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Influence of children pedestrian behaviour on pedestrian space usage

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Abstract. School children pedestrian behaviour can be seen along their journey to and from school. Pedestrian spaces used by children are places available in urban and rural areas including streets with and without pedestrian pathways. Samples data are collected from 23 elementary schools in urban and rural areas in North Sulawesi, Indonesia in the form of video records and photos taken. The aim of this research is to analyse children pedestrian behaviour and its influence on the space usage on pedestrian areas. Method of analysis is a comparative study on urban and rural areas. Results of this research are types of behaviour, factors that influence the behaviour, physical condition of pedestrian areas and space usage by children. The behaviours are duck-line walking, running, playing, walking backward and walking with bare foot in which running is the main behaviour. These behaviours are influenced by factors including following friends and responding to acts. There are similarities and differences between pedestrian space usage in urban and rural areas. Space use by children pedestrian demonstrates the way pedestrian areas should be planned. Space usage by children pedestrian indicates that there is a need of evaluation of the space available considering pedestrian children behaviour.

1. Introduction

Pedestrians require access to their destination. Children pedestrians use pathways available when walking to and from school. Easy access is important in helping children to arrive at their destination safely and comfortably. An adequate pedestrian pathway is important including its supporting facilities. Previous studies show that existing pedestrian pathways in city of Manado, Indonesia are not well maintained and most streets lack adequate facilities for pedestrian [1, 2]. On the other hand, children use pedestrian spaces as places for more than just walking areas. Their behaviour can be seen along their walking journey to and from school. They use any available access on the street with or without pedestrian pathways. Space usage is important in planning urban and rural public spaces and access to places. This condition raises question on the influence of children behaviour on the pedestrian space usage. This research focuses on children pedestrian behaviour in school areas and their surroundings. The types of children pedestrian behaviour and material use on pedestrian pathways are revealed in this research. Moreover, factors that influence their behaviour and the pattern of space usage are analysed using comparative analysis. Pedestrian areas in elementary schools in



urban and rural areas are chosen based on preliminary study on potential children pedestrian available and fair distribution of data in study area.

The location for this research includes 23 elementary schools in North Sulawesi province in Indonesia. Samples distribution can be seen on figure 1 and 2.

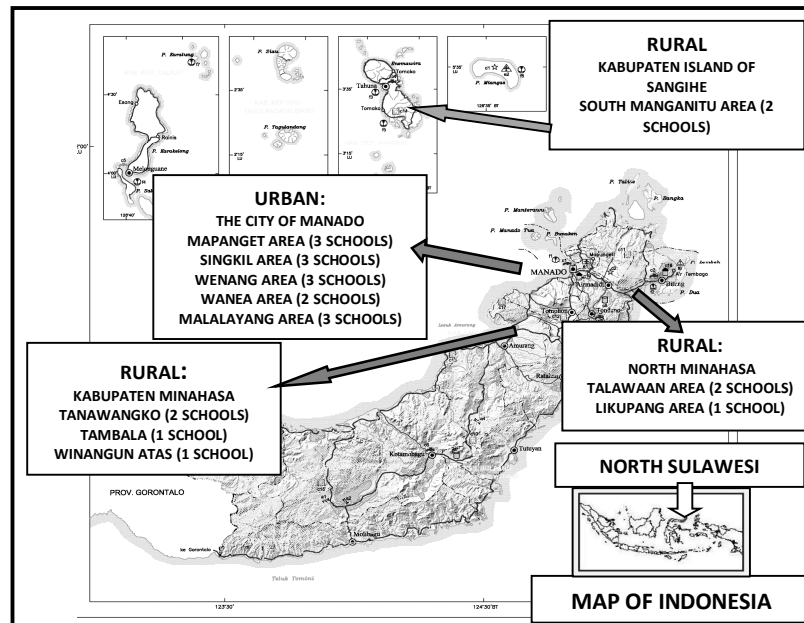


Figure 1. Map of sample distribution in North Sulawesi.

