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Comparison of prioritization of pedestrianization warrants among transport professionals- an initial assessment in Metro Manila

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Abstract: *In urban areas in developing countries, pedestrianization is now being promoted as a sustainable transport measure that can possibly shift people from using private transport to using other transport options such as public transport and non-motorized transport (NMT). This paper identifies pedestrianization warrants from the global perspective and assesses each warrant's prioritization weight through the survey/interview of transport professionals in the local setting. Analytic hierarchy process (AHP) is applied to determine prioritization weights from four sectors: the academe, non-government organizations (NGOs), local government units (LGUs), and transport-related government agencies. Results show similarities and differences of top pedestrianization warrants among different sectors. Results also suggest that among the warrants included, (1) public demand, (2) volume of pedestrians, NMT users, and commuters, (3) safety and security, and (4) level of service of pedestrians appear to be top pedestrianization warrants for all sectors combined.*

Keywords: Active Transport; AHP; NMT; Pedestrianization; Pedestrianization Warrants

1. INTRODUCTION

Pedestrianization can be considered as one of the feasible transport measures to improve walkability, safety, mobility, and the environment in densely populated areas [1]. Streets can be pedestrianized by eliminating vehicular traffic for the exclusive use of pedestrians except during restricted hours in which emergency vehicles, services, and delivery trucks are often allowed to pass through [2]. Pedestrianization schemes may also be varied depending on the demands of particular locations and the priorities of urban planners [3]. In many countries, pedestrianization is now being promoted to reclaim urban spaces [4]. This may also be attributed to multiple benefits associated with pedestrianizing street locations. Soni & Soni [1] categorized the advantages of pedestrianization based on impacts on the transportation system, society, environment, health, and the economy as well.

In the Philippines, there are already some notable pedestrianized areas such as the Calle Crisologo of Vigan City and the Session Road in Baguio City. Calle Crisologo in Vigan City is a street that implemented a full pedestrianization for the primary purpose of preservation of the cultural and historical heritage. On the other hand, the Session Road in Baguio City proposed to implement a fully pedestrianized scheme for environmental concerns and health promotion purposes [5]. In the case of Metro Manila, the prioritization of motorized vehicles on roads has caused the deficiency of pedestrian facilities which consequently led to the degradation of the walking environment [6, 7]. Due to this, some metro cities are now considering more sustainable transport options in the form of walkways and pedestrianized streets due to its perceived benefits [1, 5]. On another note, even though pedestrianization presents multiple advantages in different aspects, it is essential to also consider significant concerns related to it. Business owners have divided opinions in terms of the effects of pedestrianization on their ventures in which some perceive that pedestrianization negatively affects their income without any direct scientific correlation [1]. Moreover, public utility vehicle (PUV) drivers similarly

perceive the possible adverse effects of pedestrianization to their income since their profit is heavily dependent on the number of their passengers. Moreover, some pedestrians and PUV drivers agree that the scheme would cause traffic congestion in other areas because of closure of streets from vehicle entry [8]. There are also major transportation groups based in Manila who are also heavily against pedestrianization implementation due to the lessened profit on their end because of the added distance and travel time without an increase in fare [9]. As such, the analysis of the criteria of pedestrianization which is based on the priorities of professionals is crucial prior to the implementation of pedestrianization schemes. While preferences may vary between transportation professionals, the development of a tool that can assess the level of pedestrianization demands may aid in decision-making when considering feasible locations for pedestrianization.

Using analytic hierarchy process (AHP), this paper aims to provide an initial assessment of the prioritization weights of pedestrianization warrants based on interviews with transportation professionals from different sectors: the academe, non-government organizations (NGOs), local government units (LGUs), and officers of related government transportation agencies. This paper presents pedestrianization warrants which should be prioritized when implementing pedestrianization schemes in Metro Manila.

2. PEDESTRIANIZATION WARRANTS

Soni & Soni [1] presented warrants which can be used as indicators and justification for the pedestrianization of a certain location. These warrants are the basis of interviews conducted with the transportation professionals in this research. The warrants are enumerated as follows.

2.1 Availability of Nearby Public Transportation

Pedestrianization may be recommended in places nearby public transportation. It is suggested that access to different transport modes may decrease dependency on private motorized vehicles [1]. When people need to

travel to certain destinations that may require longer than walking distances, the availability of nearby public transportation may guarantee a sustainable and effective implementation of pedestrianization in an area.

