Economic Impacts of Roadway Utility Obstructions in the Philippines

Mary Jane CASTILLO [a], Crispin Emmanuel DIAZ [b]

[a,b] School of Urban and Regional Planning, University of the Philippines Diliman, Quezon City, 1104, Metro Manila, Philippines
[a] *E-mail:* mscastillo5@up.edu.ph
[b] *E-mail:* cddiaz@up.edu.ph

Abstract:

Road widening projects aim to alleviate traffic congestion and bring about economic benefits in terms of transport savings. Utility obstructions along the widened highways inhibit the generation of these benefits. Moreover, obstructions inflict danger against the travelling public. In a recently widened highway in Rizal Province, Philippines, it was found that from 2017 to 2018, an average of around PhP 37,813,631.79 economic losses per year were incurred due to the obstructing utility poles within the roadway. These account for unrealized traffic decongestion benefits and vehicular crash costs.

The quantitative analysis for this study also confirmed that the cost for relocating obstructing utility poles is cheaper than the unrealized project benefits plus costs of road crashes with obstructions. Thus, there is an urgent need for immediate improvement of coordination between highway and utility sectors.

Keywords: Transport Project Benefits, Road Widening, Utilities Relocation, Coordination, Road Crashes

1. INTRODUCTION

1.1 Background of the Study

The perennial problem of traffic congestion has seated deeply into our system, like culture, directing the way we do about our lives and fulfill our societal duties. Congestion is a clear manifestation of rapidly increasing urban population. As populations grow and urban communities become denser, the demands for infrastructure and services also increase. These significantly affect the fabric of urban infrastructure, which may now seem deficient compared to everything it has to accommodate. It has been indicated in the World Bank Online Databank that in 2016, the population growth rate in the Philippines was at 1.6%, exceeding that of its co-ASEAN member states Thailand and Vietnam with 0.3% and 1.1%, respectively. Expanding populations constitute increasing traffic demands and the need to provide additional utilities to cater to all households.

Similarly, travel demand is also expected to significantly increase within a decade. In a report facilitated by the National Economic and Development Authority (NEDA) and Japan International Cooperation Agency (JICA) in 2014, it was estimated that the total travel demand in the Greater Capital Region (GCR) would grow by about 20% by the year 2030. With the parallel growth in household populations and traffic demands, the interdependence of urban infrastructure systems will be strained even further. Nevertheless, the road infrastructure sector of the government should continue to strengthen its technical expertise in forecasting future traffic demand. Reasonable prediction of demand for facility expansions considering the trends of population growth and housing demand is a significant input to the management of utilities.

However, despite the intentions and intensive efforts of both sectors to bring good service to the general public, problems arise one way or another, causing inconvenience rather than amenity. Across the Philippines, the travelling public has experienced a great deal of inconvenience and losses brought about by the apparent lack of coordination between the highways sector and private utility companies. This issue is manifested by the presence of electric posts standing in the middle of a newly-widened road and by the tearing up of recently-paved or surface-overlaid street to make way for underground water service improvement projects. Furthermore, road crashes due to obstructing utilities along the roadway also happen, imposing even more losses.

Roadway obstructions entail significant disruption to the flow of traffic within and around the project area, especially in highly-dense urban settings like Metro Manila and its immediate surrounding areas. In a study conducted by JICA in 2014, it was estimated that the Philippines was losing around PhP 2.4 Billion a day due to traffic congestion. In the agency's latest update in February 2018, the daily economic losses in 2017 due to the extreme traffic conditions in Metro Manila were reported to have increased to PhP 3.5 Billion. Similarly, OECD/ECMT in 2007 suggested that the costs for road traffic congestion can amount to approximately 1% of Gross Domestic Product (GDP).

