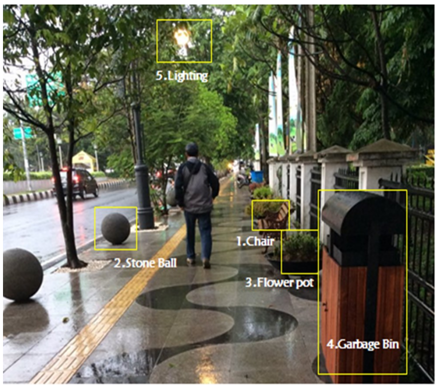
Analysis of Pedestrianisation Programme in Developing Cities : A case of "Panca Trotoar" in Bandung, Indonesia.



Five components of "Panca Trotoar" in Bandung

Public Space & Social Gathering at Pedestrian Facilities—Dago Street Bandung

Bandung is implementing a pedestrianisation programme called "Panca Trotoar" to provide citizens with safer, cleaner, and more visually appealing walking environments. The "Panca Trotoar" aims to achieve these objectives by ensuring all sidewalks have a bench for resting, a stone ball to prevent traffic on sidewalk, a flower pot for decoration, a garbage can for cleanliness and public lighting for security. The program is being partially or fully implemented in several parts of the city (table 1) since 2015 . The article aims to assess how the pedestrianisation program is meeting the need to encourage non-motorized (NMT) in Bandung city, Indonesia.

Table 1. List of Pedestrianisation Program in Bandung

No	Road Name
1	Jl. H Djuanda - Segment 1 (from Jl. Surapati until Jl. Martadinata)
2	Jl. H Djuanda -Segment 2 (from Jl. Dipati Ukur until Jl. Surapati)
3	Jl. R.E Martadinata - Segment 3 (from Jl. Aceh until Jl. A.Yani)
4	Around City Hall Office of Bandung City
5	Jl. Cibadak - Segment 1 (from Jl. Otto Iskandardinata until Jl. Astana Anyar)
6	Jl. Cisitu Lama 8,9,11
7	Jl. Sudirman - Segment 1 (from Jl. Otto Iskandardinata until Jl. Gardujati)
8	Jl. Buah Batu - Segmen 1 (from Jl. Soekarno Hatta until Jl. BKR)
9	Jl. Otto Iskandardinata - Segment 1 (from Jl. Stasiun Timur - Jl. Sudirman)
10	Jl. Ahmad Yani - Segment 1 (from Simpang Lima - railroad)
11	Jl. Dipati Ukur - Segment 1 (from Simpang Dago - UNPAD)
12	Jl.Aceh
13	Jl. Sukabumi
14	Jl. Ir. H Djuanda
15	Jl. Kopo
16	Jl. Mohammad Toha
17	Jl. Sriwijaya
18	Jl. Cibaduyut
19	Jl. Sukajadi

IGES research on assessment of pedestrian walkways in Bandung was implemented over four steps, as follows:

- The first step involved the distribution of a survey to 500 people to understand different people's preferences for a walking environment. The research apply hierarchy of walking needs within a social-ecological framework as shown in figure 1 to analyze the factor that encourage people to walk.
- The second step focus on developing walkability index at several pedestrian network in Bandung city not only consider the walker perspective but also accommodate non-walker opinions and perspectives.
- The third step involved running a simulation that analysed how changing the pedestrian environment through widening pedestrian facilities without any other supporting program may actually reduce average density of walkers per m^2 of pedestrian areas. The simulation shows interaction between walkers and vehicles at intersections within pedestrianisation network in Bandung.
- The forth step applied behavioural analysis to quantitatively assess how improvement to the pedestrian environments influence willingness to walk longer distances for different group of people. It use a logit model that consider biological, psychological and demographical aspects on decision making process to walk in Bandung.

