Evaluation of Existing Pedestrian Walkways and Facilities: An Analysis to Formulate Pedestrian Planning Guidelines

André F. DEL ROSARIO[a], Alexis M. FILLONE[b*],

[a,b] *Graduate School of College of Engineering, De La Salle University, Manila, Philippines*
[a] *E-mail: andre.fdelrosario@gmail.com*
[b] *E-mail: alexis.fillone@dlsu.edu.ph*

Abstract: The Philippines, as a developing country, is continuously undertaking new infrastructure projects like expressways, and interchanges that increases the capacity and scope of the road network. However, these infrastructures is only helpful to a certain point, and too much of is known to cause traffic congestion problems in the future. Because while infrastructures provide additional capacity and mobility for the vehicular roadway, it promotes the use of private vehicles instead of giving more attention to public transportation and improving the pedestrian environment to promote walking. This research is focused on evaluating the existing condition of pedestrian walkways and facilities in major intersection and interchanges in Metro Manila. Moreover, this research aims to determine the key elements to improve current condition of the urban pedestrian environment. With these research, traffic congestions in these road junctions as well as pedestrian accidents due to vehicular crashes will be reduced.

Keywords: Pedestrian, Safety, Interchanges, Intersection

1. INTRODUCTION

The Philippines, as a developing country, is continuously undertaking new infrastructure development projects such as expressways, interchanges, flyover, and underpasses which increases the capacity and expands the scope of the road network. These infrastructure projects such as the Skyway Extension and the SLEX-NLEX connector aim to decongest vehicular traffic and solve the long-time traffic congestion problem in Metro Manila according to DPWH secretary Mark Villar during one of his senate interviews dated September 8th, 2017.

However, having such infrastructure is necessary only to a certain point and too much of it is what causes traffic congestion problems. Bannister (2002) cited in his book that traffic congestion problems worsens overtime due to large increases in road capacity. In a way, instead of treating it as a roadway capacity problem, much focus should be given on demand management and use of public transportation. Leather, et al. (2011) further argues that these infrastructures are but temporary solutions for the traffic congestions. While it provides additional capacity and mobility for the road network, it also promotes the use of private vehicles. Thus after reaching the maximum capacity of the new roads and infrastructures, it will result again to traffic congestion mainly caused by private vehicles while leaving the pedestrians and public commuters outside the focus of development (Leather, et al., 2011).

The increasing population of the Philippines with an annual average population growth

rate of 1.73% from 2010 to 2015 according to the Philippine Statistics Authority (PSA), as well as the increase in vehicular traffic volume both contribute to the conflicts between vehicles and pedestrians that causes traffic congestion and pedestrian accidents (Lee & Abdel-aty, 2005). These conflicts are prevalent in major intersections and interchanges – where pedestrians and vehicles share the same road space at the same time. In this regard, it is important to effectively provide pedestrian walkways and adequate pedestrian facilities to minimize the conflicts between vehicles and pedestrians.

2. EFFECTS OF UNPLANNED PEDESTRIAN WALKWAYS AND FACILTIES

The inadequate walkways and facilities for the increasing number of pedestrians contribute to the increase of pedestrian accident rate. According to the MMDA Road Safety Unit, there have been about 56,018 pedestrian injuries and 1,859 pedestrian deaths due to vehicular crashers over a period of ten (10) years from 2005 to 2014 (Thinking Machines, 2015). During this time, motorcycles are the most involved in vehicular crashes having an average growth rate of 10.11% with a maximum crash count of 2400 last 2014. The second most involved in vehicular crashes are the private cars having an almost flat average growth rate of 0.16% with a maximum crash count of 1365 last 2013. The rest of the vehicle types have also an almost flat average growth rate with less than 600 count of vehicular crashes per year.

Also, lack of proper planning for the needs of the pedestrians creates vehicle-pedestrian conflicts that hinders the pedestrian to co-exist with vehicles in urban setting. These conflicts causes traffic congestion problems particularly in interchanges and major intersections if no provisions to separate/control the movements of these two. To further illustrate, a continuous uncontrolled crossing of pedestrians at an intersection is more traffic flow problematic instead of a controlled crossing with stoplight provision or a traffic enforcer controlled. Moreover, studies of Leather, et al., (2011), and van Eggermond & Erath, (2016) claims that by promoting walking, cycling, and the use of public transportation, traffic congestion problems can be reduced.

According to Retting et al., (2011) vehicle-pedestrian conflicts can be reduced by modifying the built environment of vehicles and pedestrians. One of the three suggested engineering modifications was to separate pedestrians from vehicles by time or space. In Philippine setting, these vehicle-pedestrian conflicts are in a form of the following: public utility vehicle drivers allow commuters to ride and alight in the wrong loading and unloading zones, uncontrolled pedestrians that randomly cross the vehicular traveled way, and pedestrian encroachment to the traveled way due to sidewalk discontinuity and pathway obstructions.

New Zealand Transport Agency (NZTA, 2009), a transportation agency in Europe that facilitates the modes of travel in New Zealand manages to promote and utilize walking as their second most form of travel in their urban cores. In their guideline, they practice to put the pedestrians at the very core of their planning process (NZTA, 2009). They have guidelines in providing adequate pedestrian walkway and facilities as part of their walking environment-friendly.

It is enough that these pedestrian facilities be planned and provided, but should also be well maintained and monitored by the authorities. As suggested by Shrestha (2011), pedestrian walkways should always be free from street hawkers and sidewalk vendors as these foreign elements compromises the safety, and blocks the smooth flow of foot traffic in the urban area. Malaysia, as a closer country of the Philippines here in Asia is already promoting human scale development approach to reduce traffic congestions in their urban cores by encouraging people-centric urban landscape. This approach reduces the pedestrians' dependence on cars and move towards mass transit as a means of transportation (Malaysian Economic Planning Unit, 2010).

In local setting, the Philippines have previously encourage non-motorized travel through implementing bicycle lane projects such as the Marikina Bikeways Network, and the MMDA bike lanes. However, mass transit options and pedestrian walkways together with its facilities are still lagging behind the international standards. That is why, this paper proposes a pedestrian planning guidelines that both DPWH and local government units (LGUs) can utilize to properly provide and assess the needs of the pedestrians.

3. STUDY AREAS

Presented in Figure 1 below are the study areas to be evaluated for this paper. The following are as follows: Balintawak interchange, Buendia-Osmeña intersection, and Nichols interchange. These study areas were chosen because of their direct connectivity to expressways and local roadways, thus acts as a road junction that requires a change in vehicle travel speed. Aside from the large volume of vehicles that these study areas cater, heavy foot traffic are also present in the area.

Balintawak interchange accommodates the pedestrians coming from and going the Ayala Cloverleaf development, the Balintawak public market, the LRT Balintawak Station, the Andres Bonifacio Elementary school, and those that are riding and alighting from the provincial busses at the toe of the interchange along A. Bonifacio Avenue.

On the other hand, Buendia-Osmeña intersection is a road junction that serves the largest pedestrian volume among the three, as it is not only bounded by mass transportation means such as Provincial busses from the South of Metro Manila, and Buendia station of the Philippine National Railways (PNR), but also, it is located in Makati Central Business District. Moreover, the vicinity of this road junction is also a haven for the different condominiums that houses an average of 20 floors per building; another is the presence of the Cash and Carry Mall that also attracts both vehicles and pedestrians in the area. Further, it is also one of the major entry/exit point of South Luzon Expressway (SLEX) and Skyway towards Makati and Bonifacio Global City (BGC).

