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The 5th International Symposium on Infrastructure Development IOP Conf. Series: Earth and Environmental Science 841 (2021) 012010 IOP Publishing
doi:10.1088/1755-1315/841/1/012010 1 Design Concept for Child Pedestrian-Friendly Prototype F P Makalew¹, S W M Supit¹, and N Senduk¹ 1 Civil Engineering Department, Manado State Polytechnic, Manado, Indonesia febrianne.makalew@sipil.polimdo.ac.id
Abstract. Pedestrians as active transportation require adequate facility including child pedestrian pathways.

Children as the pedestrian is a vulnerable user to an accident due to their active movement to play during their trip along the pedestrian pathway. Child pedestrian movement could lead to a crash with other users such as other pedestrians, cycles, motorcycles, and cars. Design concept and planning for child pedestrian pathway prototype is considering active child movement and object used in playing.

Proper design and construction are crucial for child pedestrians in the potential area with a massive number of pedestrian and street users. This research aims to establish a concept for child pedestrian-friendly prototype. Methods use is a mixed-method including literature study and field study. The result shows that the area for child pedestrian prototype is divided into two main areas namely pedestrian area and playing area.

The pedestrian area requires proper space for the child pedestrian flow movement. Playing an area requires space for a child to play for a limited time during walking time. Further research is a must to include child pedestrian main areas in the pedestrian standard. 1.

Introduction Children's pedestrian pathway standards and regulations have not been formed yet. Children pedestrian is a potential user in areas such as school and housing area, therefore, need to be considered in designing a pedestrian pathway. Recent research shows that children's activity as a pedestrian requires more space in terms of size and facility.

A child as a pedestrian shows his or her uniqueness due to behaviour and movement patterns. The facility available in the pedestrian area has not fulfilled yet this activity. The pedestrian facility needs to be child friendly including easy access, adequate space for walking and playing, attractive, comfortable, and safe.

Design and material use should have a safe surface to protect children in their activity. Moreover, the design should be effective and efficient with consideration of the environment surrounding the area. Therefore, the concept design should include the aspect of pedestrian child-friendly and flexible systems in installing.

The guideline for the pedestrian circulation system needs to fulfil principles and criteria such as connection, easy use, safety, comfort, and clearness [1]. The standard for pedestrian space requirement needs to consider prediction for minimal dimension space, network in the neighbourhood centre, local character, pedestrian safety from traffic and comfort area based on local climate [1].

Regulation regarding pedestrian pathways such as for housing area including comfortable and accessibility distance [1]. The criteria for a comfortable pedestrian pathway such are easy access, easy communication, and easy activity. Whilst criteria for accessibility distance consider location in which can be access based on walking ability to the public facility and neighbourhood utility available [1]. The pedestrian pathways can be part of a street such as in street design standards for housing areas.

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doi:10.1088/1755-1315/841/1/012010 2 The street needs a facility for the activity such as street facility, supported facility, and availability of public transport [1]. The pedestrian pathway is part of the supported facility.

Criteria for design pedestrian pathways including placing pathways adjacent to a street with finishing material other than street material such as paving block for the local street. For pedestrian safety element require such as placing bollard along the pathway, material surface anti-slippery, and adequate size based on street hierarchy.

Other planning standards for pedestrian pathway including width for pedestrian pathway and land division for the public facility [2]. moreover, standards related to the pedestrian pathway such as width, access, and pathway facility [1, 3, 4, 5]. The aspect of the human need to be considered as a user in planning land division and access [6].

Children trip as a pedestrian is influenced by environment and social factor [7]. Pedestrian behaviour influences route choice and space use in risk-taking by a child in a hurry [8]. Pedestrian behaviour is influenced by a pedestrian facility [9].

Previous research related to space needs and movement patterns of the elementary student shows the difference between urban and rural areas [10, 11]. The area with potential children pedestrian can be found in the school area where the school entrance area needs the facility for pedestrian activity area as well as pedestrian pathway area [11]. Children pedestrian pathway needs to consider child movement pattern such as in the school area and housing area [11, 12, 13, 14].

The settlement area with natural disaster potential also needs a facility for safety and a comfortable pedestrian evacuation route [15, 16]. Pedestrian walking speed influence the need for children pedestrian facility [17]. There is a need for adequate pedestrian pathways and activity for children as a pedestrian which is design for playing pocket in the pedestrian pathway area as can be seen on Picture 1. Concept design for children pathway prototype has not established yet.

the prototype needs to consider the child acts as a pedestrian including walking and playing. walking movement pattern dominate by straight pattern yet need to include major use areas such as in zig-zag movement pattern [11]. Figure 1. Activity and facility at Children pedestrian pathway with playing pocket area [11] 2.

