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Modeling Of Pedestrian Movement Satisfaction Based On Age In Indonesia Using Partial Least Square (Pls) : A Case Study In Manado City, North Sulawesi

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Abstract:
This study aims to determine the satisfaction model of pedestrian movement in the pedestrian area based on age in the city of Manado. The data used is from the results of a pedestrian traffic survey using a simple random sampling method, and the analysis technique used is Partial Least Square (PLS). The study results with the PLS approach show that the pedestrian movement satisfaction model based on age fits the R-square criteria. Aspects of management, technical aspects of transportation and facilities, and service quality affect pedestrian satisfaction. The management aspect has the most significant direct effect on pedestrian satisfaction and is supported by service quality. Indicators of assurance, performance, durability, availability, attention and tangible, reliability, and Aesthetics are dominant constructs in pedestrian satisfaction modeling. Quality of service, the management aspect, significantly influences the satisfaction of pedestrians over 45 years old. In comparison, the Technical aspects of Transportation and Facilities have the most critical influence on service quality for pedestrians under 25 years old.

***Key Word**: PLS, sidewalks, pedestrian satisfaction, service quality, management aspects, technical aspects.*

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I. Introduction

Manado City as the capital city of North Sulawesi Province with an area of 157.26 km2, which is flanked in the north by North Minahasa Regency and the Mantehage Strait, in the south of Minahasa Regency, west of Manado Bay, east of Minahasa Regency with a population of 451,916 in 2020 [1]. Walking is a primary human activity often overlooked when planning transportation and has been viewed as a second-class form of travel [2]. Walking is a mode of transportation that does not require expensive costs; besides that, walking can prevent and reduce the risk of developing osteoporosis and make the body more energetic. In addition, walking is a good cardio exercise for weight loss [3]. Transportation is the main element of city formation related to many things, including economic activities, human health, and the environment. Whether we realize it or not, the influence of environmental quality on the occurrence of outdoor activities generally underlies the creation of walking areas in urban areas. Transportation planning that has been made so far has been more pro-motorized vehicle users, as evidenced by the many recommendations for widening highways, construction of toll roads, flyovers, underpasses, and so on. Meanwhile, providing pedestrian facilities, such as sidewalks, crossing areas, shade trees, lighting, and other street furniture, still needs more attention [4]. Walking is a pollution-free and affordable transportation medium for all levels of society. The presence of pedestrians at a certain level will result in sharp conflicts with the flow of vehicles, resulting in traffic problems and high accident rates. The lack of adequate pedestrian facilities, especially walking and crossing facilities, dramatically impacts the safety of pedestrians. It is proven that 65% of road accidents involve pedestrian deaths, of which 35% are children [5]. So that the movement of pedestrians and their characteristics and the flow of vehicles needs to be studied to obtain a planning design that can minimize conflicts between pedestrians and motorized vehicles, increase safety, comfort, and smooth walking, and minimize traffic problems [6]. Based on description above, it is necessary to study the movement of pedestrians in Manado City based on age to increase pedestrian attention and structure good pedestrian infrastructure so that Manado is a Model Ecotourism City with the Structural Equation Modeling Partial Least Square (SEM- PLS).

II. Material And Methods

The data to be analyzed in this study is primary data from a pedestrian traffic survey which was taken directly by giving questionnaires to respondents at 9 points in the pedestrian area in the city of Manado. The research was conducted for 1 month, April 2023. The sampling method to be used is probability sampling using simple random sampling, and the analysis technique used is Structural Equation Modeling Partial Least Square (SEM-PLS) [7]. SEM modeling is done using Partial Least Square (PLS) with the following steps [8]:

1. Outer Model, includes the validity test seen from the results of factor loading and the reliability test seen from the Composite reliability value. An indicator is valid if it has a loading factor value > 0.5 and is said to be reliable if the composite reliability value is > 0.6.
2. Inner Model, this test can be seen from the results of the inner weight value, which tests the research hypothesis through the t-test on the bootstrap sample and the goodness of fit model. A model can be declared to have goodness of fit if it has a value of R-Square > 0 and a value of Q2 = 1 – (1 – R12) (1 – R22) > 0.35, providing high accuracy.