2.2 Street Geometry and Measurements

As identified by the Indian Roads Congress (IRC) [10], street geometry and measurements are key elements in suitability for vehicular traffic. The IRC provided the footprint required for the street's adjacent land use. Streets that are evaluated to be not suitable for vehicular traffic based on the criteria should be pedestrianized [1]. With the IRC's measurements, insufficient street geometry indicates a necessary implementation of transportation policies, possibly pedestrianization, to ensure safety among pedestrians and motorists within the designated area.

2.3 High Volume of Pedestrians, NMT users, and Commuters

The presence of high-volume pedestrians, non-motorized transport (NMT) users, and commuters in a particular street area indicates a higher requirement for safety and security. The constant engagement of pedestrians and NMT users with motorized transportation carries the risk of road accidents between them. Soni & Soni [1] discussed that if most of the people in a particular location use transit and NMT, it is possible for the street to be pedestrianized.

2.4 Noise and Air Pollution Level

In the Philippines, perimeter noise is measured to the adjacent land usage of areas. The National Pollution Control Commission (NPCC) devised standards to set maximum allowable noise in particular areas. Areas that are perceived to have frequent unacceptable levels of noise caused by vehicular traffic may turn to pedestrianization. On the other hand, the Department of Environment and Natural Resources (DENR) established an Air Quality Index (AQI), which is a daily measure of how clean or polluted the air specific to a certain area is. If the corresponding AQI category reaches a "Very Unhealthy to Emergency" level, pedestrianization can also help.

2.5 Level of Service of Pedestrians

The Highway Capacity Manual listed the level of services (LOS) for walkways and sidewalks. The level of service of a certain street is classified into 6 levels ranging from A to F. Parameters in determining the LOS of an area include space available for pedestrians, the flow rate of pedestrians, and their overall walking speed. According to Soni & Soni [1], pedestrianization may be an option to improve the LOS of an area.

2.6 Preservation of Heritage and Tourism

The presence of an identified heritage or tourism site is one of the viable warrants to require pedestrianization in an area. This is similar to the pedestrianization implemented in Vigan City. The implementation of pedestrianization may help in making sure that heritage sites are protected from the harsh effects of motorized vehicles.

2.7 Safety and Security

Pedestrians will only continue to be pedestrians if there is an assurance of safety and protection. Establishing a safe and secure street area can ensure pedestrians' safety which will then encourage more pedestrians to use walking as an alternative mode of transportation [7]. The criteria of safety and security should be heavily considered as a warrant for pedestrianization. Not only will it guarantee a more successful pedestrianization implementation, but it will also alter the perception of people about pedestrianization as a mode of transportation in a heavily urbanized setting.

2.8 Public Amenities and Equitable Access to Commerce

Streets and sidewalks are not only used by motorized vehicles, pedestrians, and NMTs. There are also other shared users specifically on sidewalks that are also utilized not just for transportation purposes, the purpose of pedestrians, but also for communication, shops, and other forms of businesses. In Asian countries, there is a presence of both formal and informal economic activity on sidewalks. Pedestrianization may help in promoting more economic activities in certain areas. Equal consideration must be provided to non-movement spaces and should also be deemed necessary in pedestrian network design [7, 11].

2.9 Public Demand

Pedestrianization may be required in a certain location due to popular public demand. Streets are for public use and many sectors such as pedestrians, PUV drivers, business owners, commuters, and vehicle owners are just some of the members that utilize the streets. The project on pedestrianization of Avenida was later discontinued due to different sectors having conflicting sides to the matter [9]. The absence of consultation from different sectors can cause disagreement and could turn out to the abandonment of the project. Pedestrianization could then be incorporated as a method of transportation and as a choice for people in a certain location. People's demand for priority in streets must be considered as a warrant [1].

3. METHODS

The survey/interview results were gathered from transportation professionals in Metro Manila, specifically within the academe, NGOs, transportation division of the Metro Manila LGUs, and executives in different transportation agencies. The data was then processed through the Analytic Hierarchy Process (AHP). With the use of the SuperDecisions software, the weights of each corresponding criterion were generated following the calculation procedures performed in an AHP analysis. The SuperDecisions software is a decision support and educational software that utilizes the Analytic Hierarchy Process (AHP) and the Analytic Network Process (ANP). Moreover, the software was created through the organization founded by Thomas Saaty, the developer of both methodologies.

3.1 Survey/Interview

Prior to conducting the survey interview with different

transportation professionals, the researchers introduced how the pedestrianization warrants were defined in the study. The briefing of transportation professionals on the study also included sample questions on the pairwise comparison procedure with the instructions of using the intensity scale. For better understanding, the pedestrianization warrants were also presented in photographs.

