WALKWAYS ON MALIOBORO STREET

P. Eliza Purnamasari[1], Aldorio Prastyawan Satriajaya [2], Teofilo Jose Nuratri Soares [3]

[1]*Lecturer of International Civil Engineering, Atma Jaya Yogyakarta University, Jl. Babarsari 44 YogyakartaEmail: Email : elizapoei@yahoo.com*

[2]*Student of International Civil Engineering, Atma Jaya Yogyakarta University, Jl. Babarsari 44 YogyakartaEmail: Email : aldorioprastyawan@gmail.com*

[2]*Student of International Civil Engineering, Atma Jaya Yogyakarta University, Jl. Babarsari 44 YogyakartaEmail: Email : kong_d3m0n@yahoo.co.id*

ABSTRACT

Yogyakarta is one of the favorite tourism city in Indonesia. This city has a lot of tourism objects from Temple until shopping complex. One of the favorite tourism objects is Malioboro Street; it is a Central Business District which is the destination for local and international tourist. Along Malioboro Street there are two walkways, one in the west, and the other in the east side. The walkway beside used for pedestrian also used for parking and other purposes, so it's seems so crowded and not so convenience for pedestrian. The purposes of this research are: 1) People opinions about walkway facilities in Malioboro street, 2) How about level of service of the walkway and Speed-Density-Flow model. To fulfill the objective of the study, qualitative and quantitave approaches are used. Qualitative approach is used to deal with descriptive analysis of data. Quantitative approach is used to deal with numerical analysis such as pedestrian walking speed, and characteristic of pedestrian. From this study, its can be concluded that : 1) "Good lighting" is the first priority in **Safety factors** for people who walks in Malioboro street, while " Walkway is covered by canopy" is the first priority for **Comfort attributes, and Convenience attributes have first priority in "**benchs/ rest facilities"; 2) Level-of -Service of the East side walkway is in the level B or C, while West side is in the level A or B, The Speed-Density-flow relationship models are as followed : ($V = 39,7 - 8,2\ d$); ($F = (39,7V-V^2) / 8,2$); ($F = 39,7\ d – 8,2\ d^2$) and ($V = 39,7 – 8,2/S$)

Keyword: Pedestrian, Walkway, Convinience, Level of Service

1. INTRODUCTION

Yogyakarta Special region, with the area of 3,185 square kilometer is the smallest province in Indonesia where Yogyakarta city (capital ofbYogyakarta municipality) and other four districts, namely Sleman, Bantul, Kulon Progo and Gunungkidul are stretched. Yogyakarta city is the second tourist destination after Bali due to the attractiveness of Sultanate Palace and close to the location of famous temples, such as Borobudur and Prambanan temples. One of the favorite tourism objects is Malioboro Street (figure 1).