SEM-PLS modeling consists of an outer model and an inner model. The outer model is intended to confirm the dimensions developed on a factor, while the inner model is about the relationship structure that forms or explains the causality between factors [9]. The SEM model was developed based on a conceptual framework on Management Aspects (X1), Technical Aspects of Transportation and Facilities (X2), Service Quality (Y1), and Pedestrian Satisfaction (Y2) taken from various literatures. The conceptual framework is presented as follows [10]:

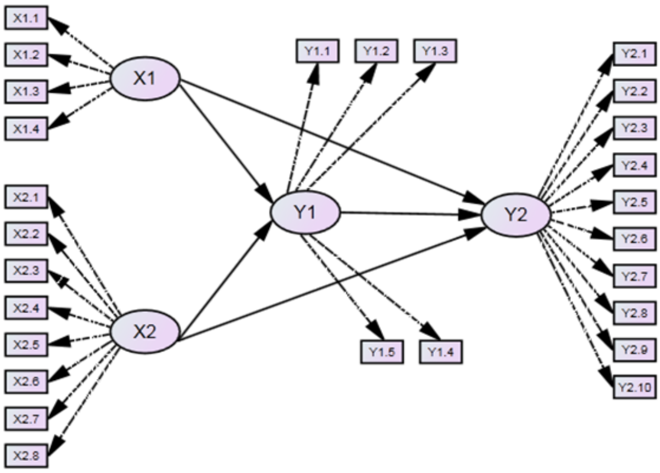


Figure 1. Pedestrian Satisfaction Conceptual Framework

III. Result

Characteristics of pedestrians based on age are presented in the following table,

Table 1: Description of Pedestrians by Age.

Pedestrian		Frequency	Percentage (%)
Age	<= 25	58	58.0
	26 - 45	34	34.0
	=> 46	8	8.0
Total		100	100.0

Table 1 shows that the percentage of pedestrians aged less than or equal to 25 years is 58 %, and those aged between 26 to 45 years are 34 %, while the lowest percentage is 8 % for pedestrians over 45 years old. This shows that pedestrians are a productive age when traveling. Furthermore, the Partial Least Square approach uses pedestrian modeling based on age characteristics.

The validity test was carried out using confirmatory factor analysis on each latent variable, namely Aspects of Management (X1.), Technical Aspects of Transportation and Facilities (X2.), Service Quality (Y1.), and Pedestrian Satisfaction (Y2.). The reliability test used composite (construct) reliability with a cut-off value of at least 0.7 [11]. Complete results are presented in Table 2.

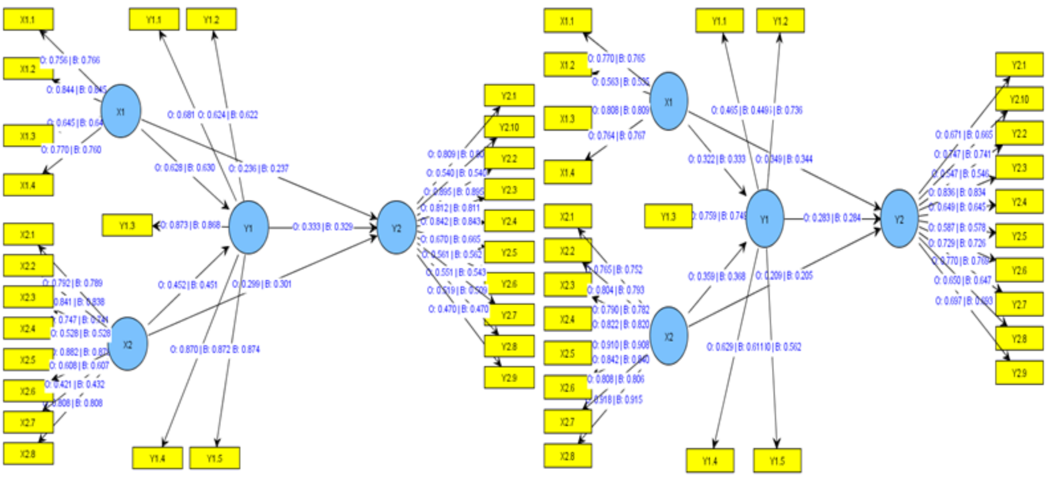
Table 2. Outer Loading and Composite Reliability Values of Each Indicator on Latent Variables Based on Pedestrian Age