The questionnaire that was used in gathering the necessitated data used Saaty's 9-point ratio scale, as shown in Table 1. The scale, which corresponds to the AHP method, represents the magnitude of priority of the identified criteria depending on the pairwise comparisons presented in the questionnaire. There were thirty-six (36) pairwise comparisons in the interview.

Table 1. Thomas Saaty's Ratio Scale (AHP)

Intensity of importance on an absolute scale	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Moderate importance	Experience and judgment slightly favor one activity over another
5	Essential or strong importance	Experience and judgment strongly favor one activity over another
7	Very strong importance	An activity is strongly favored, and its dominance is demonstrated in practice
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation
2,3,6,8	Intermediate values between the two adjacent judgments	When compromise is needed

3.2 Analytic Hierarchy Process

Analytic Hierarchy Process (AHP) is a general theory of measurement and is used to assess the subjective and personal preferences of individuals or groups in deciding about a specific scenario [12, 13]. The method utilizes the usage of hierarchic structure and pairwise comparisons to establish the relations within the structure. It is a nonlinear framework for deductive and inductive thinking, not including the use of syllogism by considering multiple factors simultaneously and making

numerical tradeoffs to arrive at a decision [12]. The method was developed by Thomas Saaty and is used in a variety of transportation-related projects from 1985 to 2012 [14].

The aggregated matrix of the pairwise comparison of the professionals from the academe, NGOs, LGUs, and government agencies is presented in Fig. 1. For classification and ease of calculations, each criterion was assigned to a specific ID, as found in Table 2. Weighted geometric means were used to produce the single matrix for each sector and were also used to aggregate for all the sectors.

Table 2. ID Assignment per Criteria/Warrant

ID	Criteria/Warrant
C1	Availability of Nearby Public Transportation
C2	Inadequate Street Geometry
C3	High Volume of Pedestrian, NMT Users, and Commuters
C4	Noise and Air Pollution
C5	Poor Level of Service of Pedestrians
C6	Preservation of Heritage
C7	Increase Safety and Security
C8	Presence of Public Amenities and Equitable Access to Commerce
C9	High Public Demand