IGES's 4 Steps Approach on Assessment of Pedestrianisation Program

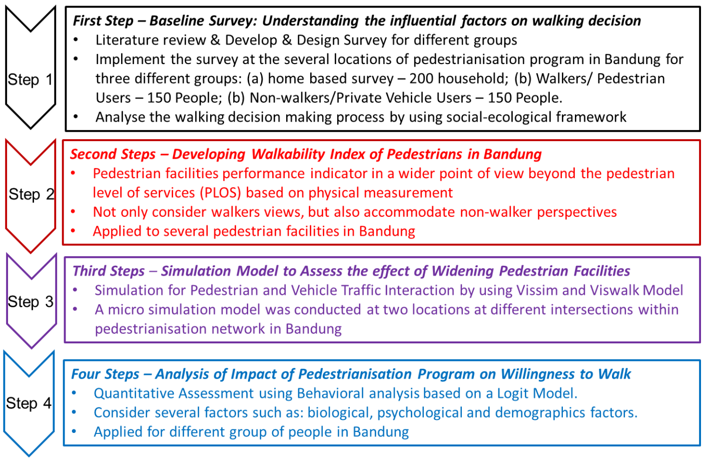


Figure 1. Four Steps Approach on Assessment of Pedestrianisation Program in Bandung, Indonesia

Step 1 : Understanding the Influential Factors on Walking Decision

The first step involved the distribution of a survey to 500 people to understand different people's preferences for a walking environment. The survey was implemented to three different groups: onsite survey of 150 walkers; in-situ survey of 150 private vehicle users at several location of pedestrianisation program and 200 home based survey at residential houses nearby location of pedestrianisation program. The research apply hierarchy of walking needs within a social-ecological framework as shown in figure 2 to analyze the factor that encourage people to walk.

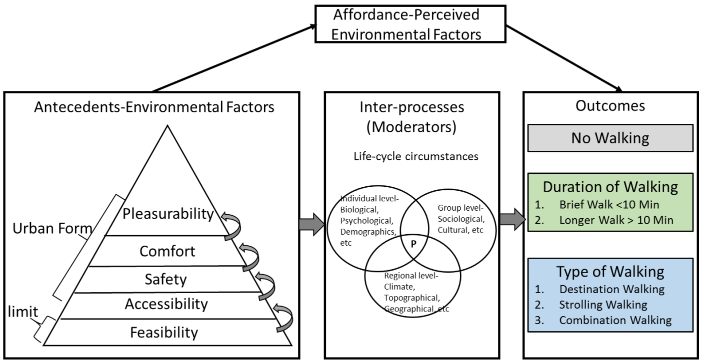


Figure 2. Hierarchy of Walking Need in a social-psychological framework (Alfonzo, 2005)

The research team applied a multi-criteria decision-making process to reflect respondent' priorities on antecedents environmental factors that influence decision to walk or not. This approach drew upon a method known Analytical Hierarchy Process (AHP) to help local respondentss prioritise factors based on the social-ecological framework developed by Alfonzo in 2005.

While previous research suggests that the most influential factor affecting the decision to walk is feasibility (involving time spent and travel distance) (Alfonzo, 2005), the survey revealed that ***safety and security were the most influential factors in Bandung***. In order to increase the shift from vehicles to walking, governments should treat security and safety as a top priority. The decision to walk is not only determined by environmental factors (figure 2) but also closely related to socioeconomic status and lifestyles (Alfonzo, 2005). For instance, vehicle ownership influences the decision to walk. Moreover, more educated and wealthier people tended to own vehicles that reduced their likelihood to walk. However, this relationship is not so straightforward. Increasing income and education may also make the benefits of walking seem more favourable. This could in turn increase the willingness to walk, offsetting the effects of a greater reliance on motor vehicles.