Research Method Research for design concept on the prototype of child pedestrian is a mixed-method approach. Literature study from previous research is used along with the field study area. The area for this field study is a pedestrian pathway on school, housing, settlement and shopping areas in North Sulawesi, Indonesia.

Location on the previous study is included in this research to strengthen the concept of the pedestrian prototype. Steps in establishing the concept design are including a sample of pedestrian pathway type in the field study area, characteristic of pedestrian-friendly based on standard and previous research, evaluation on potential pedestrian child-friendly pathway and concept of a pedestrian prototype. 3.

Result and Discussion The type of pedestrian pathway in an urban and rural area is

varied with a major system namely pedestrian with under pathway drainage system, pedestrian with an adjacent drainage system, and The 5th International Symposium on Infrastructure Development IOP Conf. Series: Earth and Environmental Science 841 (2021) 012010 IOP Publishing doi:10.1088/1755-1315/841/1/012010 3 pedestrian without a drainage system.

The drainage system is part of the street. From different places, 21 pedestrian pathways have been chosen for the evaluation of pathway design. The area of the pathway is a major area use by children for access to their destination trips such as school, house, and public area. Based on the three major types the characteristic of the pathway is based on the available drainage system, material use, plant available, location, and other elements provided. The most pathway is not well maintained. Material use is mostly rough material which is safe for pedestrians to avoid the slippery effect.

Children use the area for walking as well as playing along their walking journey. The material used for pathway surfaces is including ceramics, pebble with concrete, and concrete. Detail of pedestrian types can be seen in Figure 2, Figure 3 and Figure 4. (a) (b) (c) (d) Figure 2.

Pedestrian pathway with drainage below (a) Urban School area (b) Urban Shopping Area (c) Rural school area (d) Urban public area (a) (b) Figure 3. Pedestrian pathway without drainage (a) Rural School park area (b) Urban housing Area The 5th International Symposium on Infrastructure Development IOP Conf. Series: Earth and Environmental Science 841 (2021) 012010 IOP Publishing doi:10.1088/1755-1315/841/1/012010 4 (a) (b) (c) (d) Figure 4.

Pedestrian pathway with adjacent drainage (a) Rural School area (b) Urban school Area (c) Rural school area (d) Rural urban public area The characteristic of the pedestrian pathway with the concept of child friendly has not been established yet. Hence, the pedestrian pathway has been studied and standardization as guidance to pedestrian pathway design and construction.

From many different perspectives, a pedestrian pathway with the concept of child friendly can be designed with several characteristics such as accessibility, comfortable, and others as can be seen in Table 1. Table 1. Characteristics of child-friendly pedestrian pathways. No Characteristic Source 1 Accessibility [1, 18,19,20,1] 2 Vista [18] 3 Comfortable [18, 19] 4 Street signage [19] 5 Utility zone [21] 6 Street furniture [18, 21] 7 Distance [17, 20, 22, 27] 8 Catchment area [20] 9 Walking time [22] 10 Pathway [1] 11 Street-level design [23] 12 Walking speed [17, 22, 24, 25] 13 The age group of the pedestrians [26] 14 Crossing [1, 24, 25, 26] 15 Width based on the number of

pedestrians [1, 11 16 Movement pattern [11] The 5th International Symposium on Infrastructure Development IOP Conf. Series: Earth and Environmental Science 841 (2021) 012010 IOP Publishing doi:10.1088/1755-1315/841/1/012010 5 Based on the type of existing pedestrian pathway use by children and the characteristic of the pathway, the child-friendly pedestrian pathway is evaluated.

Factors for a child-friendly pedestrian pathway is including evaluation of movement pattern, activity, material use, object available, and colour use. The type of pedestrian is considered based on area use. Most places are lack area for children to do their activity including playing, lack of movement pattern, and unattractive use of object and colour.

The colour for the pathway surface is limited to material use including the colour of concrete, ceramic, and pebble. The evaluation of the child friendly pedestrian pathway can be seen in Table 2. Table 2. Evaluation of child-friendly pedestrian pathways. No Type of pedestrian pathway Evaluation Movement Activity Material Object available Colour 1 Urban school area No pattern available No playing area Ceramics and pebble.

Do not absorb rainwater From nature Orange, white and black 2 The urban school settlement area No pattern available No playing area Ceramics and pebble Limited From nature Orange, white and black 3 Urban housing area No pattern available No playing area Paving block From nature Grey and Orange 4 Urban public area No pattern available No playing area Ceramics Paving block Limited From nature Orange, white and black 5 Rural school area No pattern available No playing area Concrete Paving From nature Grey Orange, white and black 6 Rural school public area No pattern available No playing area Concrete Soil and grass From nature Grey 7 The rural school settlement area No pattern available No playing area Concrete Soil and grass From nature Grey The existing type of pedestrian pathway used by children and the characteristics of a child-friendly pathway leads to the potential child-friendly concept. The type of pathway is a pathway with drainage and without drainage.