		C1	C2	C3	C4	C5	C6	C7	C8	C9
[Academe] =	C1	1	3.06	0.31	1.68	0.35	0.43	0.41	0.49	0.20
	C2	0.33	1	0.25	1.14	0.62	0.90	0.72	0.44	0.26
	C3	3.27	4.04	1	2.96	2.97	3.25	2.62	2.56	0.53
	C4	0.60	0.88	0.34	1	0.37	0.86	0.60	0.38	0.37
	C5	2.84	1.61	0.34	2.70	1	2.06	1.65	1.41	0.85
	C6	2.33	1.11	0.31	1.17	0.48	1	0.89	0.51	0.46
	C7	2.43	1.39	0.38	1.68	0.61	1.12	1	0.91	0.94
	C8	2.05	2.28	0.39	2.64	0.71	1.97	1.09	1	0.51
	C9	4.95	3.86	1.87	2.71	1.18	2.17	1.06	1.94	1
[NGO] =	C1	1	1.81	0.36	2.65	0.30	1.09	0.50	0.56	0.26
	C2	0.55	1	0.27	1.23	0.54	0.33	0.65	0.29	0.32
	C3	2.76	3.77	1	4.39	1.25	2.85	2.29	1.20	1.02
	C4	0.38	0.81	0.23	1	0.27	0.46	0.43	0.37	0.25
	C5	3.30	1.85	0.80	3.73	1	2.82	1.73	1.20	0.64
	C6	0.92	2.99	0.35	2.19	0.35	1	0.66	0.50	0.40
	C7	2.02	1.54	0.44	2.32	0.58	1.53	1	1.20	0.41
	C8	1.79	3.41	0.83	2.68	0.83	2.02	0.83	1	0.42
	C9	3.81	3.13	0.98	3.92	1.55	2.52	2.42	2.40	1
[LGU] =	C1	1	1.14	0.36	0.71	0.42	0.99	0.29	0.56	0.60
	C2	0.88	1	0.49	0.46	0.38	0.55	0.32	1.01	0.60
	C3	2.75	2.06	1	1.41	0.96	1.33	0.41	1.29	0.84
	C4	1.40	2.19	0.71	1	0.58	1.88	0.36	0.95	0.58
	C5	2.38	2.63	1.04	1.72	1	2.06	0.86	1.49	1.13
	C6	1.01	1.82	0.75	0.53	0.49	1	0.29	0.90	0.36
	C7	3.47	3.12	2.41	2.80	1.16	3.40	1	3.52	1.84
	C8	1.80	0.99	0.77	1.05	0.67	1.11	0.28	1	0.72
	C9	1.68	1.67	1.19	1.73	0.88	2.78	0.54	1.39	1
[GA] =	C1	1	1.88	0.33	1.78	0.49	1.39	0.26	1.75	0.45
	C2	0.53	1	0.31	1.72	0.40	1.45	0.34	1.62	0.68
	C3	3.01	3.24	1	2.98	1.27	2.42	0.41	3.08	0.62
	C4	0.56	0.58	0.34	1	0.40	1.64	0.39	2.49	0.40
	C5	2.04	2.52	0.79	2.52	1	2.32	0.57	2.50	0.39
	C6	0.72	0.69	0.41	0.61	0.43	1	0.39	0.59	0.43
	C7	3.88	2.95	2.47	2.56	1.75	2.60	1	2.09	1.70
	C8	0.57	0.62	0.32	0.40	0.40	1.70	0.48	1	0.49
	C9	2.21	1.46	1.62	2.51	2.58	2.33	0.59	2.04	1
[All] =	C1	1	1.86	0.34	1.54	0.39	0.90	0.35	0.72	0.35
	C2	0.54	1	0.31	1.02	0.47	0.70	0.47	0.68	0.43
	C3	2.94	3.18	1	2.72	1.46	2.34	1.002	1.87	0.73
	C4	0.65	0.98	0.37	1	0.39	1.05	0.44	0.76	0.38
	C5	2.60	2.11	0.69	2.57	1	2.30	1.09	1.59	0.70
	C6	1.12	1.43	0.43	0.95	0.44	1	0.51	0.60	0.41
	C7	2.85	2.11	1.00	2.30	0.92	1.97	1	1.69	1.05
	C8	1.39	1.48	0.53	1.31	0.63	1.66	0.59	1	0.52
	C9	2.89	2.33	1.37	2.61	1.43	2.44	0.95	1.91	1

Fig. 1. Aggregated Matrices from Pairwise Comparison Results

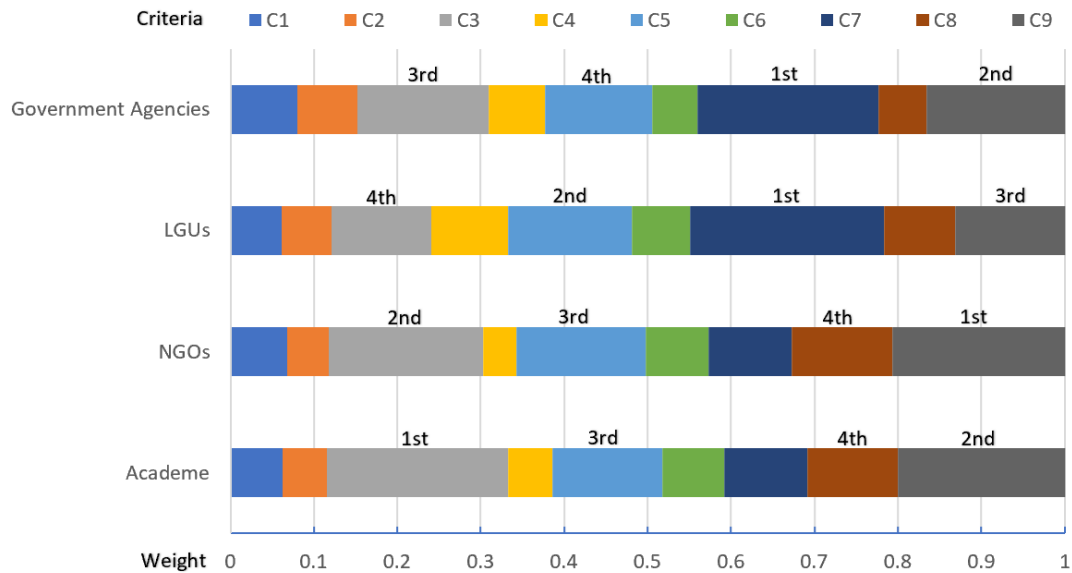


Fig. 2. Resulting Prioritization Weights per Sector

4. RESULTS/DISCUSSION

The researchers were able to gather fifty (50) respondents from Metro Manila LGUs, NGOs, the academe sector, and government agencies, particularly related to transportation, urban planning, and traffic management. To be specific, the respondents of the study included nine (9) respondents from the academe, six (6) respondents from NGOs, twenty (20) respondents from LGUs, and fifteen (15) respondents from government agencies. These numbers were used in the geometric means for the computation of the prioritization weights for all sectors combined. Shown in Fig. 2 are the resulting prioritization weights per sector. The ID assignment per warrant in this figure remains consistent with Table 2. All prioritization weights per sector sums up to one (1).