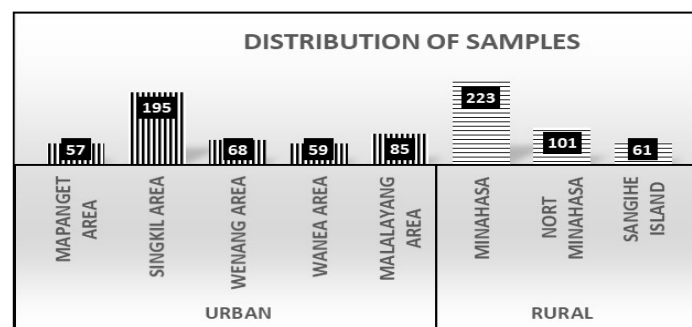


Figure 2. Distribution of samples.

2. Children pedestrian behavior

Previously researches on pedestrian behaviour are including adult pedestrian and children pedestrian behaviour. Study on the influence of pedestrian behaviour to space usage in recently is related to adult pedestrian. Pedestrian behaviour is any act and decision by pedestrian when walking through pedestrian areas. Space usage is the area used by children and the way they use. Research on model of pedestrian behaviour can be seen in model of children behaviour in urban settlements [3], special character of modifying micro model of social force, evaluation of pedestrian behaviour model based on human factor considering relation between pedestrian and the environment [4]. Evaluation on pedestrian behaviour in rural and urban areas is the evaluation on environment and its close relation with area capacity as pedestrian pathway [5]. Moreover, pedestrian behaviour is an important factor in measuring the level of walking in the environment in urban and rural areas [5]. Behaviour based on factors influence walking areas including location and access [6].

Pedestrian behaviour in different pedestrian areas such as in affordable housing and medium housing has been compared by Azmi et al. [6] in terms of the use of facilities by the community. Research shows that facility is used more often in pedestrian areas in affordable housing than those in medium housing. Recommendation for this study is to create flexible access, maximise community facilities and access standard. Public facilities can be accessed by walking are schools, playgrounds and local shops [6]. School is considered as the characteristic of environment in micro system that should be varied [7].

Children behaviour can be seen in the way they use natural elements [7, 8]. Research on children sense of place in New Mexico involving 8 to 9 years old children in three communities show gradient between city and village [8]. For children in cities and villages, exploration has similar functions. In rural areas, children with more responsibility in collecting wood for fire reveal their trip to the mountain and find special places. Children in the urban areas find their special places near their house. Children who explore, expose their freedom, control and personal needs. Playing is one of the children's behaviours which has benefit [9] and function approach [10]. Children's behaviour can be seen in their activities in rural areas [11, 12], cities and suburbs [11]. Children interaction with the environment includes playing to prepare children to be adult and apply their roles [13]. Behaviour as one of children pedestrian characteristics in urban and rural areas in relation to the environment shows differences and similarities [8, 11].

Crossing area is one of children pedestrian areas where we can see their behaviour [14, 15]. The examples of this behaviour are children taking risk [16] and safe time selected when crossing [17]. Study on children taking risk in the neighbourhood crossing area used simulator test where the sample is 10-year-old children [16]. Other study found that children aged 5 to 9 years old are the riskiest as pedestrians in crossing [17]. In the pedestrian space usage, Monteiro et al (2012) study the factors to understand and measure pedestrian space. In this study, indicators in measuring pedestrian space usage include facilities and accessibility [18].

3. Research method

Source of data is from survey on 23 elementary schools in urban and rural areas in North Sulawesi province, Indonesia. Videos and photos recorded from 14 schools in urban areas and 9 schools in rural areas. Sample data is elementary students from grade 1 to 6 aged between 6 to 12 years. Preliminary research has been done to find potential pedestrian available in schools selected. Areas of research is walking area at school and its surrounding area. Walking distance is between the boundary of school and its adjunct street to maximum 1000m from school area. Average walking distance for this research is 500m. Urban area is the capital city of North Sulawesi province, the city of Manado. Five areas in Manado have been the research location namely Mapanget, Singkil, Wenang, Wanea and Malalayang with fair distribution of school's location. Rural area is chosen based on government regulation for rural areas in North Sulawesi. Rural area is defined as area of villages or *perdesaan* under the area of Regency (Kabupaten). Locations for Kabupaten are chosen after preliminary research for potential children pedestrian available in the area. From many rural areas, three Regencies have been chosen namely Minahasa Regency, North Minahasa Regency and Island of Sangihe Regency. Number of sample is counted based on Krejcie Norman formula. Based on this formula and its table the number of sample for 183,167 students in rural area and 98,686 students in urban area [19], there is a need of minimum 383 sample data for each area. Based on survey data available are 464 students in urban areas and 385 students in rural areas. Method of analysis used is a comparative analysis of pedestrian behavior in urban and rural areas.