Lastly, Nichols interchange just south of Buendia-Osmeña intersection handles the local pedestrian volume from a large cluster of residential houses of the city of Taguig and Pasay – as it is the boundary of the two cities of Metro Manila. The students of the Philippine State College of Aeronautics, the Jeepney terminal near the interchange and the Nichols's PNR station at the toe of the interchange greatly contribute to the foot traffic in the vicinity. With regards to vehicular movements, this interchange provides access to the East and West service roads of the South Luzon Expressway (SLEX) aside from Bicutan interchange, and serves as a direct access for NAIA terminal 3 coming from the Makati and BGC.

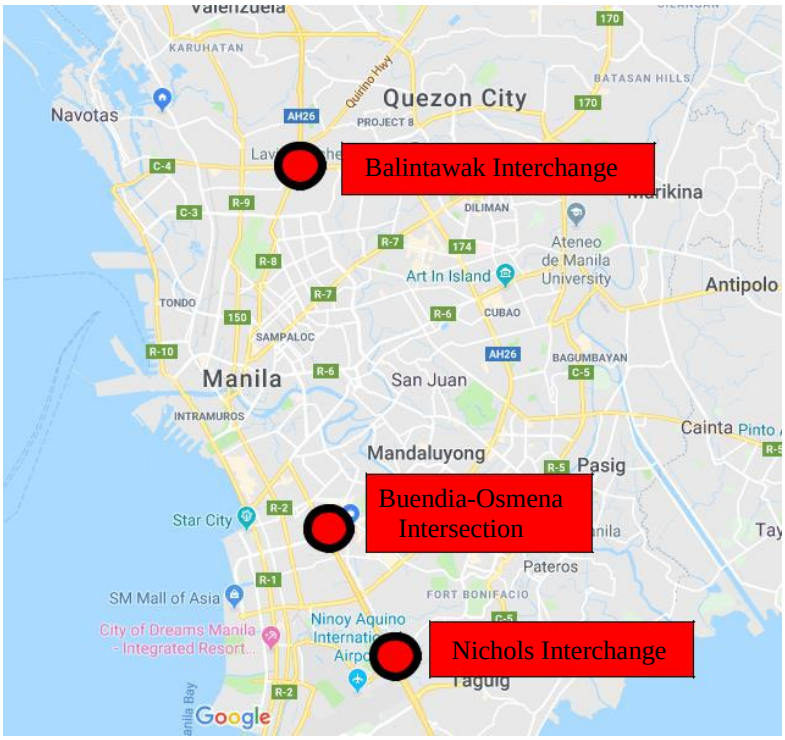


Figure 1. Study Areas Across Metro Manila

4. METHODOLOGY

In formulating a pedestrian planning guideline that can improve pedestrian walkways and facilities of future infrastructure projects, evaluation of existing interchanges and an intersection in Metro Manila was undertaken. The following items are utilized in establishing and evaluating the current condition of the study areas, as well as in formulating recommendations in improving the quality of future pedestrian walkways and facilities:

1) Vehicle-pedestrian conflicts in the study area;
2) Evaluation of existing pedestrian walkways and facilities through Pedestrian Level of Service (PLOS) assessment rating;
3) Evaluation of existing pedestrian walkways and facilities through pedestrian survey rating;
4) DPWH Planning Division's stages of planning before constructing an infrastructure project;
5) Transportation experts' assessment of qualitative walkability elements thru Analytic Hierarchy Process (AHP) using a pair-wise comparison matrix as suggested by Saaty (1980).

The first item considered in this paper is the conflicts between vehicles and pedestrians which were observed and recorded during site reconnaissance, PLOS assessment rating, and pedestrian survey rating on site. These conflicts occur due to lacking continuity of pedestrian walkways and pedestrian facilities such as delineated pedestrian crossing (at-grade, overpass, or underpass), stoplight controlled pedestrian crossing or presence of a traffic enforcer, these conflicts occur. Appendix A presents the vehicle-pedestrian conflicts on the three study locations are presented in Appendix A for a more visual presentation.

The second item in the list involves evaluation of study areas using PLOS assessment rating as used in the study of Asadi-Shekari et al., (2014). The PLOS assessment for this paper used several pedestrian indicators to determine the level of service of each study areas. The indicators used for this paper were adopted from Asadi-Shekari et al., and are presented in Table 1 below with its corresponding coefficients. PLOS assessment rating aimed to rate the three study locations and determine which pedestrian factors are lacking. The level of service rating will be based on equivalent scores from 0 to 100 for level of service (LOS) A, B, C, D, E, and F, with A being the highest, and F as the lowest.

Table 1. Pedestrian Indicators and Coefficients

Indicators	**Coefficient, c**
Slower Traffic Speed	37
Buffer and Barriers	38
Fewer Traffic Lanes	15
Street Crossing	32
Footpath Pavement	32
Crosswalk Marking	22
7. Width of Footpath	56
8. Lighting	31
9. Signing	24
10. Slope	34
11. Curb Ramp	31
12. Signal	27

$$PLOS = \sum_{i=1}^{12} c_{iPI_i} \quad (1)$$

PLOS	=	Pedestrian Level of Service
i	=	Indicator Number
c	=	Coefficient of pedestrian indicator
PI	=	Pedestrian Indicator score

The next evaluation procedure for the existing pedestrian walkways and facilities of the study areas is through pedestrian survey rating. Each of the fifty (50) on-site respondents are chosen randomly as suggested by Zainol et al., (2014). The survey assessment aimed to obtain feedbacks from the pedestrians regarding the quality of the pedestrian walkways and facilities that they currently used in their respective location.

Each respondent is given a questionnaire sheet with two picture per pedestrian variable, one depicting a poor score, and the other a high score. Each variable are rated from 1 to 9 following a Likert scale type of rating. The pedestrian variables used are as follows: (1) Weather Protection (2) Walking Surface (3) Sidewalk Width (4) PWD Ramp (5) Sidewalk Obstruction (6) Easiness in Crossing Roads (7) Over speeding Vehicles (8) Public Utility Vehicle (PUV Terminal) (9) Sidewalk Aesthetics (10) Lighting (11) Cleanliness (12) Directness of Path (13) Signage Visibility (14) Police Visibility (15).

Moreover, incorporated in the pedestrian survey questionnaire are demographic questions for each of the respondents and used for survey data correlation. In search for solutions to improve the pedestrian walkways and facilities in Metro Manila, eighteen (18) DPWH personnel were interviewed. The interviewees were part of the DPWH's Planning Service Division (PSD), headed by Undersecretary Cathalina Cabral, PhD.

The department's PSD is sub-divided into five (5) more divisions namely: Statistics Division (SD) – in charge of collecting and encoding data to their database, Project Preparation Division (PPD) – conducts pre-feasibility studies and determine if the project is viable using secondary data, Environmental Division (ED) – conducts environmental and social assessment for the pre-feasibility study, Development Planning Division (DPD) – evaluates and approves the project based on the pre-feasibility study, and Programming Division (PD) – in charge of lobbying the project to the Department's project pipeline for funding, after approval of DPD. The conducted interviews provided insight on the current planning procedure of DPWH prior to an infrastructure project design and construction. The results of this survey were utilized to identify the possible modifications and improvements to their present procedures in their pedestrian studies and facilities maintenance.