If proven true, the lack of planning, coordination, and compliance to existing policies cause damages that result to additional costs to the government the private sectors, as well as the travelling population. The presence of utilities, particularly electric posts, within the road carriageway delays the realization of traffic decongestion effect because of road widening. However, while relocation of facilities might be expensive, the delay in relocation of facilities appears to give rise to yet other problems, such as 1) traffic disruptions caused by the obstructions; and 2) the road safety hazard of the obstacle in the "new" lane. Prompt relocation is apparently hampered by: 1) the tedious process of acquiring new facility locations; and 2) the institutional complexities between the public and private sectors during the relocation process.

Despite the enactment of national laws and policies that aim to solve the highway-utility problems, road obstructions remain widespread across the country. The institutional restrictions, among many concerns, pose critical setbacks on both the utility and highway sectors.

Government agencies conduct studies to determine the technical and economic feasibility of public investment projects. It follows standards and procedures that are guided by recognized development institutions such as the Asian Development Bank (ADB) and The World Bank. However, studies on technical and economic aspects may sometimes overlook other details in implementation that may significantly constrain and defer the expected benefits from such public investments. These include, among many others, concerns that are political in nature, and issues on inter-agency coordination that often lead to delays in implementation, as well as the above discussed losses and costs arising from poor coordination of projects in the same space (i.e. the roadway).

1.2 Research Problem

There are factors that bring about the failed coordination between different urban infrastructure systems, which in turn impose negative economic effects. It is necessary to assess the factors that cause the lack of coordination between the highway and utility sectors and to determine the economic impacts due to the sub-optimal use of the recently widened road lanes.

1.3 Research Objectives

The study is primarily focused on helping effective policy implementation for the attainment of the economic objectives of public investment projects—particularly national roads. The study recognizes the need to find out ways to harmonize the functions of public roads and adjoining utility lines. The study aimed to:

1. Identify and assess the scale of economic impacts of utility poles left on road widening projects in terms of direct costs (construction costs and ROW acquisition costs) and indirect costs (traffic disruption costs and safety hazards)
2. Come up with policy recommendations towards the improvement of public works-utility coordination

1.4 Scope and Limitations

The study is focused on the effect of conflicts between road widening projects and the presence of obstructions (i.e. electric power utility lines that were not relocated) within the roadway. Inasmuch as some principles may also apply with the case of other facilities such as water utilities, this study does not cover these discussions as comprehensively. Moreover, the study does not cover discussions on other matters such as displacements due to the road widening project.

Ortigas Avenue Extension (National Road Section S01598LZ)

Figure 1. Road Section S01598LZ - Photographed on Feb. 26, 2018

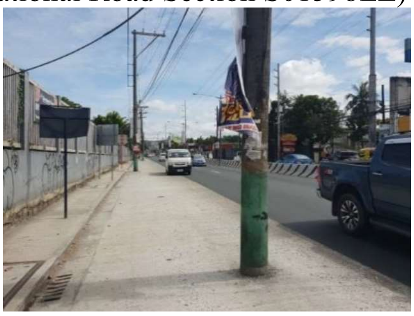

Figure 2. Road Section S01598LZ - Photographed on Jan. 20, 2019

The problem is evident across many different places in the country; However, due to the limitations in time and resources, the research was limited to a specific study area —where manifestations of challenges in highway-utility coordination are present (See figures above). Furthermore, quantitative analyses relied on secondary data that may not fully capture the conditions of the study area which is located in Rizal, a highly urbanizing province situated on the east of Metropolitan Manila. The study was primarily inspired by the actual observed problem in the case of the widened road sections of the Ortigas Avenue Extension.

1.5 Significance of the Study

Providing a deeper understanding of the complexities of coordination between agencies responsible for highway development and utility companies as well as the identification of underlying factors that introduce possibly avoidable costs or disbenefits to the society as a whole will potentially help the appropriate entities—relevant government agencies such as the Department of Public Works and Highways (DPWH), Department of Energy (DOE), as well as local government units – improve the implementation and control over local infrastructure projects so that these projects may better deliver their intended benefits.