Focusing on the transport professionals from the academe sector and non-government organizations (NGOs), it can be observed that C3 (High Volume of Pedestrian, NMT Users, and Commuters), C5 (Poor Level of Service of Pedestrians), C8 (Presence of Public Amenities and Equitable Access to Commerce), and C9 (High Public Demand) turned out to be the top priorities for both sectors to warrant a pedestrianization implementation. If the resulting prioritization weights would be ranked, the academe and NGOs would almost have similar results except for the first and second ranking criteria. The academe sector's top pedestrianization warrant is the presence of a high volume of pedestrians, NMT users, and commuters, while the NGOs' top pedestrianization warrant is the presence of a high public demand for pedestrianization of a certain location. It is important to note that some respondents pointed out the overlapping definitions between C3 and C9. To clarify, C3's definition focused on the presence of the demand (high volume of pedestrians, NMT users, and commuters) while C9's definition focused on the acceptability of pedestrianization to the public.

From the transport professionals in local government units (LGUs) and government agencies, it can be observed that C3 (High Volume of Pedestrian, NMT Users, and Commuters), C5 (Poor Level of Service of

Pedestrians), C7 (Increase Safety and Security), and C9 (High Public Demand) ranked as top warrants for pedestrianization. Both sectors' top pedestrianization warrant is to increase the safety and security in a location. This warrant did not appear in the resulting top pedestrianization warrants from the academe and NGOs. On the other hand, the presence of public amenities and equitable access to commerce did not appear on the top pedestrianization warrants of LGUs and government agencies. The rest of the criteria (C3, C5, and C9) appeared as top pedestrianization warrants if the resulting prioritization weights are to be looked at per sector.

In contrast, the warrants with the least prioritization weights can also be observed from Fig. 2. Based on the responses, both the academic and NGO sectors' least prioritized warrant turned out to be C4 (Noise and Air Pollution). The LGUs sector has C2 (Inadequate Street Geometry) as the least prioritized warrant, while transport professionals from government agencies have C6 (Preservation of Heritage) with the least weight.

Differences and similarities in priorities may be attributed to the varying roles and responsibilities of each sector in the transportation field. LGUs and government agencies' responsibilities are more oriented toward project implementation of transportation plans and traffic management measures. On the other hand, NGOs and the academic sector's roles are more oriented toward research, consultation, and advocacies in transport advancement.

In Fig. 3, the resulting prioritization weight of each warrant for all sectors combined is shown. This is aggregated by applying geometric means from each sector. Combining all pairwise comparison responses, C9 (High Public Demand) and C3 (High Volume of Pedestrian, NMT Users, and Commuters) appeared to be top warrants for pedestrianization according to transport professionals in Metro Manila. This is followed by C7 (Increase Safety and Security) and C5 (Poor Level of Service of Pedestrians). Warrants with the least weight for pedestrianization are C2 (Inadequate Street Geometry) and C4 (Noise and Air Pollution).

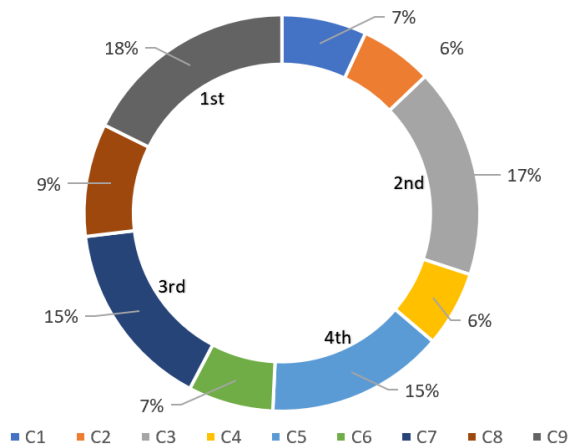


Fig. 3. Resulting Prioritization Weight of Each Pedestrianization Warrant from All Sectors Combined