Laten variable	**Indicator**	**Outer Loading**	**Composite Reliability**

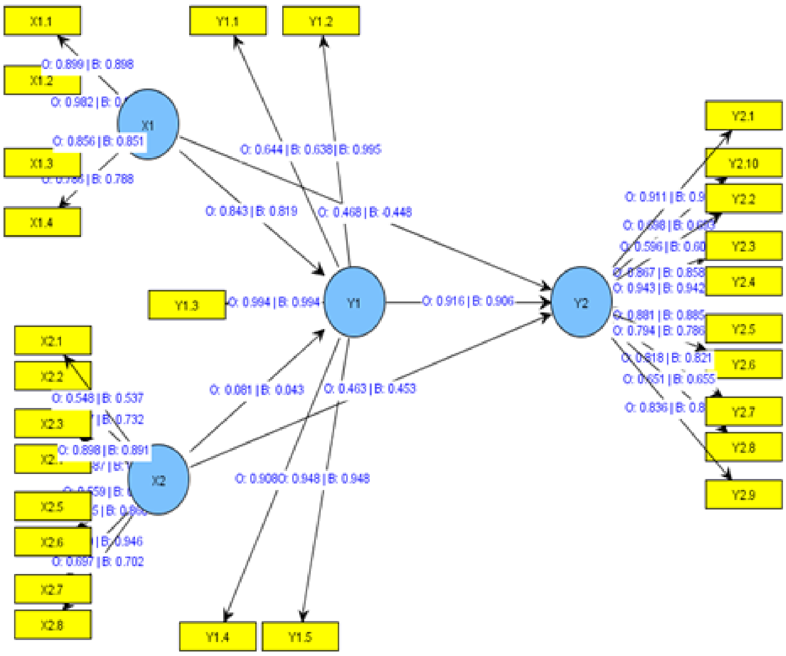
		<= 25	26 – 45	=> 46	<= 25	26 – 45	=> 46
Aspects of Management (X1)	Performance (X1.1)	0.756	0.770	0.899	0.842	0.820	0.934
	Warranty (X1.2)	0.844	0.563	0.982			
	Ease (X1.3)	0.645	0.808	0.856			
	Responsiveness (X1.4)	0.770	0.764	0.786			
Technical Aspects of Transportation and Facilities (X2)	Performance (X2.1)	0.792	0.765	0.548	0.891	0.948	0.900
	Aesthetics (X2.2)	0.841	0.804	0.737			
	Ease (X2.3)	0.747	0.790	0.898			
	Reliability (X2.4)	0.528	0.822	0.487			
	Endurance (X2.5)	0.882	0.910	0.559			
	Frequency (X2.6)	0.608	0.842	0.865			
	Convenience (X2.7)	0.421	0.808	0.950			
	Availability (X2.8)	0.808	0.918	0.697			
Service Quality (Y1)	Reliability (Y1.1)	0.681	0.465	0.644	0.892	0.774	0.958
	Responsiveness (Y1.2)	0.624	0.736	0.995			
	Level of Assurance (Y1.3)	0.873	0.759	0.994			
	Caution (Y1.4)	0.870	0.629	0.908			
	Tangible (Y1.5)	0.872	0.580	0.948			
Pedestrian Satisfaction (Y2)	Guarantee (Y2.1)	0.809	0.671	0.911	0.893	0.901	0.948
	Responsiveness (Y2.2)	0.895	0.547	0.596			
	Performance (Y2.3)	0.812	0.836	0.867			
	Aesthetics (Y2.4)	0.842	0.649	0.943			
	Convenience (Y2.5)	0.670	0.587	0.881			
	Reliability (Y2.6)	0.561	0.729	0.794			
	Durability (Y2.7)	0.551	0.770	0.818			
	Frequency (Y2.8)	0.519	0.650	0.651			
	Convenience (Y2.9)	0.470	0.697	0.836			
	Availability (Y2.10)	0.540	0.747	0.698			

Table 2., shows all indicators for each latent variable having a loading factor value above 0.5 with a p-value smaller than α = 0.05, so the indicator is valid and significant, except for pedestrians aged less than 25 years in terms of technical aspects of transportation and facilities with comfort indicators (0.421), on pedestrian satisfaction (Y2) with comfort indicators (0.470). Pedestrians aged between 26 to 45 years on the quality of service (Y1) with an indicator of reliability (0.465). In comparison, the composite reliability scores all give values above 0.7, so the latent variables in management aspects (X1), technical aspects of transportation and facilities (X2), service quality (Y1), and pedestrian satisfaction (Y2) are reliable.

Once the validity and reliability of all latent variables have been tested and confirmed, they can be included in the analysis through a path diagram as shown in Figure 2. The results are both valid and reliable.



(a) Pedestrians aged less than 25 years old **(b) Pedestrians aged between 26 to 45 years old**



(c) Pedestrians aged over 45 years old

Figure 2. The relationship between exogenous and endogenous latent variables

The path coefficient test in Figure 2 and the above equations are presented in detail in the following table:

Table 3. Results of Path Coefficient Testing Model of Pedestrian Movement Satisfaction Based on Age

Variable	**Age**					
	<= 25		26 – 45		=> 46	
	Koef.	**Uji t**	**Koef.**	**Uji t**	**Koef.**	**Uji t**
Aspects of Management (AP) => Quality of service (KL)	0.628	21.686	0.322	11.653	0.843	40.145
Technical Aspects of Transportation and Facilities (ATTF) => Quality of service (KL)	0.452	12.526	0.359	16.681	0.081	2.125
Management Aspect (AP) => Pedestrian Satisfaction (KP)	0.236	5.054	0.349	8.290	0.468	12.177
Technical Aspects of Transportation and Facilities (ATTF) => Pedestrian Satisfaction (KP)	0.299	6.289	0.209	7.485	0.463	16.871
Quality of service (KL) => Pedestrian satisfaction (KP)	0.333	4.074	0.283	5.900	0.916	47.624
R-Square	Y1 → 0.597 Y2 → 0.444		Y1 → 0.256 Y2 → 0.377		Y1 → 0.618 Y2 → 0.738	