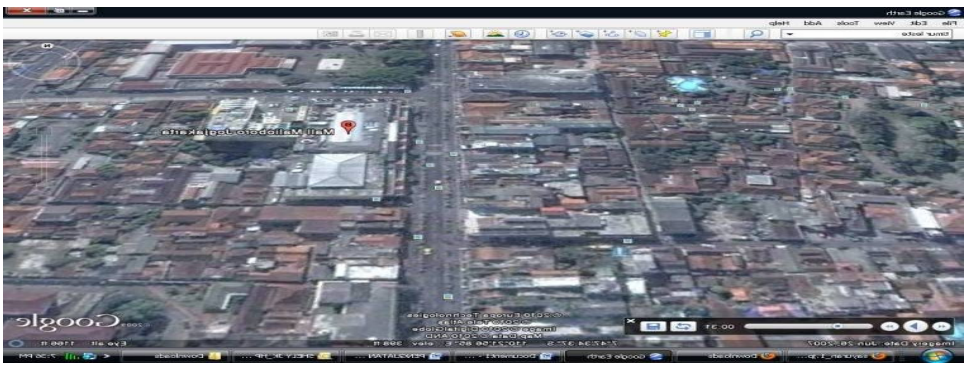

Figure 1

Malioboro street, as a part of street connecting Tugu in the North and Sultanate Palace in the Sourth was constructed in eighteenth century by Sultan Hamengku Buwono I, who was also famous as king Mangkubumi I. Due to the starting point of view that Malioboro street is a palace ceremonial grounded facility, it has a special cultural value for the city. But following with development of the city, Malioboro not only as the representative of cultural and government activities but also as a Central Business District (CBD) which is the destination for local and international tourist of Yogyakarta. Along Malioboro Street there are two walkways, one in the west and the other in the east side. In the downtown areas, whatever their purposes and what kind of transportation mode they used, people will end as pedestrian. So pedestrian walking facilities are as important factors in supporting the existence of CBD. The walkway in Malioboro street beside used for pedestrian also used for parking and other purposes, so it's seems so crowded and not so convenience for pedestrian. The purposes of this research are: 1) to know people opinions about pedestrian facilities in Malioboro street 2) How about Level of Service of the walkways and 3) Speed-Density-Flow relationships model.

2.LITERATURE REVIEW & BASIC THEORY

2.1. Pedestrian Studies

Pedestrian studies are used for a variety of purposes in transportation planning. They are used to justify pedestrian and transit malls, pedestrian overpasses and tunnels, escalators and moving belts, downtown shopping malls, urban stadium etc., which provide large concentrations of pedestrians that have to be accommodated. Our aging population is also requiring more emphasis on pedestrian facilities and changing some of the parameters (e.g., walking speed) traditionally used in pedestrian activities. Provision of special aids for handicapped persons (wheelchair ramps at intersections or to supplement stairs, audible traffic signals for the blind, etc.) has become an important aspect of the urban planning process (John D., 1992)

As in other types of studies, pedestrian volume studies depend on how the data are going to be used. The data may be expressed in terms of volume (persons per hour), flow rate (person per foot per minute), spacing (square feet per person), or walking speed (feet per minute). Virtually all pedestrian studies are manual counts or projected flows (for new facilities). The manual counts are, of course, labor intensive; therefore, the hours to be counted should be chosen carefully. Short-term sample counts may be used that are then expanded to provide an estimate of the full term count (John D, 1992)