4.1 Consistency in Responses

Consistency Ratio (CR) can be used to measure the degree of inconsistency of responses in this form of data gathering. A CR value greater than 0.1 could mean inconsistent results and that the response or the criterion may be removed. The CR value is calculated using the quotient of Consistency Index (CI) and the Random Index (RI) number corresponding to the number of criteria used (in this case, RI=1.4499) [15]. There is an acceptable range of inconsistency computed from the responses gathered: less than 0.1 or 10%. From the consistency index and ratio shown in Table 3, the CR values are 4.29%, 2.30%, 1.53%, 4.50%, and 0.99% for the academe, NGOs, LGUs, government agencies, and a combination of all the sectors, respectively. All the CR values are less than the threshold provided by Saaty [15], hence all the judgments, regardless of the sector are consistent and have acceptable variation. The acceptance of the judgments and weights can justify the methodology done such as the number of respondents interviewed or asked, the number and pairwise comparison of warrants, and that the responses are similar and have acceptable variations with each judgment.

4.2 Significance of Pedestrianization Warrants and Corresponding Prioritization Weights

With extended progression in promoting non-motorized transport as a transportation mode, pedestrianization has been considered as an effective and low-cost approach to shifting people from private transport to other modes of sustainable transport options. While pedestrianization can provide positive impacts in different sectors of a certain area, identifying the level of demand to pedestrianize an area and the governing warrant for pedestrianization can be challenging in decision-making. In this regard, the determination of prioritization weights from different transport professionals may help in understanding when and where pedestrianization measures can be implemented. The weights presented in this study can be used in the development of pedestrianization tools that can help urban and transport planners in policymaking. Active transport measures such as pedestrianization may help improve the

environment, especially in urban areas, and in the successful development of sustainable smart cities [16]. Urban transportation is one of the top contributors to environmental emissions in cities [17]. This is also observable in Metro Manila in the Philippines.

Table 3. Consistency Report

	Consistency Index (CI)	Consistency Ratio (CR)
Academe	0.0622	0.0429
NGOs	0.0334	0.0230
LGUs	0.0222	0.0153
Govt. Agencies	0.0652	0.0450
Combined	0.0143	0.0099

5. CONCLUSION

This paper focused on determining the prioritization weights of given pedestrianization warrants from the responses of transport professionals in Metro Manila. The prioritization weights can be computed through pairwise comparison questions and the application of analytic hierarchy process (AHP). Similarities on top pedestrianization warrants between the academe members and transport professionals from NGOs were observed. On the other hand, the same situation can be observed regarding top pedestrianization warrants between professionals from LGUs and transport-related government agencies. Overall, results suggest that among the warrants included, (1) public demand, (2) volume of pedestrians, NMT users, and commuters, (3) safety and security, and (4) level of service of pedestrians appear to be top pedestrianization warrants for all sectors combined. In a practical application of the implementation of pedestrianization, equal prioritization may be given to all warrants included in this study. However, different locations may require different considerations. In the case of Metro Manila, the top pedestrianization warrants identified in this study can aid in decision-making on when and where pedestrianization can be implemented.

Criteria	Weight	Score	Weighted Score
C1 Availability of Nearby Public Transportation	0.0694	x 0.7	= 0.0486
C2 Inadequate Street Geometry	0.0595	x 0.3	= 0.0179
C3 High Volume of Pedestrians, NMT users, & Commuters	0.1713	x 0.8	= 0.1371
C4 Noise & Air Pollution Levels	0.0618	x 0.2	= 0.0124
C5 Level of Service of Pedestrians	0.1453	x 0.4	= 0.0581
C6 Preservation of Heritage & Tourism	0.0697	x 0.2	= 0.0139
C7 Safety and Security	0.1540	x 0.3	= 0.0462
C8 Public Amenities and Equitable Access to Commerce	0.0921	x 0.7	= 0.0644
C9 Public Demand	0.1769	x 0.8	= 0.1415
Pedestrianization Index:			0.5401

Fig. 4. Theoretical Sample of a Proposed Pedestrianization Index

6. FUTURE RESEARCH

Using the prioritization weights identified in this study, a *pedestrianization index* that can be used to assess the potential of a location for pedestrianization may be

formulated. Fig. 4 shows a theoretical sample of a proposed pedestrianization index.

Although there are available measures for some of the pedestrianization warrants included in this study, some of the criteria are classified as qualitative. Future research may focus on quantifying each of the identified warrants in this study.

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