The last item considered in this paper involved seventeen (17) surveyed transportation experts that ranked different pedestrian qualitative walkability elements based on their professional practice and academic knowledge. These walkability elements are as follows: comfort, convenience, safety, security, walkway continuity, and attractiveness. Except for attractiveness, each of the elements have their respective sub-elements: for comfort – weather protection, walking surface, sidewalk width, PWD ramp and rail, and free from obstruction, for convenience – at-grade crossing, overpass/underpass crossing, path directness, and signage visibility, for safety – manned pedestrian crossing, stoplight for pedestrian crossing, and sidewalk fence, for security – police visibility, CCTV provision, and absence of concealed areas, and lastly for walkway continuity - PUV terminal connectivity, PUV lay-by, sidewalk continuity.

The main elements followed by the sub-elements were ranked using a pair-wise comparison matrix. The results were then analyzed using Analytic Hierarchy Process. After this, the scores in percentage of the main elements were used as a multiplier to the scores of the sub-elements in order to have a weighted score on each sub-element. This process were repeated to each of the experts' questionnaire. After calculating the results for all the experts, Geometric Mean was used to represent all the expert's ranking assessment per element and sub-element.

5. RESULTS

Presented below are the results of the different data analysis and interview summaries of the surveys conducted. These results include the pedestrian level of service (PLOS) assessment rating, and pedestrian survey assessment based on the existing pedestrian walkways and facilities of the study areas. This paper also presents the results of the interview surveys with DPWH planning personnel regarding their project planning process, and transportation experts' professional insights in improving the current pedestrian walkways and facilities, and raking the pedestrian qualitative walkability elements to determine which are to be prioritize for pedestrian planning of new infrastructure projects.

5.1 Evaluation of Existing Pedestrian Walkways and Facilities through PLOS Assessment Rating

Based on the pedestrian walkways and facilities of Balintawak Interchange, Buendia-Osmeña Intersection, and Nichols Interchange, pedestrian level of service rating were obtained for each location. However, unlike the PLOS suggested by the Highway Capacity Manual, this method does not relay on pedestrian flow and speed but rather on the pedestrian walkways condition and the availability of important pedestrian facilities. PLOS assessment in each of the study areas involved actual measuring and recording of the walkway and facilities such as traffic speed adjacent to the sidewalk, buffer and barrier measurements, number of traveled lanes, number of street crossings, crosswalk marking (zebra markings), sidewalk width, lighting, adequate signing, sidewalk slope, curb ramp for PWDs, and traffic signal for pedestrian crossing. The pedestrian walkways and crossings in each study area were mapped and are presented in Figure 2, 3, and 4 for Balintawak Intechange, Buendia- Osmeña Intersection, and Nichols Interchange, respectively.

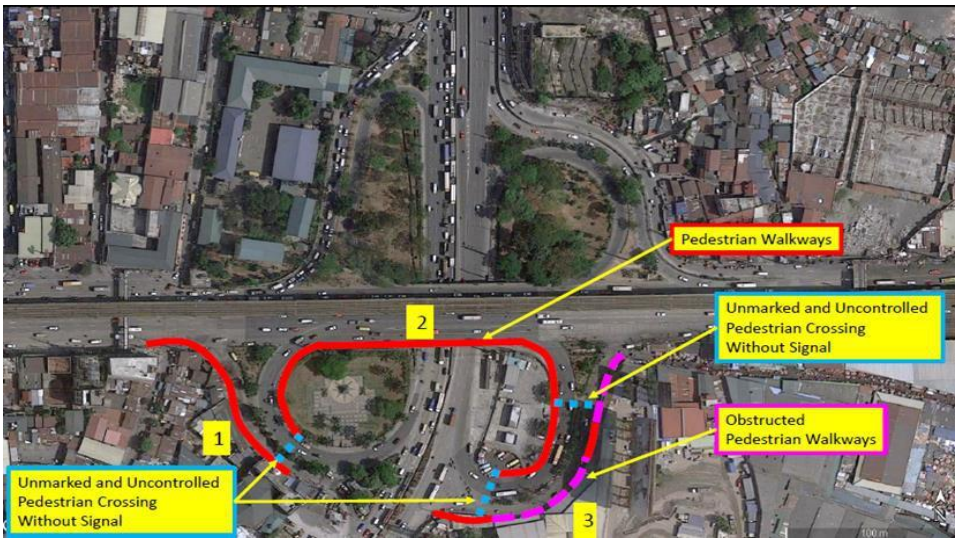


Figure 2. Pedestrian Walkways and Crossings in Balintawak Interchange

As shown in Figure 2, the Balintawak interchange have three (3) necessary pedestrian crossings. All of which do not have pedestrian traffic signal, and crosswalk markings; while traffic enforcers are only present in during rush hour. These crossings are represented by broken lines in color blue. As observed on site, pedestrian walkways are occupied by vendors and parked vehicles, these sidewalks are represented by broken lines in color magenta. While the usable standard sidewalks are represented by the solid lines in color red. Further, this lack of adequate pedestrian walkways have significantly contributed to the low PLOS assessment rating of the area. The following are the available pedestrian signage in the area: (1) one transit terminal sign, (2) one no loading and unloading sign, (3) three no littering sign, (4) three no parking sign, and one pedestrian sidewalk sign.

Moreover, as shown in Figure 3, the Buendia-Osmeña intersection have four (4) necessary pedestrian crossings. Of all four, only one has pedestrian crosswalk markings, and while the intersection is controlled by traffic enforcers for vehicular movement, pedestrian movement crossing Gil Puyat Avenue is still uncontrolled and without provision of pedestrian traffic signal. Marked pedestrian crossing is represented by broken lines in color yellow, while unmarked pedestrian crossing by broken lines in color orange. Pedestrian sidewalks on the other hand are adequately provided on three out of four observed walkways in the area that are represented by straight color red lines. The following are the available pedestrian signage in the area: (1) three pedestrian crossing sign, (2) two bus stop sign, (3) one no loading and unloading sign, (4) one no parking sign, and (5) one pedestrian sidewalk sign.

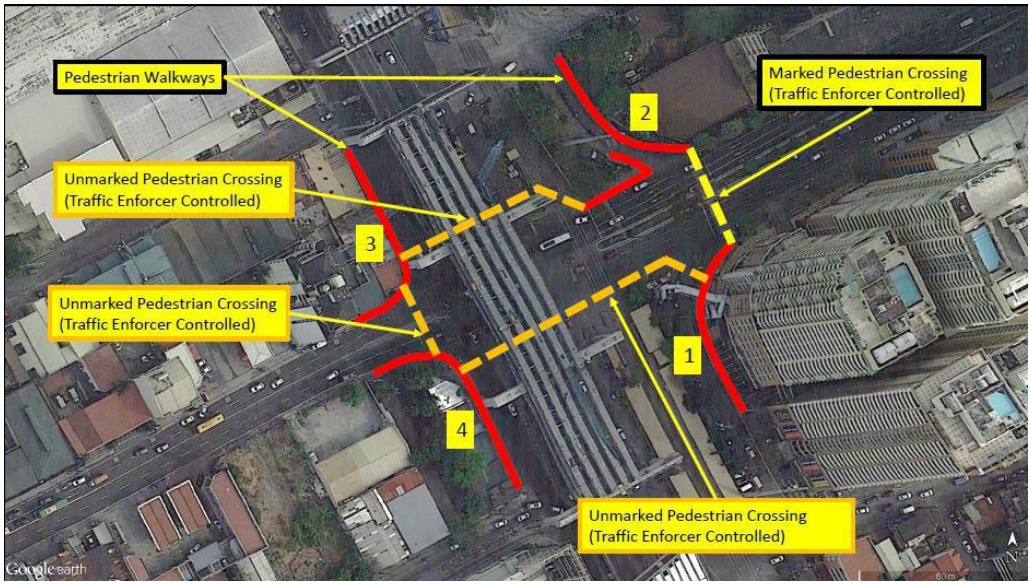


Figure 2. Pedestrian Walkways and Crossings in Buendia-Osmena Intersection

Lastly, as shown in Figure 4, the Nichols Interchange have four (4) necessary pedestrian crossings. All four of them are uncontrolled pedestrian crossing with only one having crosswalk markings. The pedestrian crossings have no pedestrian traffic enforcers nor pedestrian traffic signals. Marked pedestrian crossing is represented by broken lines in color yellow, while unmarked pedestrian crossings by broken lines in color blue. In addition to this, adequate pedestrian walkways are adequately provided on two out of four observed walkways in the area that are represented by straight color red lines. The following are the available pedestrian signage in the area: (1) one transit terminal sign, (2) one no loading and unloading sign, (3) one way finding sign.