4. Result and discussion

Results of this research are similarities and differences between children pedestrian behaviours in urban and rural areas. The comparison of these areas is analysed in terms of number of children pedestrian groups, types of children pedestrian behaviours, factors that influence children behaviour, types of pedestrian surface material and pattern of pedestrian usage areas. From sample data in urban

areas there are 194 students or 41.81% from the total sample and from sample data in rural areas there are 207 students or 53.77% from the total sample.

The lowest number of children walking is 1 child and the highest is group of 7 children. Figure 3 shows the difference between number of children pedestrian behaviour in urban and rural areas. Children pedestrian behaviours in both areas are duck-line walking, running, playing and backward walking. Duck-line walking is an act where a child walks followed by one or more children and shapes a line. This name of behaviour is taken from the way how group of duck walk.

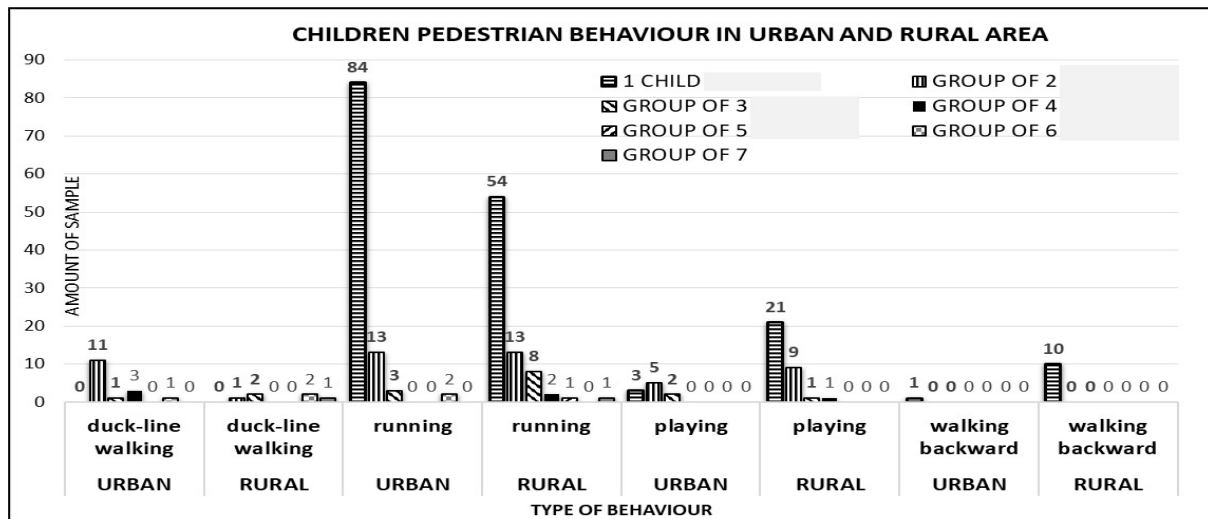


Figure 3. Children pedestrian behaviours in urban and rural areas.

Factors that influence children pedestrian behaviours include responding to do the behaviour by himself or herself, following friends’ behaviours, avoiding vehicle traffic and crossing streets. The main children pedestrian behaviour in urban and rural areas is running which can be seen in figure 4. Responding to running is an act to run by a child without being influenced by other children. This act is the main reason for children to run in both areas.