Figure 3. Hierarchy of Walking Needs in Bandung (2017)

Step 2: Developing Walkability Index of Pedestrian Walkways

Walkability Index for Bandung

The walkability index model is arranged by walkability components that reflect the performance of pedestrian facilities such as: geometric and surface condition, connectivity to surrounding destinations or public transportation, the sense of safety in crossing, existence of others, width of sidewalk, and the easy access to local stores, visual attractiveness, and social inclusion components are then regarded as the walkability components of pedestrian facilities. The walkers and non-walkers perspective of such components are compared to the physical indicator of pedestrian facilities (Park et al,2014). Those components such as width of side walk, percentage of commercial uses, average building width, and others. Then, the walkability model was developed based on the assumption that there was a linear correlation between the performance perspective of pedestrian facilities and its physical indicators. The analysis was applied to different land-use types such as: education facilities, commercial and business districts and also offices.

Across walkers and non-walkers, the attractiveness and visual appeal of pedestrian facilities received the highest score on the pedestrian index. In contrast, facilities for disabled persons and protection from environmental impact received the lowest score . There were some different perspectives on the key elements of a walkability index among pedestrian users and non-walkers. For the walkers, the built environment (captured by the percentage of commercial and residential areas; average building height and width; average building distance; access to commercial and local vendors; and total width of walking zone) were important factors. For non-walkers, visual appeal (captured by the amount of street furniture; access to commercial areas; percentage of sidewalk with unappealing characteristics) were important factors. There should be due attention to recognizing the different preferences of walkers (the built environment) and non-walkers (visual appeal) to maximize the use of pedestrian facilities.

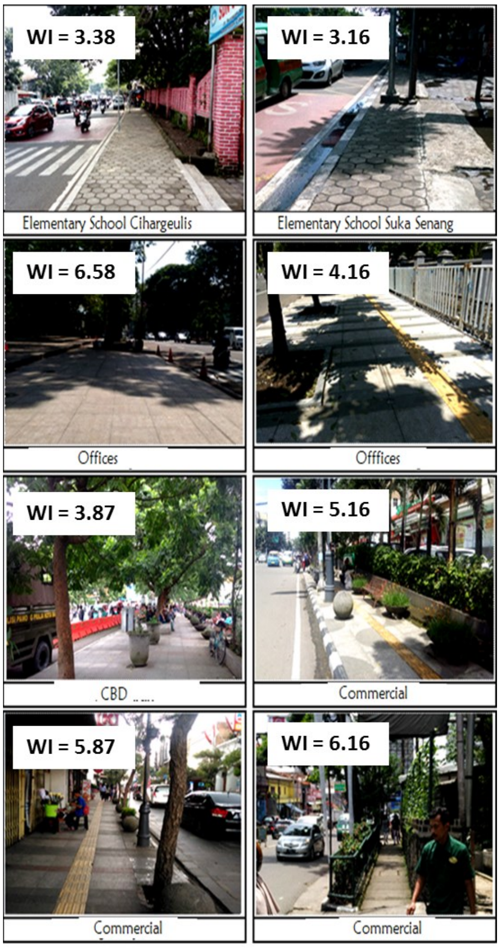


Figure 4. Walkability Index in Bandung

Step 3: Micro Simulation the Effects of Widening Pedestrian Facilities

A question related to the survey results is what would be the impacts of introducing some of the desired changes to the pedestrian environment. To help answer this question, the result of the survey were then entered into micro-simulation model that can help simulate interactions between pedestrian behaviour and vehicle use. The model considers how several variable related to pedestrians, vehicles and pedestrian environments influence walking and traffic flows. The overarching model consists of two models: Vissim (traffic simulation model) and Viswalk (pedestrian simulation model). The changes analysed in the model involved improvements to security and safety; a crossing facility that could help disabled people; and improved connectivity with public transport facilities. The model was applied on the two busiest intersections in Bandung, namely: Sudirman-Otista-Asia Africa and Asia Africa-Alun Alun.