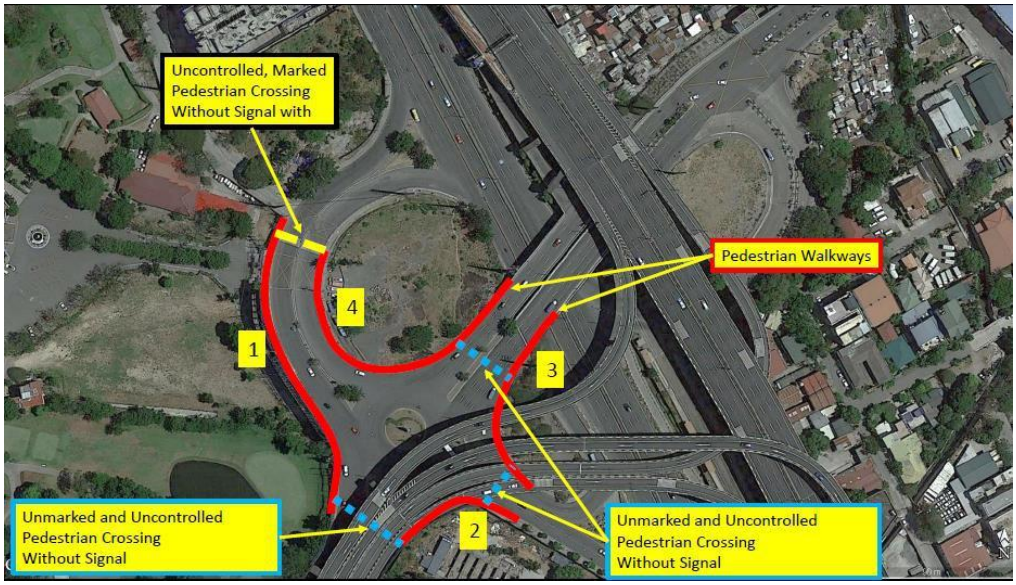


Figure 4. Pedestrian Walkways and Crossings in Nichols Interchange

Further discussing the PLOS score ratings obtained from the three study areas, the coefficient value per indicator represents the maximum value that each indicator can have. And while all three study areas are serving high volumes of vehicle and pedestrian traffic, they do not share the same sufficiency in terms of pedestrian walkways and facilities.

Summary of the scores and ratings of each study area are presented in Table 2, 3, and 4 below.

Table 2. Equivalent PLOS scores of Study Locations

PLOS Indicators	Code	Coefficient	Equivalent PLOS Score		
			Nichols Interchange	Buendia Intersection	Balintawak Interchange
Slower Traffic Speed	PI 1	37	37.00	37.00	37.00
Buffer and Barriers	PI 2	38	38.00	38.00	25.33
Fewer Traffic lane (number of travel lane)	PI 3	15	0.00	0.00	10.00
Street crossing	PI 4	32	7.02	32.00	3.07
Footpath Pavement	PI 5	32	28.80	30.18	21.59
Crosswalk marking	PI 6	22	5.50	5.50	0.00
Width of footpath	PI 7	56	28.00	40.60	18.67
Lighting	PI 8	31	23.25	23.25	15.71
Signing	PI 9	24	6.00	10.50	12.00
Slope	PI 10	34	14.73	15.87	0.00
Curb ramp	PI 11	31	0.00	7.75	0.00
Signal	PI 12	27	0.00	0.00	0.00
Total		379.00	188.30	240.65	143.36

Table 3. PLOS Equivalent Rating

Study Location	PLOS % Score	PLOS Rating
Nichols Interchange	49.68%	C
Buendia-Osmena Intersection	63.50%	B
Balintawak Interchange	37.83%	D

Table 4. PLOS % Interpretation

PLOS % Rating	PLOS % Score	Interpretation
A	80-100	Highest quality, many important pedestrian facilities are present
B	60-79	High quality, some important pedestrian facilities are present
C	40-59	Average quality, pedestrian facilities present, but there is a room for improvement.
D	20-39	Low quality, minimal pedestrian facilities
E	1-19	Lowest quality, very unpleasant
F	0	There is no standard pedestrian facility

As presented in Table 2, pedestrian sidewalks and crossings have significantly affected the PLOS rating in each location. Low score ratings were recorded on Nichols and Balintawak Interchange due to the lack of pedestrian sidewalks and crossings as shown in Figure 2 and 4. The significant score reductions were particularly observed in footpath pavement, width of footpath, street crossing, and crosswalk marking indicators. Moreover, these four were the major factors that drove the PLOS rating of the two mentioned study locations lower than that of Buendia-Osmeña intersection. The PLOS assessments calculated for Nichols and Balintawak Interchange yielded scores of only 49.68% and 37.83% with corresponding PLOS rating of C and D, respectively. While Buendia- Osmeña Intersection on the other hand yielded a score of 63.50% with a PLOS rating of B due to more sufficient pedestrian walkways and facilities, and pedestrian crossings.

5.2 On-site Pedestrian Assessment Survey

The surveys were conducted on September 4, 2018 on three study locations - Nichols Interchange, Buendia-Osmeña Intersection, and Balintawak Cloverleaf Interchange. There were fifty (50) respondents for each study location. Out of the combined one hundred and fifty respondents, 82 are male, and 68 are female. Also, it was noted that 66 are still studying, while 84 are working. The pedestrian surveys yielded a mean score rating of 4.73, 4.74, and 4.12 out of 9, respectively for Balintawak Interchange, Buendia-Osmeña Intersection, and Nichols Interchange. The mean scores per variable are presented in Figure 5, while the Mode of all three study areas is identified to be five (5).