The type of pedestrian pathway available is the potential to be improved to a child-friendly pedestrian. The improvement is including material use on pathway surfaces with better quality in terms of safety, comfortable and attractive material. Moreover, the activity of children is considered as the design factor of a child-friendly pathway by providing an area for walking and playing.

Also, the pattern uses for the pedestrian area is based on child movement. Object use by children is natural and manmade is considered to be provided in the playing area. Detail of potential design can be seen in Table 3. Concept design for children pedestrians is based on the characteristic of the child-friendly environment and flexible

construction system.

Factors influence design for pedestrian child friendly is children's activity, dimension, and design pattern. Activity in children's pedestrian areas should be child friendly which is a design based on children's preference during their walking journey. Activity is including walking and playing. The walking area requires an adequate area for walking with a unique pattern including a zig-zag pattern.

Playing areas require major activity by children such as playing with objects and running. Children experience with [The 5th International Symposium on Infrastructure Development IOP Conf. Series: Earth and Environmental Science 841 \(2021\) 012010 IOP Publishing doi:10.1088/1755-1315/841/1/012010](https://doi.org/10.1088/1755-1315/841/1/012010) 6 nature and built environment by using objects available such as leaves, branches for nature, and water bottle for manmade.

Dimension requires children's pedestrian pathways is established based on the previous study. Specific dimension for children pedestrian has not included in pedestrian standard design. The size for the pedestrian pathway according to standard available consider adult and child as the user.

The previous study for the child pedestrian pathway dimension is 1.6 meters wide. this width is used as a dimension for a child-friendly pedestrian prototype. The size is a measure based on child activity therefore the child is the main user. For playing area, playing pocket is attached to the pedestrian pathway. dimension for this area is between 12 m² to 14 m². In the urban area, the size of 12m² is adequate for a child acting as a pedestrian. Table 3.

Design for the child-friendly pedestrian pathway. No Type of pathway Potential child-friendly pedestrian 1 Drainage under pathway Improve surface material Foundation with reinforced concrete Object provided Improve colour scheme Available pattern based on the movement Available playing area 2 Drainage adjacent to the pathway Improve surface material Reinforced concrete construct above drainage system Object provided Improve colour scheme Available pattern based on the movement Available playing area 3 No drainage Improve surface material with paving block Foundation strong base Object provided Improve colour scheme Available pattern based on the movement Available playing area Table 4.

Design for the child-friendly pedestrian pathway. No Variable Pattern 1 Activity Playing area Colour: attractive Manmade object: bottle, Nature object: leaf, branch Walking area: movement pattern Play Walk 2 Dimension 2.4m 1.6m 3 Design pattern 4 Supported

factors Construction system: Flexible Prefabricated, Building block The 5th International Symposium on Infrastructure Development IOP Conf. Series: Earth and Environmental Science 841 (2021) 012010 IOP Publishing doi:10.1088/1755-1315/841/1/012010 7 The design pattern is based on child activity.

As pedestrian movement pattern is important to be considered in create pedestrian flow area. based on previous study movement patterns including straight pattern and zig-zag pattern. The straight pattern is dominant whilst zig-zag patterns can be found in a certain area. these two patterns are included in the prototype.

The straight pattern is the main pattern for pedestrian flow due to the nature of walking direction. The zigzag pattern is appearing during walking time as part of playing and access choose by a child to reach a particular temporary destination. The temporary destination is including street vendor cart, friend house, public facility, and area with the available object for playing.

The variable for the design of a child pedestrian-friendly pathway can be seen in Table 4. 4. Conclusion and Suggestion The child-friendly pedestrian pathway prototype requires an adequate facility for child movement including walking and playing. Type of pedestrian pathway is a pathway with underground drainage, pathway with adjacent drainage and pathway without drainage in an urban and rural area.

Characteristic of the friendly pedestrian pathway such as accessibility, comfortable, pathway width and movement pattern. The design concept for the prototype of the child-friendly pedestrian pathway is based on child activity, dimension, pattern and supported facility. The concept of child pedestrian-friendly needs to be considered in establishing guidelines for design and construction pathways.

Further research on design and prototype is crucial in providing a safe place for child pedestrians. Moreover, research on the implementation of the design concept of the child-friendly pedestrian pathway in the urban and rural area including material use and construction method.

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