Figure 5. Location of Micro Simulation Model in Bandung

The simulation shows that widening sidewalk around 1 meter will increase traffic delays about 5.03% and also increase average stop times of vehicle about 1.22% . In contrast, simply widening pedestrian facilities without any other supporting programs may reduce the pedestrian performance (average density – number of pedestrian users per m^2) by about 4.55%. Therefore, it is important to combine parking policies with parking facilities to encourage more people to walk in Bandung city. A suite of policies—as opposed to any single measure—is needed to maximize the benefits of pedestrianization.

Figure 6. Photo of Actual Situation in Sudirman—Otista Intersection

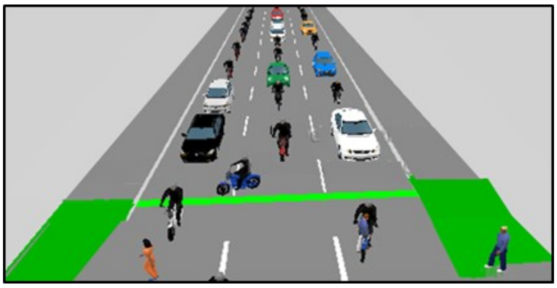


Figure 7. Visual Micro Simulation—Before Calibration

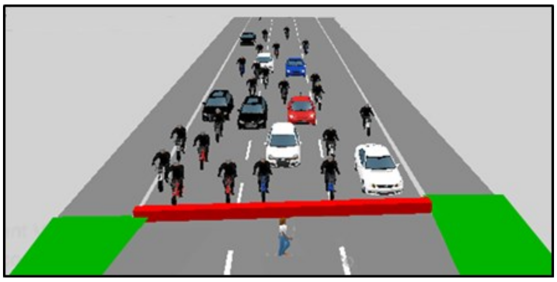


Figure 8. Visual Micro Simulation—After Calibration

Step 4: Analysis of the Impact of Pedestrinisation on Willingness to Walk Longer Distance

Acceptable Walking Distance in Bandung

The study reviews the walking distance from the user/walkers experience and the non-user (private vehicle users) perception. The walking distance of walkers was calculated based on approximate distance between origin and destination of the walking path which was reported in the questionnaire survey. While for non-walkers, acceptable walking distance was calculated based on their perception which attained by asking the non-user through an interview survey.

The result shows that acceptable walking distance of pedestrian users approximately 470 meter per day while the survey suggest the distance that private vehicle users would be willing to walk is 0.84 km which is incidentally longer than the estimated result for pedestrian users (figure 9).

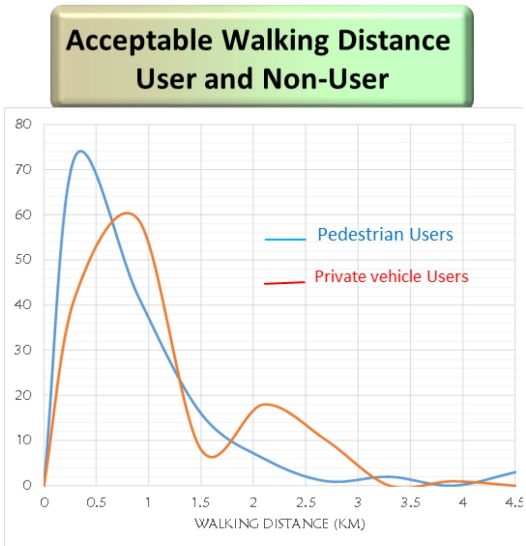


Figure 9 Comparison of Acceptable Walking Distance of Walkers and non-walker in Bandung

Willingness to Walk: Before & After Pedestrianisation

This study reveals that improvement of pedestrian facilities increase acceptable walking distance of typical citizen in Bandung. The result shows the increasing of willingness to walk among walkers are more than double the amount of the non-walker group or about 424 meter per day. These results indicates the improvement program had a clear impact on the walking distance in Bandung (see Figure 10). Looking at the impact of program by different respondents, most of private vehicle were willing to increase the distance they were willing to walk less than 500 meter. While the general citizen were willing to increase their walking distance a longer distance (Figure 11). The ordered logit model can help explain how much of the previously discussed factors contributed to the changes in distances in the pedestrian improvement program.