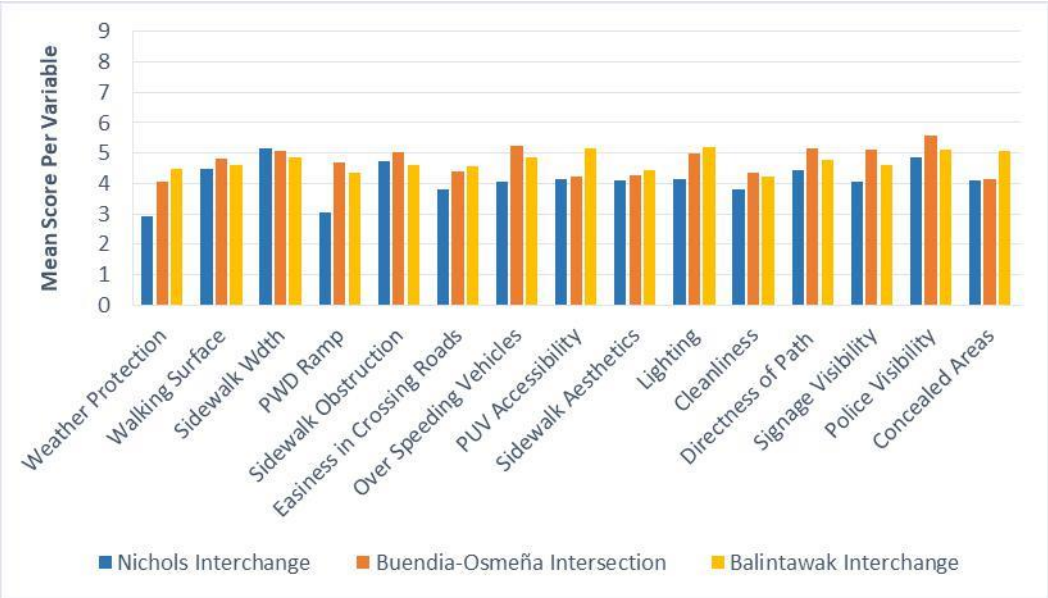


Figure 5. Mean Scores of the Pedestrian Walkway and Facility Variables per Study Location

5.3 DPWH Planning Personnel Survey Interview

The eighteen (18) interviewed DPWH personnel are all part of the DPWH's Planning Service Division (PSD) headed by Undersecretary Cathalina Cabral, PhD. This department is in charge of undertaking feasibility studies prior to project funding, design, and construction. The conception of a project has three (3) phases, the first phase is the project planning under the Planning Service Division (PSD) – which have been mentioned above; the second phase is the Detailed Engineering Design under the Bureau of Design (BOD) – done after the full-blown feasibility study and preliminary engineering design from the Project Planning phase; the third is the Construction Phase under the Bureau of Construction (BOC) of DPWH.

Among the interviewees is Engr. Nenita R. Jimez, officer-in-charge of the Development Planning Division (DPD), she mentioned during the course of the interview that all preliminary engineering plans coming from the PSD have pedestrian facilities on them as part of their Department Order 164 (DO 164) that states all DPWH projects should have a complete set of road attributes including shoulder, curb and gutter, and the pedestrian sidewalk. However, it is only stated that a sidewalk is necessary in the design and construction, but does not include the provisions for pedestrian crossings that are the key to complete the pedestrian walkways in a project vicinity, especially in interchanges and major intersections.

Moreover, for existing intersections and interchanges, Bureau of Quality and Safety (BQS) assumes the responsibility for pedestrian facilities improvement. Improving both pedestrian walkways and facilities are critical in encouraging the pedestrians to use the sidewalks and move away from using vehicular travelled way, they added. Also, one of the PSD personnel cited that sidewalk vendors should be prevented from encroaching to the pedestrian sidewalks. With the help of the local government units (LGUs), this can be achieved as they are the ones issuing the permits for these establishments, however for the unregistered vendors, they also have the authority to swept and prevent these sidewalk vendors from occupying the pedestrian sidewalks.

Further, interview questions for providing public utility stops along the stretch of major roadways was also asked. They responded that it is something they consider, however, it falls under the jurisdiction of the Metro Manila Development Authority (MMDA). They think that it is not widely provided due to insufficient space in the road corridor of the urban environment. But again, with the help of the LGUs, additional road right of way can be obtained. Lastly, the PSD interviewees were asked on how they decide when to put up a pedestrian overpass or construct a pedestrian underpass, they said that this depends on the length of ROW, volume and speed of the traversing vehicular traffic, flood risk of the project including cost savings, and lastly, the aesthetics preferred by the LGUs.

5.3 Assessment of Existing Pedestrian Walkways and Facilitiesin the Urban Environment by the Transportation Experts

About seventeen (17) transportation experts from different Universities and consultancy firms from the industry were surveyed and interviewed for this paper. The questionnaire provided a section where existing conditions of pedestrian walkways and facilities in Metro Manila can be discussed. Most of them mentioned that sidewalks are being occupied by vendors, there is no continuity for the walkways, it is too narrow, and sometimes none at all. Also, due to the lack of passenger transfer facilities, PUVS board and alight at illegal stops, thus encouraging passengers to disobey traffic rules. These cases not only cause traffic congestions, but also increases the rate for vehicle-pedestrian accidents. The experts added that existing pedestrian walkways and facilities are not responsive to the present needs of the pedestrians, car-centric, and have no regard to the distances of crossing facilities.

With regards to the vehicle-pedestrian crashes due to uncontrolled pedestrian crossings, the experts suggested that pedestrians should be separated from vehicular movement or they could be provided with a controlling factor at pedestrian crossing location such as pedestrian traffic light or traffic enforcer. Strict implementation of policy for both pedestrians and vehicles should also be observed to reduce these vehicle-pedestrian conflicts, they added. Aside from the separation of vehicles and pedestrians, they also think that the following improvements to both existing and future interchanges and major intersection: wider sidewalks that can provide two-way foot traffic that are free from street vendors and obstructions, covered walkways/sidewalks, zebra crossings, pedestrian signals, traffic enforcers, increased security, proper lighting, and standard PWD provisions.

To ensure the above mentioned improvements, Dr. Sigua of UP Diliman, NCTS suggested a "paradigm shift – give priority to crossing pedestrians, people before vehicles". Truly, if we put the pedestrians at the heart of every infrastructure design, we'll have a more pedestrian friendly environment. Other traffic consultants also pointed out that LGUs in conjunction with the barangay officials, should stop letting the vendors occupy the pedestrian walkways just to prevent conflicts with voters, especially during the time of the election. In addition to this, one of the traffic consultants from SMDI Consultants - a transportation consultancy firm, and a graduate student from UP Diliman suggested that the national government should have a branch that handles transportation and transport related duties that include ensuring that each planned infrastructure have considered the necessary provisions for the pedestrians, and continuously monitor existing pedestrian walkways in the country for new pedestrian needs in terms of continuity, as well as the maintenance. Lastly, most of them suggested that pedestrian needs should be considered in the early stages of infrastructure planning and not after infrastructure completion.

5.4 Assessment of Qualitative Walkability Elements by Transportation Experts using Analytic Hierarchy Process (AHP)

Part of the survey questionnaire of the transportation experts is the ranking of the different qualitative walkability elements using pair-wise comparison matrix. These elements were categorized into six (6) groups: safety, security, walkway continuity, convenience, comfort, and attractiveness. Safety scored the highest at 22.9% which represents its weighted importance across the all six elements. This was followed by security, walkway continuity, convenience, comfort and attractiveness with scores of 18.5%, 18.4%, 18.4%, 12.7% and 9.1% respectively.

In calculating each element's weighted importance, weighted geometric mean was utilized prior to AHP analysis. Initially, the transportation experts' weighted average were calculated individually then the data were combined to a single value using a weighted geometric mean per element. The equivalent geometric mean scores of the six (6) elements are presented in Figure 6 below.