2. REVIEW OF RELATED LITERATURE

2.1 Interrelationships of Urban Infrastructure Systems

The integrated infrastructure systems approach of Saidi *et. al* (2017) recognizes the considerable efficiencies and synergistic benefits among each individual component. The conventional relationship or cycle among the components begins with transport infrastructure introducing accessibility to land thereby inducing residential and industrial development. The birth of new settlements and industries warrant supporting infrastructural expansions that are independently operated.

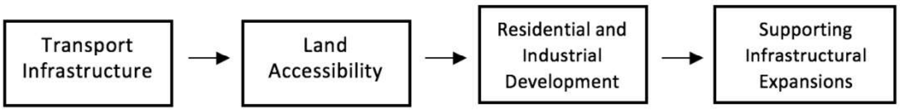

Figure 3. Relationship of Infrastructure System Components, Saidi et. al (2017)

However, Saidi *et. al* (2017) recognize that urban infrastructure systems are now becoming interdependent as they are subject to common factors such as: information and technological innovation, risk of failure to due age, population growth, extreme events, and climate change.

When populations grow and lands are made accessible, residential and industrial development are thereby induced. According to Saidi *et. al* (2017), the birth of new settlements and industries warrant supporting expansions of infrastructure such as utilities, transportation, and social infrastructure.

Graham and Marvin (2001) believe that infrastructure networks integrate urban spaces and bind separate cities, regions, and nations into functioning geographical and political wholes. These are systems that require public regulation in order to add cohesion to territory.

Guided by related literature, this study is anchored to the principal idea that road transport infrastructure and the utilities sector are two closely interdependent urban infrastructure systems. Having adopted this principle, this study is aimed at demonstrating the importance of harmonized urban systems development in order to avoid significant economic disbenefits.

Taking population growth as an example of a critical driver to the interdependency of urban infrastructure systems, this study suggests that the components reveal to be connected as follows:

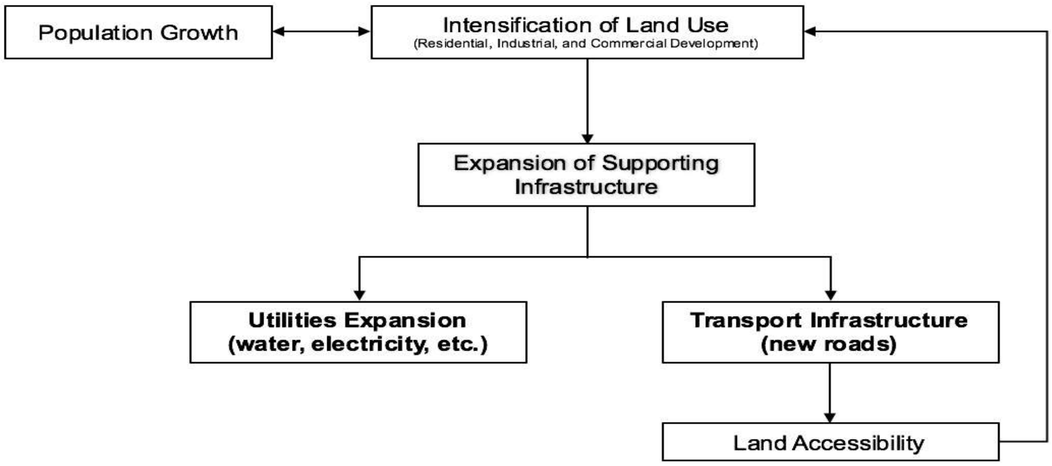

Figure 4. Interdependency of Urban Infrastructure Systems
Relating to Population and Land Use

2.2 Highway-Utility Coordination

2.2.1 Experience from other countries

For the United States of America, the idea of strengthening coordination between the public roads sector and utilities sector dates back to the late 1950s at the height of Federal-aid Interstate Projects. Kirk, J. (1960) suggested the importance of policies affecting utilities in the light of highway construction. It was the American Water Works Association (AWWA) that championed "A Policy on the Accommodation of Utilities on the National System of Interstate and Defense Highways" which was adopted on 1959 by the American Association of State Highway Officials (AASHO). Above all, it was always the interest of the general public that has been secured in the accommodation, adjustment, relocation, or installation of utilities as being brought upon by development.

