pedestrian path element has the highest performance value while the highest importance value is on the pedestrian path element and marker with the same score. While the elements of the sand game vehicle have the lowest performance value. According to experts, the highest development priority for Trunojoyo Smart Park is development based on game elements that are appropriate to the child's developmental stage. The limitation of this research is that it was only conducted in one case of the park with a limited number of respondents and experts. Further research can be carried out on other city park case studies so that more comprehensive conclusions can be obtained.

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