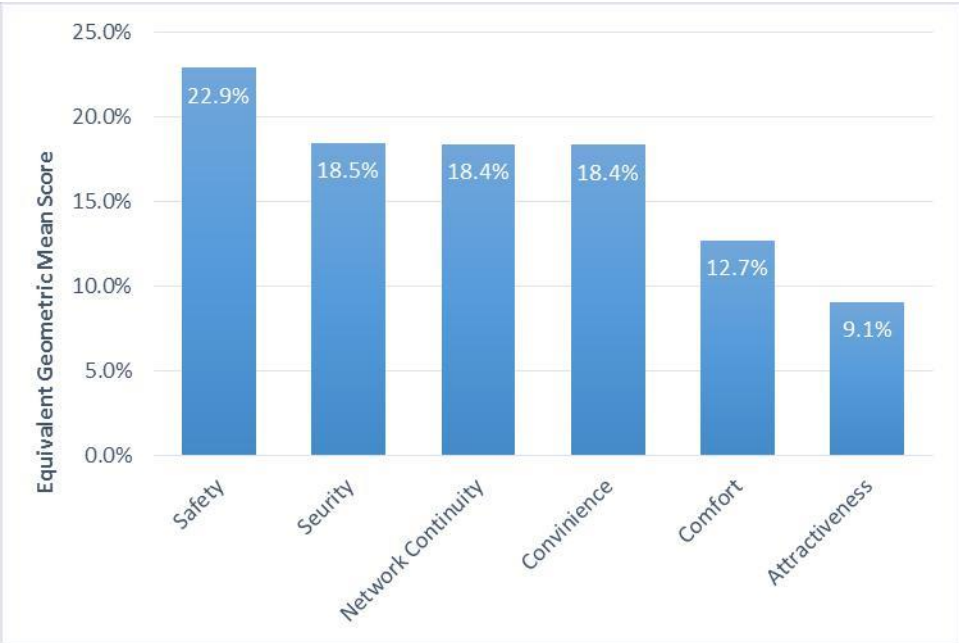


Figure 6. Expert's Hierarchal Ranking of the Qualitative Walkability Elements

The sub-elements of comfort are as follows: weather protection, walking surface, sidewalk width, PWD ramp and rail, and free from obstruction. Among these, the last one proves to be the most significant for the surveyed experts with a weighted geometric mean score of 26.1% and an equivalent weight of 3.3%. Continuing, the sub-elements of convenience are at-grade crossing, overpass/underpass crossing, path directness, and signage visibility. With at-grade crossing identified to be the most preferred sub-element with a weighted geometric mean score of 30.9% and an equivalent weight of 5.7%.

Safety, the third element category, includes manned pedestrian crossing, stoplight for pedestrian crossing, and sidewalk fence; and the preferred sub-element by the experts is the stoplight for the pedestrian crossing with a weighted geometric mean score of 44.2% and an equivalent weight of 10.1%. For the fourth element, security includes police visibility, CCTV provision, and absence of concealed areas. For this group, police visibility is the most preferred by the experts with a weighted geometric mean score of 36.8% and an equivalent weight of 6.8%. And lastly, walkway continuity includes PUV terminal connectivity, PUV lay-by, sidewalk continuity; among these, the experts favored PUV terminal connectivity with a weighted geometric mean score of 38.6% and an equivalent weight of 7.1%. The equivalent geometric mean scores of all the sub-elements are presented in Figure 7 below.

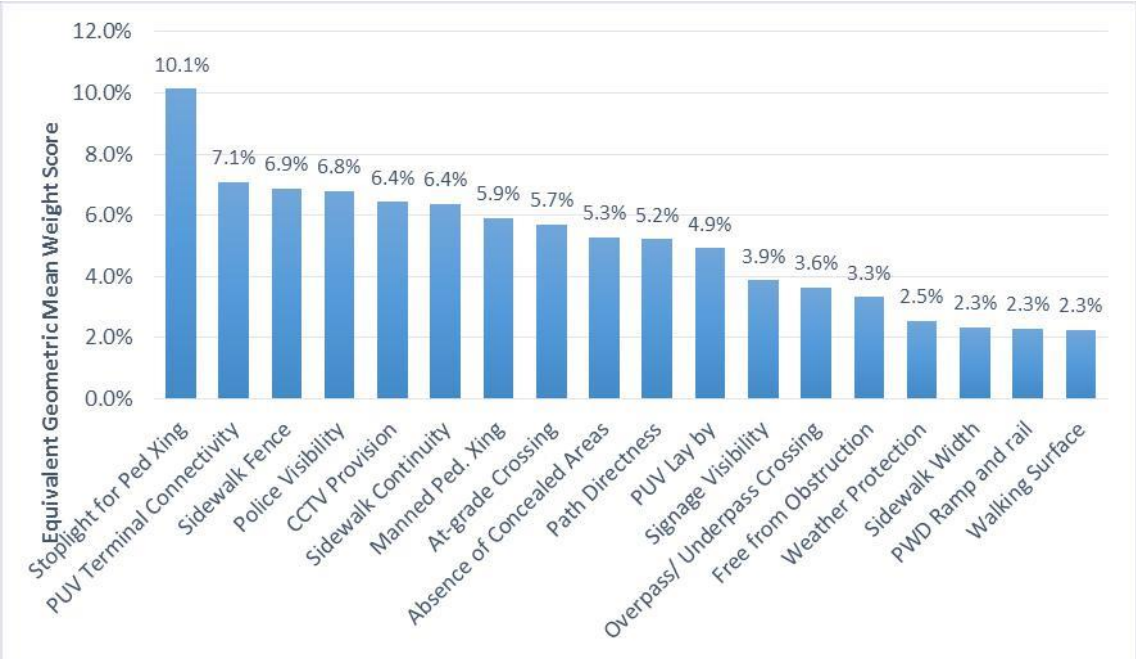


Figure 7. Expert's Hierarchal Ranking of the Pedestrian Walkways and Facilities Sub-elements

6. CONCLUSIONS

Based on the observed vehicle-pedestrian conflicts in the study locations, encroachment of the pedestrians to vehicular travelled way due to sidewalk obstructions, and uncontrolled pedestrian crossings brought by lack of dedicated pedestrian crossings significantly increases the possibility of pedestrian accidents, and impede affect the safety of the pedestrians and considerably impede the vehicular traffic flow.

The evaluation of the existing pedestrian walkways and facilities in the three study locations was conducted through PLOS assessment and on-site pedestrian survey assessments. The first assessment yielded the following results: Balintawak Interchange scored the lowest (37.83%) with PLOS rating of D due to lacking pedestrian crossings and because of obstructed sidewalks. Buendia-Osmeña Intersection on the other hand scored the highest

(63.50%) with a PLOS rating of B with adequate provisions on sidewalk and crossings. Lastly, Nichols Interchange scored 49.68% with a PLOS rating of C that requires improvement on its sidewalk width and pedestrian crossings. In summary, the results of the conducted PLOS assessments show that all three study locations still have improvements to make to further/fully eliminate vehicle-pedestrian conflicts in the area.

The results of the second assessment – on-site pedestrian surveys, yielded mean scores of 4.73, 4.74, and 4.12 respectively for Balintawak Interchange, Buendia-Osmeña Intersection, and Nichols Interchange. The calculated mean scores from the pedestrians' feedback reflects almost the same description of the PLOS rating mentioned above. The statistical mode for all three locations was identified to be in the middle of the used Likert scale of 9 which is 5. These results suggest that the actual users of the pedestrian walkways and facilities are barely satisfied with present pedestrian environment and that improvements are really needed.