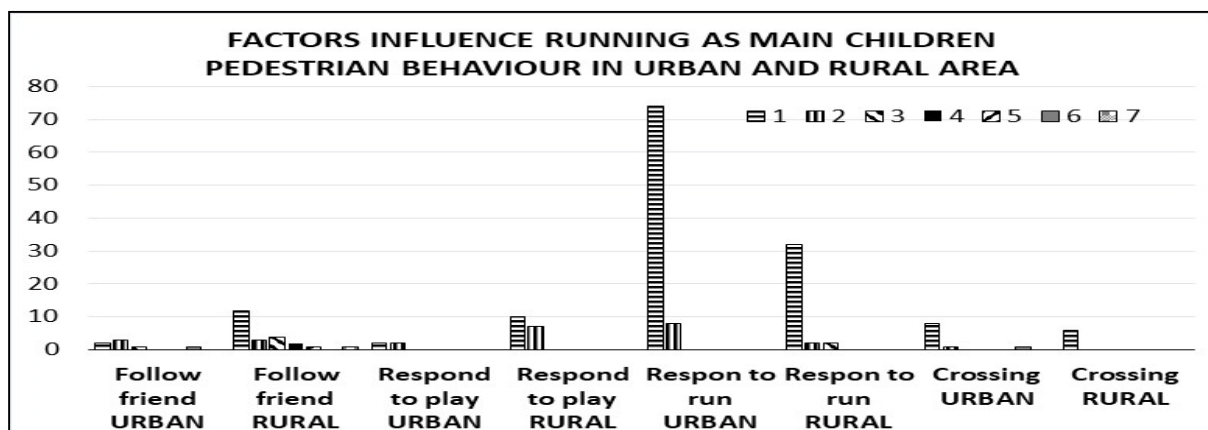


Figure 4. Running as main children pedestrian behaviour in urban and rural areas.

The physical condition of pedestrian area includes material type of pathway surface such as asphalt, concrete, grass and soil. The number of children pedestrian using pathway based on type of material on surface can be seen from figure 5.

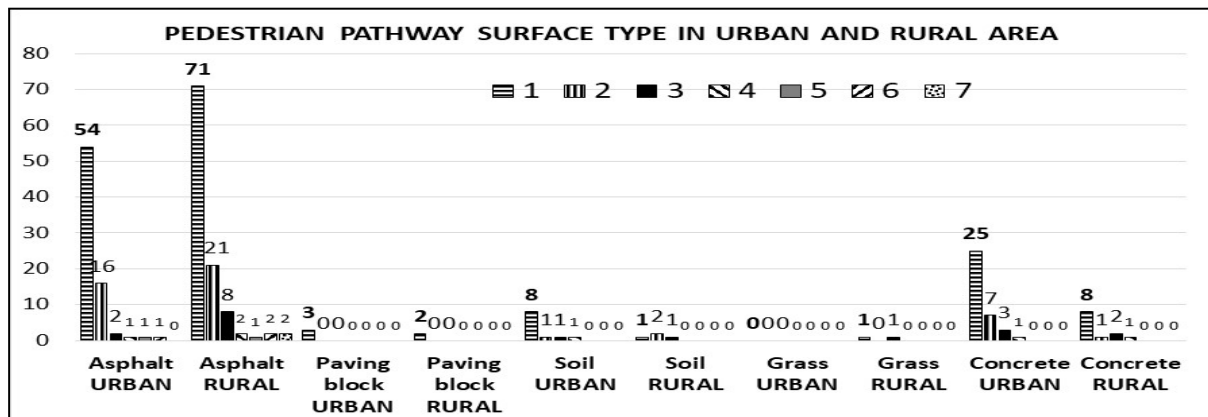


Figure 5. Pedestrian pathway surface type in urban and rural area.

Based on data provided, there are similarities and differences between children pedestrian behaviours in urban and rural areas. The comparison is based on the types of behaviour, pathway surface type and obstacle along the journey as shown in table 1.

Table 1. Similarities and differences of children pedestrian behaviour in urban and rural area.