2.2. Pedestrians Level of Service

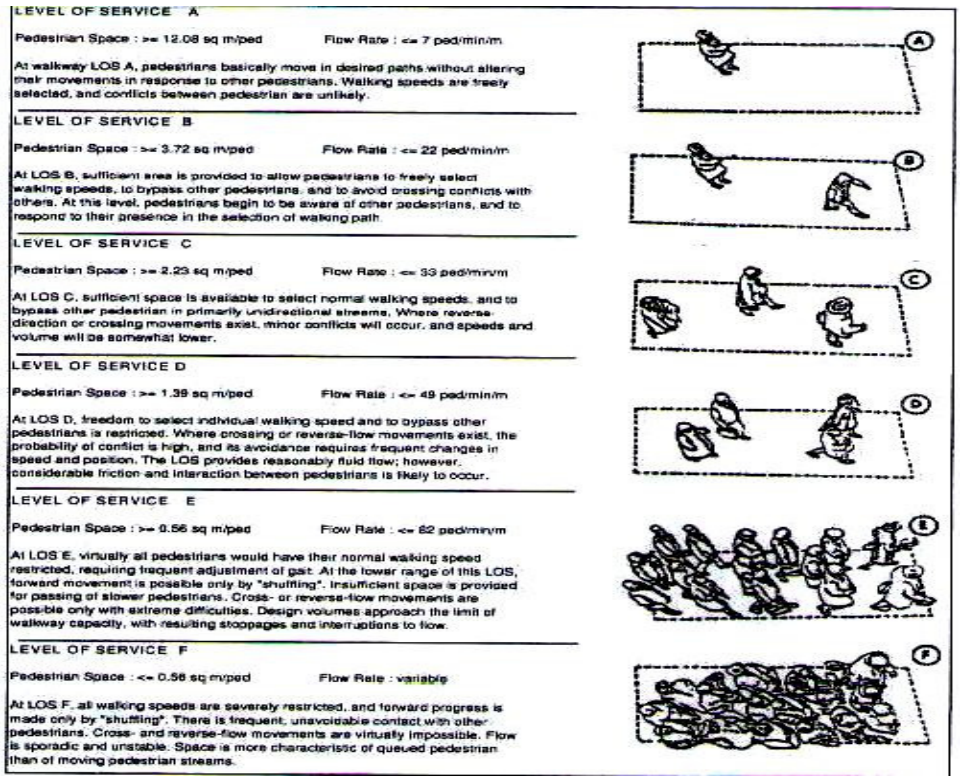

Figure 2 Illustration of walkway level of service (source: TRB, 1985)

According to John J Fruin (1971) The Level-of-Service Concept was first developed in the field of traffic engineering in recognition of the fact that capacity design was, in effect, resulting in planned congestion The Highway Capacity Manual, the most authoritative reference on Highway design practice, develops standards for six levels of design, based on service volumes and a qualitative evaluation of driver convenience. This qualitative evaluation includes the freedom to choose desired vehicle operating speed, the ability to overtake and pass other vehicles, and the freedom to change lanes. The level-of-Service concept provides a useful model for the design of pedestrian spaces as well. Pedestrian service standards should, similarly, be based on the freedom to select normal locomotion speed, the ability to bypass slow-moving pedestrians, and the relative ease of cross-and reverse-flow movements at various pedestrian traffic concentrations (Figure 2)..

Although speed is an important indicator for level of service since it is easy to observe and to measure, the primary measure of effectiveness used in defining pedestrian level of service is space or the inverse of density, in this case, mean speed and flow rate are considered to be supplementary criteria (Transportation Research Board,1985),

2.3. Speed- Density-Flow relationships

These models have a close concept with those used for vehicular streams (Transportation Research Board,1985), in the sense that flow is given in terms of pedestrian per unit of width of a walkway per unit of time, and the speed of pedestrian (V) is given in unit of distance divided by time, represented by m/min. In this regard, Pushkarev and Zupan (1975) mention that relationships between flow, speed and density of pedestrians as in Figure 3. Comparison of Speed-Density-Flow relationships studies between countries as in Table 1.