In investigating the DPWH planning procedures including the pedestrian studies, it was identified that the PPD and DPD are the two most significant division in terms of pedestrian planning. The former as facilitator of pedestrian studies and the latter as the evaluator of preliminary study requirements prior to design and construction implementation. By effectively coordinating with these divisions, future development projects can be provided with adequate pedestrian walkways and facilities. And Ms. Nenita Jimenez – officer in charge of the DPD suggests that the regional and district offices should have frequent joint meetings to discuss and monitor pedestrian problems in their respective areas. On another note, to efficiently coordinate with LGUs and the DPWH offices (main, regional and district offices), this research proposes a technical working group (TWG) assigned per city. This group would be part of the pedestrian planning process of the DPWH as well as other local government issued projects. The TWG would be comprised of representatives of LGU, DPWH planning personnel, and transport engineers that are capable of analyzing both the present and future needs of the pedestrians in area.

Regarding the results of PLOS and AHP, it is interesting to note that while safety was identified to be the most preferred qualitative walkability element by the transportation experts, lack of adequate pedestrian walkways and pedestrian crossings are the key factors to improve PLOS rating based assessed interchanges and major intersection. This suggests that the results of AHP analysis and PLOS evaluation lead to the same assessment which is to increase/improve the safety features of future interchanges and major intersections. These improvements would lead to lesser vehicle-pedestrian conflicts and reduce the risks for pedestrian accidents and vehicular traffic congestion.

Lastly, although not all qualitative walkability sub-elements used in AHP analysis were included in the list of indicators for PLOS assessment, these sub-elements were represented in the PLOS assessment ratings. And based on the results of this research, both PLOS evaluation and AHP analysis provided an identical conclusion – that the studied existing interchanges and major intersection have insufficient pedestrian safety facilities. Finally, AHP analysis can ideally be used for improving future pedestrian walkways and facilities of interchanges and major intersections, while PLOS assessment rating is ideal for improving existing interchanges and major intersections.

7. RECOMMENDATION

Based on the evaluation of existing interchanges and major intersection using PLOS assessment, it was identified that lacking pedestrian walkways and crossings as shown in Figure 5-10 to 5-12 needs to be improved to significantly increase the PLOS score rating of

the area. In addition to this, based on the transportation experts' assessment on qualitative walkability elements, stoplight signal for pedestrian crossing under main walkability element of safety was identified to be the most important element to significantly improve the pedestrian environment of the area.

On another note, based from the interview with Ms. Nenita of DPWH planning, there is a coordination problem with the DPWH main office to their district and regional offices, as well as with the DPWH and the LGUs. Thus, pedestrian planning preparation as well as updating/improvement of the existing pedestrian walkways and facilities are impeded. In this regard, this research proposes a TWG comprised of representatives from the different stakeholders mentioned above along with a transport engineers per city. This group will be spearheaded by the local government as they are the primary users of the pedestrian walkways and facilities of the area. Also, this group would be part of the pedestrian planning process for future infrastructure projects, and would also oversee the maintenance and updating of the pedestrian walkways and facilities especially on interchanges and major intersection. Lastly, this TWG group is proposed to be mandated by the national government especially for Metro Manila and on other major Metropolis in Visayas and Mindanao.

The members of the proposed TWG would have the following roles to ensure the improvements of pedestrian walkways and facilities on future infrastructure projects:

1. Local Government Unit (LGU) Representative
   - To prevent vendors, street hawkers, and parked vehicles from occupying the pedestrian walkways.
   - To maintain the cleanliness of the pedestrian travelled ways and to ensure that pedestrian facilities are properly working.
   - To provide police and traffic enforcer assistance stationed within the vicinity of interchanges and major intersections.
   - To assist in acquiring/maintaining the recommended public transport terminal.

2. DPWH Planning Division Representative
   - To ensure that adequate pedestrian study would be conducted during the planning stage of the new project.
   - To ensure adequate pedestrian walkways and facilities are included in the planning phase of the project.
   - To include the studied pedestrian walkways and facilities, and access to public transport when funding for the new infrastructure project.

3. Transportation Experts
   - To yearly assess the pedestrian walkways and facilities on interchanges and major intersections for maintenance/repair works.
   - To yearly conduct pedestrian studies that would address new pedestrian needs such as PWD provisions, and crossing provisions within the interchange or major intersection.
   - To continuously develop adequate access to public transport terminal and to recommend effective transport terminal locations.

For subsequent and more in-depth studies specifically on improving pedestrian walkways and facilities in urban environment, the researcher suggest that:

- More sample respondents should be used for the on-site pedestrian surveys
- Utilize focus group discussions with the residents to discuss their needs in terms of walkability and pedestrian facilities
- Further studies be made for standardizing the evaluation of pedestrian level of service based on pedestrian walkways and facilities here in the Philippines

REFERENCES

Bannister, D. (2002. Transport Planning, 2nd Edition. New York, NY: Spon Press Retrieved from https://epdf.tips/transport-planning-transport-development-and-sustainability.html

Leather, J., Fabian, H., Gota, S., & Mejia A.,. (2011). Walkability and Pedestrian Facilities in Asian Cities. Retrieved from https://www.adb.org/sites/default/files/publication/28679/adb-wp17-walkability-pedestrian-facilities-asian-cities.pdf

Lee, C., Abdel-Aty M., Comprehensive analysis of vehicle–pedestrian crashes at intersections in Florida, Accident Analysis & Prevention, Volume 37, Issue 4, 2005, Pages 775-786, Retrieved from www.sciencedirect.com.lib1000.dlsu.edu.ph/science/article/pii/S0001457505000564

Thinking Machines. (2015). More than 57,000 Metro Manila Pedestrians Hit by Vehicles Since 2005. Retrieved from https://stories.thinkingmachin.es/road-danger-pedestrians/

Retting, R. A., Ferguson, S. A., & McCartt, A. T. (2003). A review of evidence-based traffic engineering measures designed to reduce pedestrian–motor vehicle crashes. American journal of public health, 93(9), 1456-1463.

Shrestha, B. (2011). Street typology in Kathmandu and street transformation. Urbani Izziv, 22(2), 107-121. Retrieved from http://www.jstor.org.lib1000.dlsu.edu.ph/stable/24920582

Malaysian Government. The Economic Planning Unit. (2010). Tenth Malaysian Plan. Malaysia: Prime Minister's Department Putrajaya.

Republic of the Philippines. Philippine Statistics Office. (2015). Philippines in Figures.

Van Eggermond, M., & Erath, A. (2016). Pedestrian and transit accessibility on a micro level: Results and challenges. Journal of Transport and Land Use, 9(3), 127-143. Retrieved from http://0-www.jstor.org.lib1000.dlsu.edu.ph/stable/26203234