NO	ITEM	SIMILARITIES	DIFFERENCES	
			URBAN	RURAL
1	PATHWAY SURFACE TYPE			
a	Asphalt	V		
b	Paving block	V		
c	Soil	V		
d	Grass		X	V
e	Concrete	V		
2	OBSTACLE ON PATHWAY			
a	Puddle		V	X
b	Tree roots		X	V
c	Broken concrete		X	V
d	Open Concrete drains	V		

Notes: V = Available. X = Not Available

The similarity of behaviour type in urban and rural areas is in both areas all behaviour types are available although the number of children is different. In terms of pathway surface material type and the similarity of both areas are most types available. The difference is that grass is not available in urban areas. Material asphalt is the highest due to the use of street as pedestrian access. Children pedestrians use streets as pedestrian pathways because the pathways for pedestrians are unavailable or inaccessible. Inaccessibility can be caused by the pedestrian pathway that is used for planting trees, tree pots and other materials. The similarity of the obstacle in pedestrian pathways is that both areas have open concrete drain.

Factors that influence children pedestrian behaviour are varied based on different behaviours which can be seen from table 2. Children behaviour of running is influenced by responding to running. Responding to running is an act by children themselves to run. The cause of children to run is a response to reach the school faster in the morning due to time limitation, a response to reach places such as shops and homes faster in the afternoon and no other friends who influence them to run.

Responding to running is not necessarily one child's act but also two or more children without intending to follow friends. Following friends is an act to do the same activity such as duck-line walking, running, playing and walking backward.

Local behaviour is the behaviour which occurs considering its uniqueness and limitation in a certain place yet have a great influence on the children pedestrian space use. Local behaviour found in this research area is the use of object to play during their walking to and from school and the use of any available facilities along the street. Objects use can be divided into manmade objects and objects from natural environments. Manmade includes objects, toys, and instruments such as flutes and used objects such as bike wheels and mineral water bottles. Natural objects include parts of tree such as leaves, branches and roots and other objects such as stones. Facilities provided along the street are used by children to play such as bridge and water tap in rural areas. The example of local behaviour is a child in a school in a rural area in Winangun Atas running home from school while playing bike wheel and roll it with stick. This is a response to play during his journey home. He uses the local street available as there is no pedestrian pathway. Other example is the use of tree leaf as an umbrella to cover his head during walking. More varieties of local behaviour during walking can be found in rural areas. Children in these areas tend to play more during their journey with larger number of students comparing with those in urban areas.

Table 2. Similarities and differences of factors children pedestrian behaviour in urban and rural area.

NO	ITEM	FACTORS	DIFFERENCES	
			URBAN	RURAL
1	Duck-line walking	Following friend	V	
		Avoiding vehicle		X V
2	Running	Following friend	V	
		Responding to play	V	
		Responding to run	V	
		Crossing	V	
3	Playing	Responding to play	V	
		Following friend		X V
4	Walking backward	Responding to play	V	
		Following friend		X V
5	Walking Barefoot	Responding to play	V	

Notes: V = Available. X = Not Available

Space use based on children pedestrian behaviour shows similarities and differences in urban and rural areas as can be seen on figure 6 and 7. Space usage in this research is a micro area of pedestrian pathway. The areas include pathways, road side and streets. The similarities of space usage in urban and rural areas are the behaviour of duck-line walking, running and playing on streets without pathway and playing on local streets. The areas used are roadsides of local and secondary streets for duck-line walking, the area of local and secondary streets for running and playing and the area of street for local street without roadside.

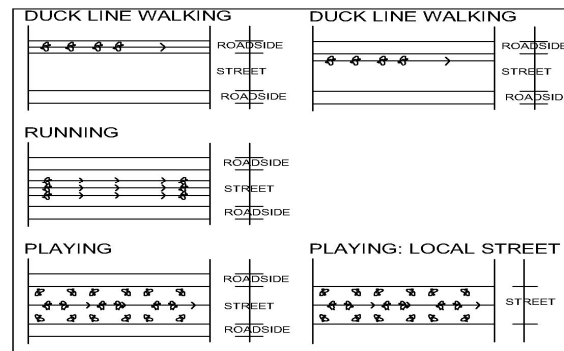


Figure 6. Similarities of space usage based on children behaviour in urban and rural area.