American Public Works Association Research Foundation, on the other hand, facilitated a research called "Accommodating Utility Plant Within the Right-of-Way of Urban Streets and Highways". The study aimed to provide policy guidelines on the accommodation of utility facilities within public right-of-way in urban places, in consideration of associated factors such as safety, appearance, cost, quality of service, reliability, maintenance efficiency and public convenience (Wyss and Dodson, 1973).

Moreover, the United States of America seems to have established a replicable model for policy development on the matters of highway-utility coordination. This may have been long adopted by its cities and states in their formulation of policies and regulations. Way back in 1973, Kansas City in the state of Missouri firmly enacted a legal decision-making utility companies responsible for the removal and relaying of its facilities, at its own expense, when such action is required to give way to public improvement. Further, the inclusion of utility facility adjustment works as part of road construction contracts was institutionalized in the city (Burkhead, 1973).

Furthermore, different utilities are likewise expected to be in good harmony. As suggested by Baarslag *et. al* (1969), proper coordination between utilities may provide the opportunity for different utilities to utilize a joint ditch, as with the case of underground facilities (tunnels), in order to generate cost savings and other benefits for the good of all.

The Strategic Highway Safety Plan of the American Association of State Highway and Transportation Officials (AASHTO) (2005), identifies the strategy of the U.S. to implement a national policy to reduce the risk of fatalities and injuries due to roadside utility poles. In the U.S., the National Academies of Sciences, Engineering, and Medicine (2004) recognizes utility pole crashes as a subset of run-off-road (ROR) crashes.

AASHTO (2005) reports that in 2003, utility poles are the third leading fixed object hazard in terms of highway deaths in the U.S.. According to the National Cooperative Highway Research Program (NCHRP) Report of the National Academies of Sciences, Engineering, and Medicine (2004), there were at least 1,008 fatal crashes associated with utility poles in 2002. The distribution of maximum severity for crashes with all poles, including utility poles, are shown as follows:

Table 1. Distribution of maximum severity for pole crashes

Maximum Severity	% Share
Fatal	1%
Incapacitating	7%
Non-Incapacitating	17%
Possible Injury	15%
None	60%

Source: National Academy of Sciences, Engineering, and Medicine (2004)

The local transportation professionals are expected to identify the most hazardous poles for removal or relocation, and the participation of utility companies is crucial. AASHTO (2005) sees the need to provide training for transportation experts and utility company personnel in order to supplement the effort to ensure effectiveness. The National Academy of Sciences, Engineering, and Medicine (2004) states that the initiatives are dependent on factors such as the institutional arrangements and procedures of involved agencies, the need for additional right-of-way, and the need to follow other exigent processes (e.g. considerations on environmental impact). Varying factors also affect the associated costs for each identified measure. See table below.

Table 2. Classification of strategies towards road safety in relation to utility poles

Timeframe	Relative Cost to Implement and Operate			
	Low	Moderate	Mod. to High	High
Short (less than 1 year)	Relocate poles in high-crash locations; Shield drivers from poles in high-crash locations; Improve driver's ability to see poles in high-crash locations	-	-	-
Medium (1-2 years)	Develop, revise, and implement policies to prevent placing or replacing poles within the clear zone	Apply traffic calming measures to reduce speeds on high-risk sections	Use break-away devices Decrease number of poles along the corridor	Relocate poles along the corridor farther from the roadway
Long (more than 2 years)	-	-	-	Place utilities underground

Source: National Academy of Sciences, Engineering, and Medicine (2004)

It should be noted that the discussions above regarding the U.S. case of road crashes associated with utility poles refer to *roadside* utility poles. Such fixed objects are situated outside the road carriageway, and thus, may not be considered as obstructions.