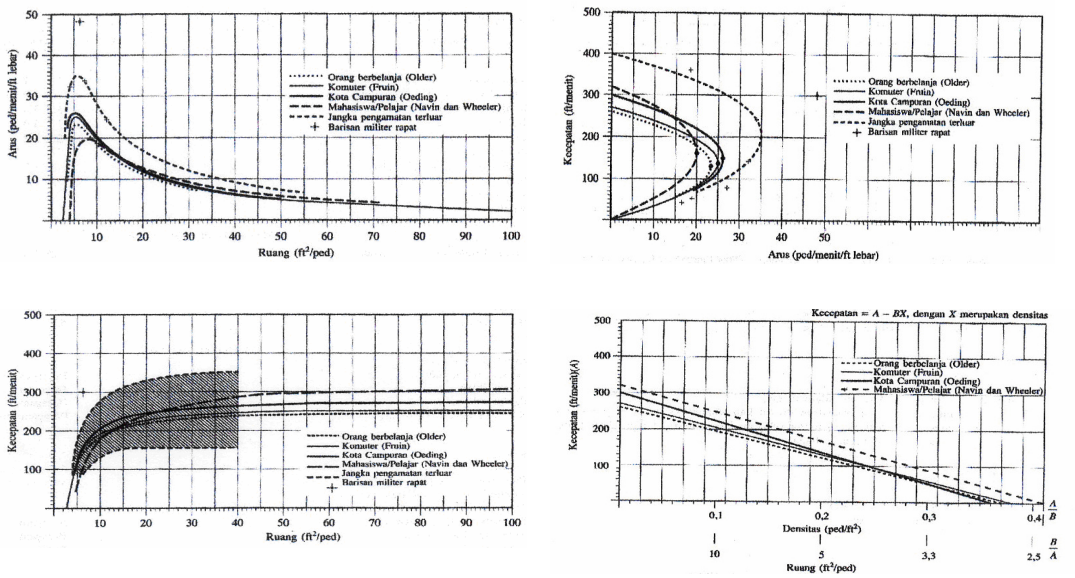

Figure 3 Relationship among Flow, Speed and Density (Pushkarev, 1975)

Table 1 Comparison of Speed-Density-Flow relationships studies between countries

Type of flow and source	Equation		
	Speed-density	Flow-density	Flow-speed
Shoppers, Older	V=78,6-20,2d	F=78,6d-20,2d^2	F=(78,6V-V^2)/20,2
Commuters, Fruin	V=81,4-20,4d	F=81,4d-20,4d^2	F=(81,4V-V^2)/20,4
Mixed traffic, Oeding	V=89,9-23,6d	F=89,9d-23,6d^2	F=(89,9V-V^2)/23,6
Shoppers, Yoshioka	V=67,8-16,8d	F=67,8d-16,8d^2	F=(67,8V-V^2)/16,8
Shoppers, Tanaboriboon	V=73,9-15,3d	F=73,9d-15,3d^2	F=(73,9V-V^2)/15,3
Shoppers, Eliza	V=59-12,2d	F=59d-12,2d^2	F=(59V-V^2)/12,2

2.4. Pedestrian requirements

According to Anthony (2001), Pedestrians come in many shapes, sizes and abilities – children, elderly, people with mobility, visual or hearing impairments, luggage laden persons, pregnant women, and so on- namely

everyone. In general they can be divided into pedestrians with or without mobility problems. Pedestrians, as well as being diverse in type, are diverse in needs and purpose. The use of space allocated for pedestrians can be classified as follows : (a) functional, used to walk from one place to another, space/path is used only as medium for movement to reach an activity location; eg., to the workplace, to catch a bus, etc. (b) active, space used when walking is seen as an end in itself or part of an activity, rather than a means to get to a place; eg., window shopping, strolling in city streets; (c) passive, characterized by standing, chatting, sitting and watching. Beside that, all pedestrian also need a safe, convenient and comfortable environment.

These general requirements of pedestrians are : 1) **safety**, pedestrians are physically vulnerable. Some pedestrians are more vulnerable than the others, so more care should be taken of children, the elderly and those with impairments.2) Pedestrians also need **security**, this can be improved by open and socially active space with good lighting, which encourages "public watch', at least, people should be allowed to see far enough to anticipate potential danger and take avoiding action. 3) **convenience**, pedestrian paths should provide direct and continuous routes with minimal level changes. Delays should be minimized and congestion eliminated, especially at junctions. Useful facilities such as public phones, bins, kiosks, waiting and stopping areas should be provided as appropriate. Good orientation should be provided through network design, including signs. The pedestrians should be guided such that they know where they are, and how to proceed further for their destinations. In short, pedestrian paths should be easy to follow; and 4) **comfort**, the desire to walk is heightened by the provision of a pleasant environment. Crowding, noise, polluted air, weather exposure, high or low temperatures should all be avoided or screened from pedestrians (Anthony, 2001)

3. DATA COLLECTION AND ANALYSIS

In conducting the study, primary and secondary data collection were carried out. Primary data collection comprises : (1) structured interview by using questionnaires; (2) field data measurement for pedestrian speeds study, while secondary information were collected from Tourist Information Centre of Yogyakarta Municipality. Survey of pedestrians was mainly done by observers manually at Malioboro Street, the business centre of Yogyakarta.:

Speed – Density – Flow Relationships

- Flow = Speed x Density……. (1) * Flow = Speed/space …….. (2)
- F = V x d F = V / S

Speed – Density Relationship

- Speed = A – B x Density ….. (3)

  V = A – B x d

Flow – Space Relationship

$$Flow = \frac{(AxSpace - B)}{Space^2} \text{ ..... (4)} \qquad Speed = \frac{Length.of.study.area.x60}{time(\sec)}(m/\min) \text{ .....(5)}$$

$$Flow = \frac{number.of.pedestrian.in.the.study.area}{60xEffective.width}(ped/m/\min) \text{ .....(6)}$$

Where F is the average flow of pedestrian per unit of effective walkway width, expressed as pedestrian per minute per meter. V is the average pedestrian walking speed, represented by meter per minute. While d is the average number of pedestrians per unit of area within a walkway or queuing area, expressed as pedestrian per square meter, and S is the reciprocal of density, represented by square meter per pedestrian.

A is theoretical speed attained by a traffic stream under conditions of completely free flow, with an unlimited amount of space per pedestrian; while B is the slop of the straight-line or a factor that, devided by A, as the theoretical minimum space allocation per pedestrian at a point where all movement in the traffic stream grind to a halt and speed in zero and B/A is the theoretical minimum space.

There is an assumption in this study, because shoppers in Yogyakarta have a similar posture with those of in Singapore, as a result, B/A= 0,207 m2 / ped for shopper in Singapore (Tanaboriboon in Poei Eliza, 1997) can be used in the analysis.

4.STUDY RESULTS

From analysis of the 67 respondents in Malioboro it was found that 63% respondents were men and 37% were women (Figure 4) They came from many countries eg USA; Ireland; Australia etc.(.Figure 5) with many purposes to go to Malioboro street (Figure 6). From field data collection, results of the speed study of pedestrian as in Table 2.