The estimation results by using logit model shows that individual attributes such as age and education level tended to increase walking distance. In contrast, changes to walking behavior were negligible for people who walked very little (less than 250 meter per day). While the effect of the three aforementioned variables were consistent across respondents, some variables influenced certain group differently; for example, motorcycle ownership had a positive influence on increasing walking distance for general citizen. Meanwhile, wealthy and unhealthy people did not to increase their walking distance. Further, gender and weight played an important role to improve walking behavior of non-walker group or private vehicle user. The model also capture interactions such as the link between gender and vehicle ownership.

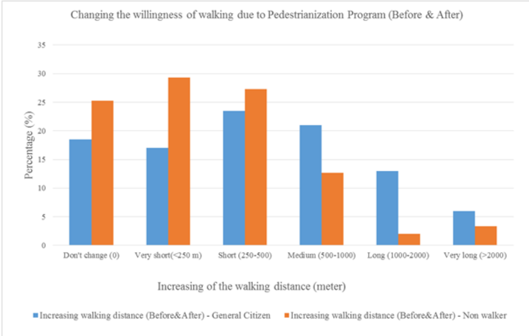


Figure 10. Changing the walking behaviour among different groups

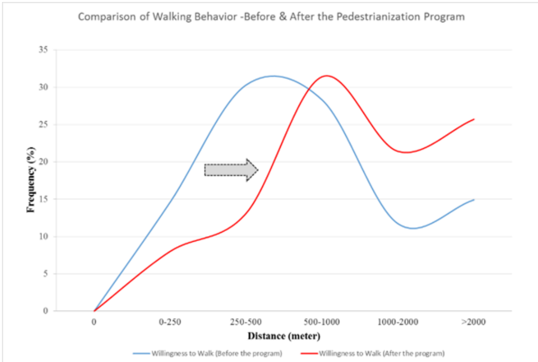


Figure 11. Comparison of Walking Distance, Before & After Pedestrianisation Program

Discussion and Way Forward

Co-Benefit Analysis

By combining the data on the acceptable walking distance and assumed influence on the shift from private vehicle to walking, the calculation reveals that the changes to pedestrian environment would yield around 1.76% drop in volatile organic compounds (VOCs) and a 1.2% drop in carbon dioxide (CO_2). These estimates are largely in line with those developed from the initial study that was conducted by by IGES using International Vehicle Emission (IVE) model in 2016. In evaluating these results, it is also important to bear in mind that more significant reductions could be achieved with more significant changes to the pedestrian environment.

Table 2. Estimation Results of Potential reduction of Emissions from Non-Motorized Transport (NMT) program

Emission	Daily Emission Reduction (Million Gram)	Emission reduction (%)
CO_2	1.82	1.20
VOC	0.23	1.76
NOx	0.18	0.95
PM	0.01	1.10

Way Forward

The article demonstrate a comprehensive approach to evaluate an effort to promote non-motorized transport through an improvement of pedestrian facilities in developing cities. There are four key messages from the study:

- First, the key influential factor affecting the decision to walk may differs from one place to another.
- Second, recognizing the different preferences of groups in the city would lead to maximize the use of pedestrian facilities.
- Third, quantitative analysis based on behaviour model is useful and important for science-based policy process
- Forth, combination of policies is needed to maximize the benefits of pedestrianisation at city level

The results of the study could provide feedback to city government in developing cities in order to improve the pedestrianization program towards the implementation of Sustainable Development Goals (SDGs) in Bandung city and other cities in Indonesia and also Asia. Although the study covered several interesting findings, it was not free from limitations. For instance, self-reported measures of walking distance may include bias and reliability issue of analysis results because it was based on information given by respondents; there is a need for actual measurement. Further, the sample size is rather small and may be increased to capture more parts of the city as the pedestrian program expands.

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