This study discovers that, in the Philippines and in other countries, there is limited available literature on highway-utility coordination, particularly on the conflicts surrounding the management of obstructive utility poles *within* the road carriageway. The lack or absence of international publications on utility obstructions may suggest, subject to actual and intensive verification, that the problem does not occur in other countries. This brings the realization that if the problem does not happen in other countries, it should not be happening in the Philippines as well. The need to solve the problem of utility obstructions in the Philippine highways is even more emphasized. In view of the observed lack of available, related research or academic publications in the Philippine context, the study capitalizes on relevant policies in place and focuses on the review of existing regulations on road utility obstructions.

2.2.2 Policies, inter-agency, and inter-sectoral coordination in the Philippines

Section 9 of Republic Act (RA) No. 10531 or the "National Electrification Administration Reform Act of 2013" duly amended Section 16(j) of Presidential Decree No. 269 as follows:

> "x x x
>
> In the event of the need of such lands and thoroughfares for the primary purpose of the government, the electric cooperative shall be properly compensated;"

In 2014, the Department of Public Works and Highways (DPWH), through the Department Order No. 73 Series of 2014, issued a policy on the removal of all obstructions and prohibited uses within the right-of-way of National Roads. The policy prohibits the presence/occurrence of a list of objects and structures along national roads including "*posts and towers of Electric Cooperatives and Major Electric Power Distributors; distribution lines; posts for cables of phone and mobile service providers*".

Recent developments in policymaking have provided significant improvements to the rights of way (ROW) acquisition procedures. With the enactment of the new "Rights of Way Act of 2016" or Republic Act 10752, various sectors have been guided better in terms of ROW matters. However, ROW acquisition still remains to be one of the most problematic activities in the delivery of public infrastructure.

Subsequently, in 2017, the Department of Energy (DOE) and DPWH entered into an agreement through Joint Circular No. 1, that was aimed to maintain easements and to relocate improperly located electric utilities within the government's rights of way. Under the guidelines, programming and planning of DPWH projects such as roads, bridges, flood control structures, and government buildings will have to be coordinated with the National Electrification Administration (NEA) and electric cooperatives as a way to address ROW concerns. This was followed by the DOE-DPWH Joint Circular No. 2 (JC2) issued in 2019. JC2 stipulates additional provisions and creates an Inter-Agency Task Force Group to ensure the successful implementation of both Joint Circulars.

2.3 Cost-Benefit Analysis

A review of the different approaches on the calculation of costs related to utility placement and installation was conducted by Hunt *et al.* (2012). The paper noted that according to Tighe *et al.* (2002), costs to be recognized for utility placement shall include costs due to traffic disruption, deleterious environmental effects, health and safety hazards, premature deterioration of paved surfaces, and major risks to adjacent infrastructure. On the other hand, a study by Jung and Sinha (2007) considered the summation of the following:

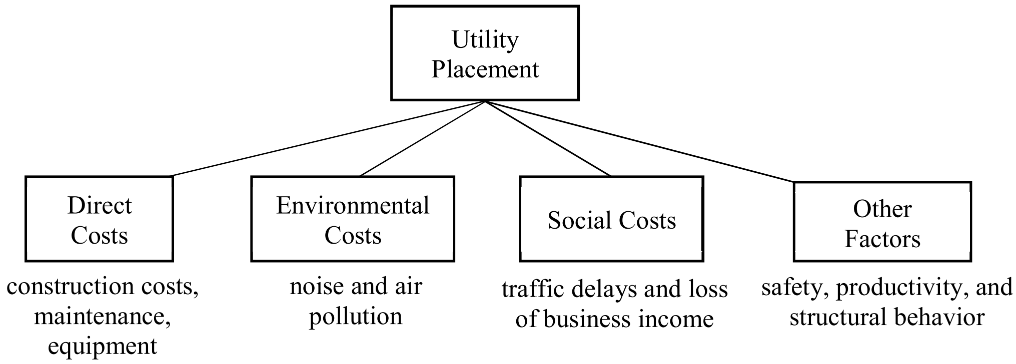

Figure 5. Costs of Utility Placement, Jung and Sinha (2007)

Given the unforeseen need for road widening activities, and with the utilities obstructing the required roads right-of-way, the figure depicted by Jung and Sinha (2007) shows the costs that have to be borne not only by the utility companies, but also by all other members of the society. This serves as clear effects of a shortfall not only on one sector's strategies, but also in the field of long-term urban planning as a whole.