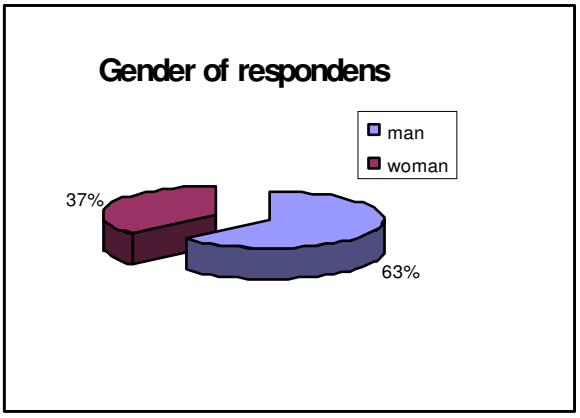

Figure 4

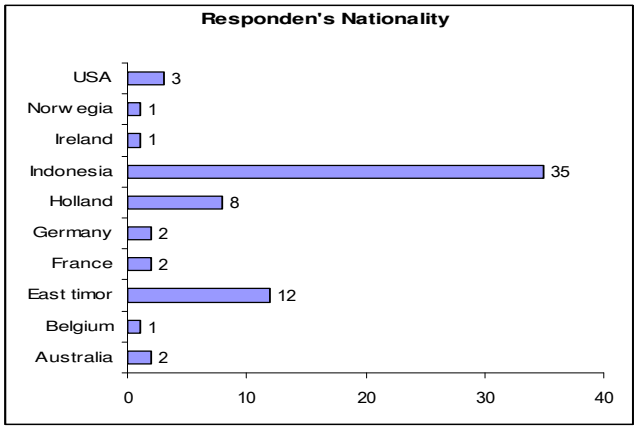

Figure 5

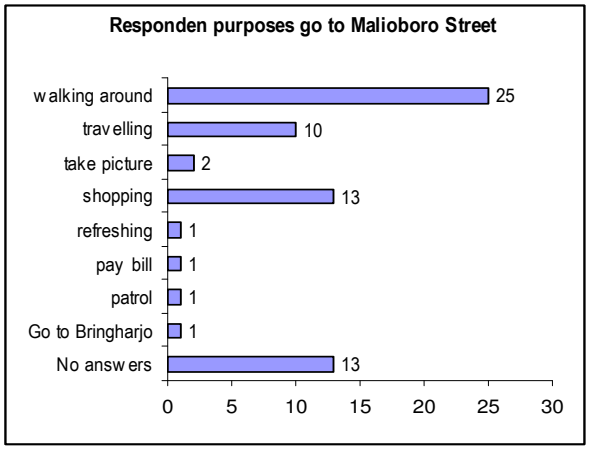

Figure 6

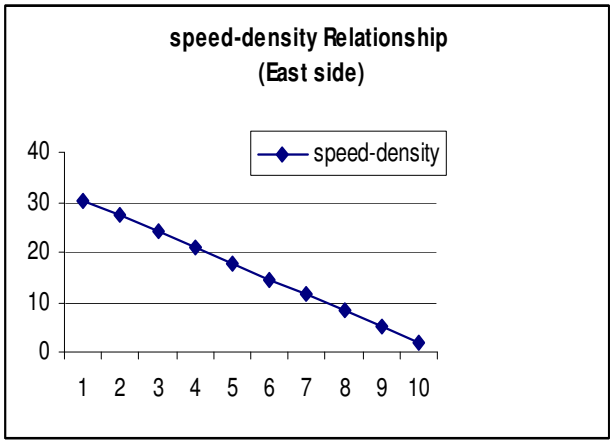

Figure 7

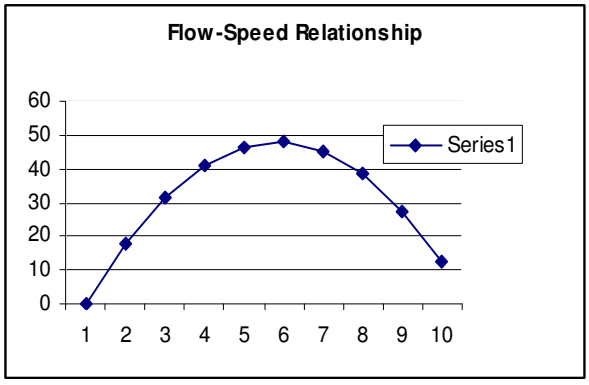

Figure 8

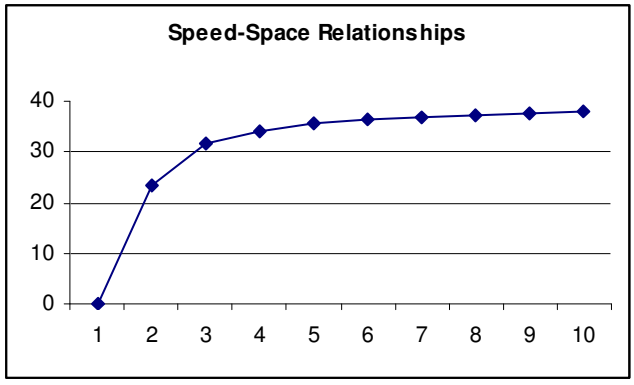

Figure 9

As the relationship between Speed and Density in Malioboro street was assumed to be linear, the result of this study can be presented by the following equations (see Figure 7; 8 & 9) :

Speed-Density relationship : $V = 39,7 - 8,2\ d$

Flow and Speed relationship can be formulated as : $F = (39,7V-V^2) / 8,2$

The Flow-Density relationship is given as follow : $F = 39,7\ d – 8,2\ d^2$

The equation of Speed-Space relationship is : $V = 39,7 – 8,2/S$

The results of Level-of –Service of Malioboro Street are as in Table 3

Table 2. Results of the speed study of pedestrian in Malioboro street (East and west side)