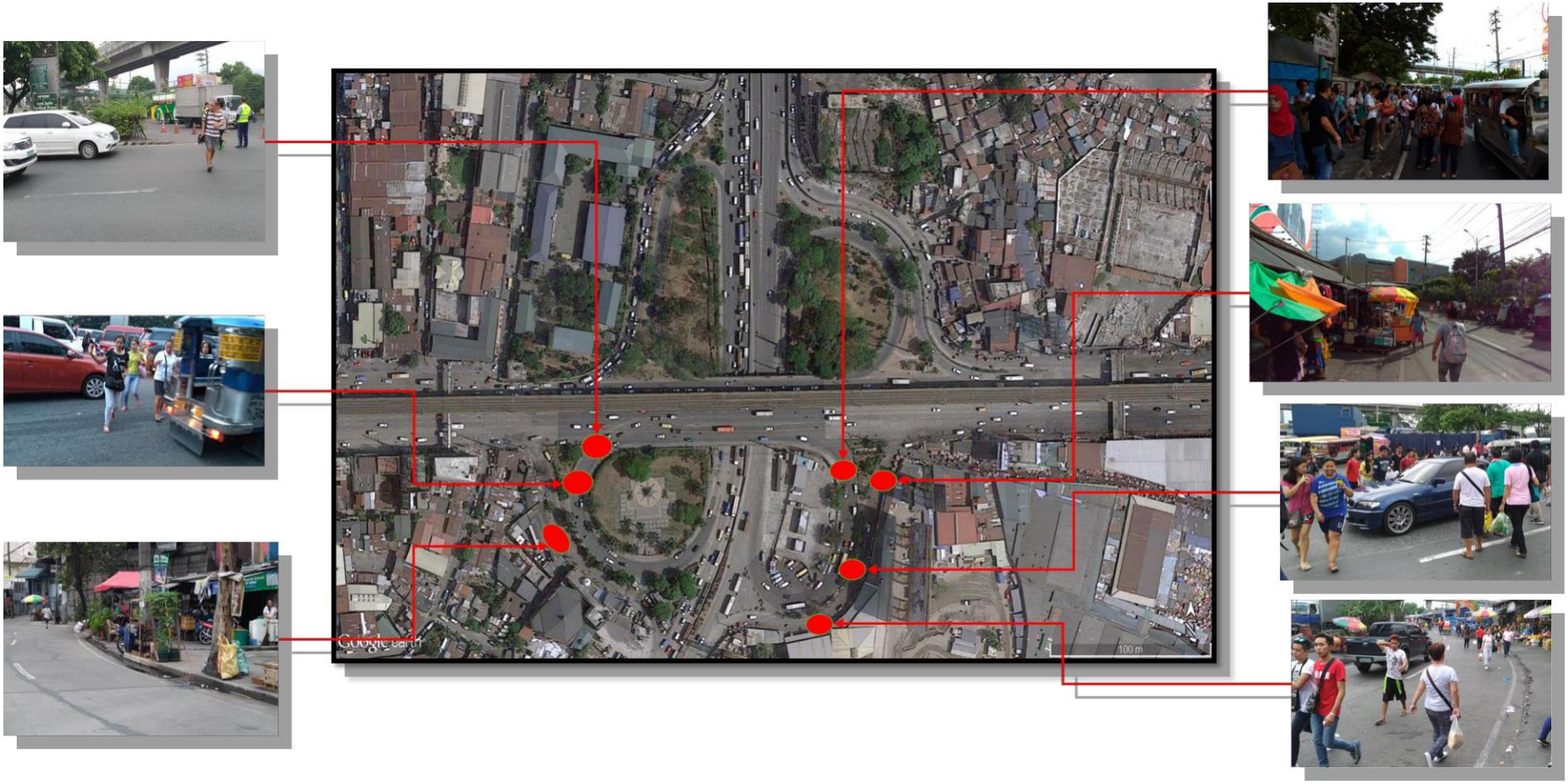
New Zealand Government. New Zealand Transport Agency. (2009). Pedestrian planning and design guide. New Zealand: New Zealand Transport Agency.

Asadi-Shekari et al., (2014). Pedestrian Level of Service Method for Evaluating and Promoting Walking Facilities on Campus Streets. Journal of Land Use Policy 38(2014), 175–193

Zainol et al., (2014). Evaluation of users' satisfaction on pedestrian facilities using pair-wise comparison approach. IOP Conf. Ser.: Earth Environ. Sci. 18 012175

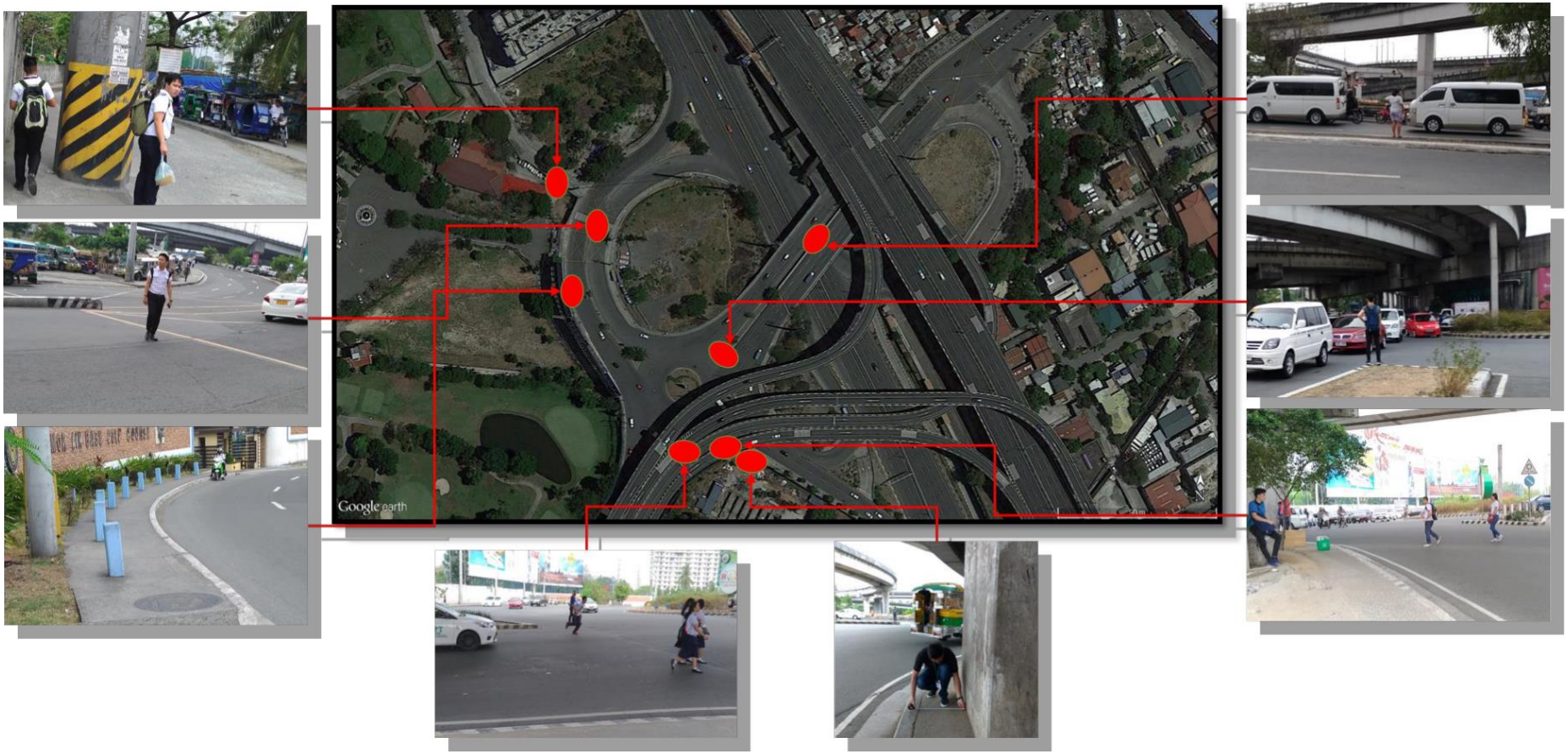
Saaty, T. L. (1980). The Analytic Hierarchy Process: Planning, Priority Setting, Resource Allocation. McGraw-Hill

APPENDIX A
Vehicle-Pedestrian Conflicts in Study Areas



Vehicle Pedestrian Conflicts in Balintawak Interchange

Vehicle Pedestrian Conflicts in Buendia-Osmeña Intersection



Vehicle Pedestrian Conflicts in Nichols Interchange