Based on Table 3, the interpretation of each path coefficient is as follows:

- Management aspect (X1) positively and significantly affects service quality (Y1); the most excellent effect occurs on pedestrians over 46 years of age. This can be seen from the path coefficient, which is positive at 0.843 with a T-Statistic value of 40,145, more significant than the t-table with a significance level (α) determined at 0.05 at 1.96. Thus the Management Aspect (X1) has a direct effect on the Service Quality (Y1) of 0.843, which means that every time there is an increase in the Management Aspect (X1), it will increase the Service Quality (Y1) by 0.843.
- Transportation and Facilities Technical Aspects (X2) positively and significantly affect service quality (Y1); the most excellent effect occurs on pedestrians under 25 years old. This can be seen from the path coefficient, which is positive at 0.452 with a T-Statistic value of 12,526, more significant than the t-table with a significance level (α) determined at 0.05 at 1.96. Thus the Technical Aspects of Transportation and Facilities (X2) have a direct effect on the Quality of Service (Y1) of 0.452, which means that every time there is an increase in the Technical Aspects of Transportation and Facilities (X2), it will increase the Quality of Service (Y1) of 0.452.
- Aspects of Management (X1) positively and significantly affect pedestrian satisfaction (Y2); the most remarkable effect occurs on pedestrians over 46 years of age. This can be seen from the path coefficient,

which is positive at 0.468 with a T-Statistic value of 12,177, more significant than the t-table with a significance level (α) determined at 0.05 at 1.96. Thus the Management Aspect (X1) has a direct effect on pedestrian satisfaction (Y2) of 0.468, which means that every time there is an increase in the Management Aspect (X1), it will increase pedestrian satisfaction (Y2) by 0.468.

- Technical Aspects of Transportation and Facilities (X2) positively and significantly affect pedestrian satisfaction (Y2); the greatest effect occurs on pedestrians over 46 years old. This can be seen from the path coefficient, which is positive at 0.463 with a T-Statistic value of 16,871, more significant than the t-table with a significance level (α) determined at 0.05 at 1.96. Thus the Technical Aspects of Transportation and Facilities (X2) have a direct effect on pedestrian satisfaction (Y2) of 0.463, which means that every time there is an increase in the Technical Aspects of Transportation and Facilities (X2), it will increase pedestrian satisfaction (Y2) of 0.463.
- Service quality (Y1) positively and significantly affects pedestrian satisfaction (Y2); the greatest effect occurs on pedestrians over 46 years of age. This can be seen from the path coefficient, which is positive at 0.916 with a T-Statistic value of 47,624, more significant than the t-table with a significance level (α) determined at 0.05 at 1.96. Thus the quality of service (Y1) has a direct effect on pedestrian satisfaction (Y2) of 0.916, which means that every time there is an increase in service quality (Y1), it will increase pedestrian satisfaction (Y2) by 0.916.

From the table above, it can be explained that the contribution of the Management aspects (X1), Technical Aspects of Transportation and Facilities (X2) to Service Quality (Y1) in the pedestrian model aged less than 25 years is 59.7 percent, ages between 25 to 45 years is 37.7 percent and over 45 years of age 61.8 percent. Furthermore, the contribution of management aspects (X1), technical aspects of transportation and facilities (X2), and Quality of Service (Y1) to pedestrian satisfaction (Y2) in pedestrian models aged less than 25 years is 44.4 percent aged between 25 and 45 years by 25.6 percent, and age over 45 years by 73.8 percent. This shows that the priority in developing aspects of Management (X1), Technical Aspects of Transportation and Facilities (X2), and Quality of Service (Y1) is pedestrians over 45 years old.

IV. Conclusion

The results showed that the Pedestrian Movement Satisfaction Model based on age in Manado is fit. Guarantee and performance indicators are the dominant shapers in the management aspect, durability and availability indicators are the dominant shapers in the technical aspects of transportation and facilities, then attention and tangible are the dominant shapers in service quality, and reliability and aesthetic indicators are the dominant shapers in pedestrian satisfaction. Quality of service, the management aspect, has the most significant influence on the satisfaction of pedestrians who are more than 45 years old. In comparison, the Technical aspects of Transportation and Facilities have the most significant influence on the quality of service for pedestrians who are less than 25 years old.

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