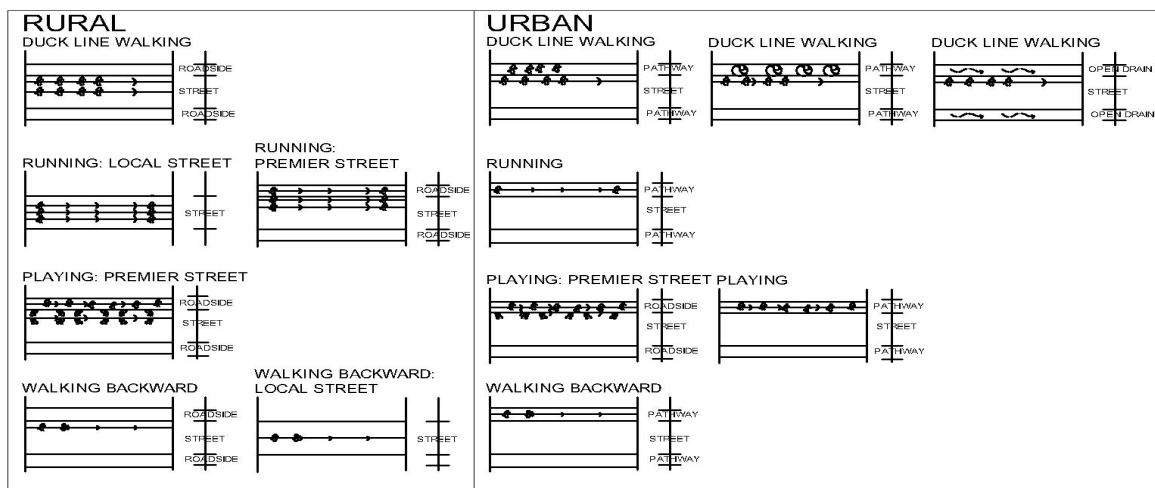


Figure 7. Differences of space usage based on children behaviour in urban and rural areas.

The differences of space usage in duck-line walking are in rural areas children pedestrian walk in two lines while for those in urban areas this act is not available. In urban areas, children walk duck-line at the edge street with pathways. They do not use the pathway because the area is occupied by large trees. Children also use the edge of street with pathway due to limited space of pathway for sharing with another pedestrian. Moreover, the edge of street is used by children for streets with open drain.

In the behaviour of running, the differences of space usage between urban and rural areas are that in rural areas children use streets in local streets without roadsides and the roadsides and half of the street for premier streets while in urban area children use pathways for premier streets.

The differences of space usage in playing are that in rural area children use roadside areas and up to half of the street in premier streets while in urban area children use roadside areas and the edge of the street for premier streets and use pathway for streets with pathways.

The differences of space usage in walking backward are that children use the edge of the street for streets with roadsides and the middle of street for local streets without roadsides or pathways while in urban areas children use pathways for streets with pathways.

From the evaluation of similarities and differences of space usage by children pedestrians, different types of behaviour influence the area used by children on different types of streets. On behaviour of running and playing, the use of space is larger due to the use of any available space on streets. On this type of street, there is no pathway therefore children use street as their space for running and playing. Children pedestrian behaviour must be considered in planning streets and pedestrian areas. Spaces

used by children are influenced by type of behaviour, number of group pedestrians, the way children face the obstacles on pedestrian areas and surface material. From all obstacles faced by pedestrian children, the similarity is children use open drain as area of walking by stepping on the edge of it as part of playing. In the areas where there is no pathway for pedestrians, children use streets as wide as possible in all types of streets from local to premier.

5. Conclusion

Children pedestrian behaviours in urban and rural areas in North Sulawesi Indonesia show differences and similarities and their influence on the space usage. All types of behaviours are walking duck-line, running, playing and walking backward can be seen in both areas. Spaces in pedestrian pathways are not just for children to walk but also for their activities. The activities are more varied for those in rural areas. Based on the children pedestrian behaviour and how they use the spaces available, there is a need for planning a good pedestrian space and its facility to accommodate children pedestrian behaviour in urban and rural areas. Pedestrian pathways should be planned to accommodate children activities. Planning for pedestrian area in urban and rural area should consider the differences between urban and rural areas. From the children behaviour differences and similarities, areas required for children pedestrians in urban and rural areas, there is a need further investigation considering space usage with different numbers of children in a group.