Characteristics		Men	Women	Average
West side	Mean walking speed (m/min)	52,9	46,2	48,9
	Range high	67,3	61,6	64,7
	Range low	36,6	33,3	33,7
East side	Mean walking speed (m/min)	30,2	30,8	30,4
	Range high	44,8	46,6	44,9
	Range low	23,7	22,6	23,4
Total average (East and West side)		41,7	38,5	39,7

Level-of –Service of Malioboro Street on West side is A or B on weekend, and A on workday. For the East side of the walkway volume of pedestrian is greater then West side, so that Level of Service become decrease around B or C. (see Table 3 & 4)

Table 3.: Pedestrian Level –of Service in Malioboro Street

Level of Service	Vol/cap ratio (V/C)	Flow Rate (ped/m/min)	Average Speed (m/min)	Space (m2/ped)	Density (ped/m2)
A	<= 0,08	<= 4	>= 39,7	>= 9,925	<=0,101
B	<= 0,28	<= 13	>= 36,829	>= 2,833	<=0,353
C	<= 0,40	<= 19	>= 35,283	>= 1,857	<=0,538
D	<= 0,60	<= 29	>= 32,36	>= 1,116	<=0,896
E	<= 1,00	<= 48	>= 19,856	>= 0,413	<=2,421

Table 4

No	Time	Volume (ped)	Volume/(60xWe)	LOS
	(West side)			
1	10.00-11.00 (weekend)	447	2,66	A
2	14.00-15.00 (weekend)	802	4,77	B
3	19.00-20.00 (weekend)	679	4,04	B
4	10.00-11.00 (work day)	387	2,30	A
5	14.00-15.00 (work day)	588	3,50	A
6	19.00-20.00 (work day)	387	2,30	A
	East side			
1	10.00-11.00 (weekend)	1054	9,76	B
2	14.00-15.00 (weekend)	1835	16,99	C
3	19.00-20.00 (weekend)	1247	11,55	B
4	10.00-11.00 (work day)	796	7,37	B
5	14.00-15.00 (work day)	1783	16,51	C
6	19.00-20.00 (work day)	1113	10,31	B

The goal of study by using Kendall's W Test is to find which factors will become the priority for pedestrian by ranking. (Table 5) **For Safety Factors**, "good lighting" is the first priorituy followed by "walkway is flat enough"; "Safely walking along walkway" ; " there are many zebracrosses for crossing the roadway" and the last priority is " walkway is not slippery"

" Walkway is covered by canopy" is the first priority for **Comfort attributes, followed by "**walkway is wide enough"; "Good looking and c lean walkway"; " pleasant environment" and the last priority for Comfort is "Free to walking fast"

While **Convenience attributes have first priority in "**benchs/rest fac ilities"; followed by "Bins / rubbish can"; "Yogya map /destination guide"; "hydran for fire protection"; "lane or sign for handicapped people"; "toilet"; "public phones & internet café" and the last priority is ""drinking water tab facility"

Table 5 Kendall's W Test

Ranks		Ranks		Ranks	
safety attributs	**mean rank**	**comfort attributs**	**mean rank**	**Convenience attributes**	**Mean Rank**
good lighting	3.49	walkway is covered by canopy	3.54	benchs	5.86
walkway is flat enough	3.18	walkway is wide enough	3.37	Bins / rubbish can	5.81
Safely walking along walkway	3.01	Good looking and c lean walkway	2.92	Yogya map	5.04
there are many zebracrosses for crossing the roadway	2.99	pleasant environment	2.65	hydran	4.89
walkway is not slippery	2.34	Free to walking fast	2.53	lane for handicapped people	4.30
				toilet	4.11
				public phones & internet	3.42
				drinking water tab fac ility	2.56

5. CONCLUSIONS

1. From this study, its can be concluded that pedestrian requirements based on respondents are : 1) "Good lighting" is the first priority in **Safety factors** for people who walks in Malioboro street, while the last priority is "walkway is not slippery" 2) "Walkway is covered by canopy" is the first priority for **Comfort attributes, and** "Free to walking fast" is the least importance for them, 3) **Convenience attributes have first priority in "**benchs/ rest facilities"; while "drinking water tab facility" is not so important for respondents.