6. References

- [1] Makalew F P 2014 Toward great streets using urban design approach, the case study of Manado *The Int. Conf. on Environmentally Friendly Civil Engineering Construction and Materials (Manado, Indonesia)* (Indonesia: Civil Engineering Department Sam Ratulangi University) pp 385 - 394
- [2] Makalew F P 2014 Identifikasi fasilitas jalan perkotaan: tantangan jalan kaki sebagai transportasi ramah lingkungan, studi kasus kota Manado Urban street facility identification: a challenge for walking as environment friendly, case study of Manado *Pros. Hasil Penelitian Terapan (Manado State Polytechnic)* vol 2 (Indonesia: Unit Penelitian Politeknik Negeri Manado)
- [3] Rezasoltani M, Mostafa B and Said I 2015 A model development for children's walking in neighborhood *Procedia - Social and Behavioral Sciences* vol 201 (United Kingdom: Elsevier) pp 30 – 38
- [4] Papadimitriou E, George Y and John G 2009 A critical assessment of pedestrian behaviour models *Transp. Res. F-Traf.* **12** 242–255
- [5] Azmi D I, Karim H A and Amin M Z M 2012 Comparing the walking behaviour between urban and rural residents *Procedia - Social and Behavioral Sciences* vol 68 (United Kingdom: Elsevier) pp 406 – 416
- [6] Azmi D I and Karim H A 2012 A comparative study of walking behaviour to community facilities in low-cost and medium cost housing *Procedia - Social and Behavioural Sciences* vol 35 (United Kingdom: Elsevier) pp 619 – 628
- [7] Kytta M 2006 Environmental child-friendliness in the light of the bullerby model *Children and Their Environments, Learning, Using and Designing Spaces* ed C Spencer and M Blades (Cambridge: Cambridge University Press) chapter 9 pp 141 - 158
- [8] Derr T 2006 Sometimes birds sound like fish': perspectives on children experiences *Children and Their Environments, Learning, Using and Designing Spaces* ed C Spencer and M Blades (Cambridge: Cambridge University Press) chapter 7 pp 108 - 123
- [9] Lester S and Maudsley M 2007 The values and benefits of children's play in natural settings *Play, Naturally, A Review of Children's Natural Play* (England: National Children's Bureau Enterprises Ltd) chapter 3 pp 23 - 47
- [10] Heft H 1988 Affordances of children's environments: a functional approach to environmental description *Children's Environments Quarterly*, **5** 29-37

- [11] Kytta M 2002 Affordances of children's environments in the context of cities, small towns, suburbs and rural villages in Finland and Belarus *J. Environ. Psychol.* **22** 109 - 123
- [12] Yatiman N A, Aziz N F and Said I 2012 Affordances of homeschool journey in rural environment for children's performances *Procedia-Social and Behavioral Sciences* vol 68 (United Kingdom: Elsevier) pp 395 - 405
- [13] Mrnjaus K 2014 The child's right to play?!, *Croat. J. Educ.* **16** 217-233
- [14] Geßler A L, Peter H, Sara K, Rene K, Xue H L, Qi H S, Johanna B, Zhi J and Guan Z Y 2013 Crowd research at school: crossing flows, *Traffic and Granular Flow* **13** 137-144
- [15] Kadali B R and Vedagiri P 2013 Modelling pedestrian road crossing behaviour under mixed traffic condition, *European Transport Trasporti Europei* **55** 1 - 17
- [16] Charron C, Aurélie F and Nicolas G 2015 Do child pedestrians deliberately take risks when they are in a hurry? An experimental study on a simulator, *Transp. Res. F-Traf.* **15** 635–643
- [17] Meir A, Parmet Y and Oron-Gilad T 2013 Towards understanding child-pedestrians' hazard perception abilities in a mixed reality dynamic environment, *Transp. Res. F-Traf.* **20** 90–107
- [18] Monteiro F B and Campo V B G 2012 A proposal of indicators for evaluation of the urban space for pedestrians and cyclists in access to mass transit station *Procedia - Social and Behavioral Sciences* vol 54 (United Kingdom: Elsevier) pp 637 – 645
- [19] Biro Pusat Statistik (BPS) Statistic of North Sulawesi Province 2016 Social *North Sulawesi in figures* (Indonesia: BPS-Statistics of North Sulawesi Province) chapter 4 pp 81 - 142