2. Speed-Flow-Density relationships are represented by the following equations:

$V = 39,7 - 8,2\ d$;
$F = (39,7V-V^2) / 8,2$
$F = 39,7\ d – 8,2\ d^2$
$V = 39,7 – 8,2/S$

3. Level-of –Service of Malioboro Street on West side walkway is A or B on weekend, and A on workday. For the East side walkway' volume of pedestrian is greater then West sidewalkway's, so that Level of Service in East side walkway become decrease around B or C.

6. REFERENCES

Anthony Gar O.Y., Peter R.H., Simon Ka W.Ng, (2001), *Modern Transport in Hong Kong for the 21st Century*, Centre of Urban Planning and Environmental Management, University of Hong Kong, Hong Kong.

Edgard K Morlok. (1985). *Pengantar Teknik dan perencanaan Transportasi.* Erlangga, Jakarta.

Herbert S. Levinson; Robert A. Weant (1982); *Urban Transportation Perspectives and Prospects*; Eno Foundation for Transportation, Inc; Westport; Connecticut.

James L. Pline (1992), *Traffic Engineering Handbook*, Fourth Edition, Institute of Transportation Engineers, Printice Hall, Englewood Cliffs, New Jersey

John J. Fruin, (1971), Pedestrian Planning and Design, Metropolitan Association of Urban Designers and Environmental Planners, Inc., New York

John D. Edwards, Jr., P.E. (1992), *Transportation Planning Handbook*, , Institute of Transportation Engineers, Printice Hall, Englewood Cliffs, New Jersey

Jotin Khisty, C and Kent Lall, B. (1990*). Transportation engineering, An Introduction.* Prentice Hall, Englewood Cliffs, New Jersey.

Lulie, (1995), Karakteristik dan Analisis Kebutuhan Fasilitas Pejalan Kaki Studi Kasus di Jalan Malioboro, Yogyakarta, Tesis S2, Institut Teknologi Bandung.

Munawar, ahmad.(2004). *Manajemen Lalu Lintas Perkotaan*. Penerbit Beta Offset, Yogyakarta.

Pushkarev, Zupan J.M.(1975). *Urban Space for Pedestrian*. The MIT press, Cambridge,England.

Poei Eliza P.(1997). *Interaction between Pedestrians, Sellers and Vehicles in the Yogyakarta Down Town, Indonesia*. Master Thesis, Nihon University, Japan.

Poei Eliza P.(1997). "*Coexistence of Pedestrian, Vendor and Vehicle in Yogyakarta, Malioboro, Indonesia*" Proceedings Kanto Civil Engineering Conference in Utsunomia University

Poei Eliza P.(2009), "*Tingkat Kepuasan Pedestrian terhadap Fasilitas Trotoar dan Zebra Cross Studi Kasus di Depan Plaza Ambarukmo Yogyakarta*". Konteks 3.

Rodney T. (1997), *The Greening of Urban Transport*, Edition II, John Wiley & Sons, Inc., New York.

S. Papacostas, C. (1987). *Fundamentals Of Transportation engineering*, Englewood Cliffs, New Jersey.

S. Papacostas, C. and D. Prevedouros, P. (1993), *Transportation engineering and Planning*. Prentice – Hall, Englewood Cliffs, New Jersey.

Simon P. Washington, Matthew G.Karlaftis, Fred L.Mannering. (2003), *Statistical and Econometric Methods For Transportation Data Analysis*, A CRC Press, Washington.D.C.

Transportation Research Board (1985), *Highway Capacity Manual, Special Report 209*, National Research Council, Washington,D.C.