Vilventhan and Kalidindi (2016) studied the interrelationships of factors causing delays in the relocation of utilities through a cognitive mapping approach. Jung (2012) defines utility relocation as "the adjustment, replacement, or relocation of utility facilities as required by a highway construction project." The main factors affecting the outcome of road construction projects are technical and organizational factors. These are exhibited mainly in the delays in land acquisition and utility relocation, and holds true in the case of the infrastructure projects in India (World Bank Report, 2007).

Direct costs are also expected to cover the acquisition cost for the land where facilities are to be relocated. For the cost-benefit analysis of this study, land acquisition cost will only be included if utility poles have to be relocated outside the available road right-of-way of the government.

Electric poles standing along the roadway pose serious hazards to motorists. In the Global Status Report on Road Safety, the World Health Organization (WHO) (2018) lists 'unsafe road infrastructure' as one of the risk factors of road crashes resulting to death and injuries. Other identified factors include speeding, distracted driving, and driving under the influence of psychoactive drugs or substances such as alcohol. WHO (2018) highlights that road traffic crash is the number one cause of death for people of all ages and the eighth leading cause of death for people aged five to twenty-nine, with around 1.35 million deaths per year worldwide. Twenty to fifty million people are non-fatally injured, although many are reported to incur disabilities as result of the crash-caused injuries. For most countries, road traffic crashes cost around 3% of their gross domestic product (GDP).

De Leon (2007) conducted a study on the socio-economic cost of road vehicular crashes in the case of Philippines. Using the Human Capital Method (Gross Output Methodology) as recommended by the Asian Development Bank and the Transport Research Laboratory of the United Kingdom, it was found that at least PhP 3.5 Million is lost per fatal crash. The cost components of crash vary depending on the severity of crash. PhP 734,867 is lost in every serious crash, while PhP 71,483 is lost in a crash resulting in minor injuries. A Property Damage Only (PDO) case entails economic costs amounting to PhP 42,671.

De Leon (2007) classified road crash/accident costs into two: the economic costs ("market values") and the social costs ("non-market values"). The economic costs include the value of lost production/output of the casualty, as well as costs of medication, vehicle and property repair costs, and administration costs. The social costs, on the other hand, are monetized values added to quantify the pain, grief, and suffering of the casualties' families. These are usually calculated based on factors such as Court Awards and Willingness-to-Accept/Willingness-to-Pay. According to Jones-Lee (1976), the Willingness-to-Pay method is the best way to measure road accident costs for the purpose of Cost-Benefit Analysis. However, Mooney (1977) stated various limitations of the said method which includes "human's psychological inability to value the risk properly" as well as the complex and subjective measurements of the survey questionnaires.

While the reviewed literature used the terms such as "safety hazards" and "accidents", the term "road crash" following Stewart and Lord (2002) considers "crash" as a more encompassing term to include events that are intentional or caused by negligence, as well as those that are truly accidental. The objectives of this study are to define the magnitude of economic impacts that coincide with the issues of highway-utility coordination and to generate solutions to minimize the costs for both utilities and road transport sectors, conceivably through the discipline of long-range planning with the aid of improved policy-making and implementation.

3. RESEARCH METHODOLOGY

3.1 Conceptual Framework

Public road projects, along with other capital investments in general, have corresponding costs and benefits. Costs include not only the construction, maintenance, and roads rights-of-way acquisition costs, but also other indirect costs such as traffic disruption costs. On the other hand, the social and economic benefits include savings from vehicle operating costs (VOC) and economic value of passengers' time.

Obstructions in the roads right-of-way usually result to delays in road projects implementation. To the same effect, its lingering presence even after the new roads have been constructed result to the deferment of realization of benefits, thereby breaching the purpose for which the roads were constructed—traffic decongestion. Moreover, road crashes, particularly vehicular crashes due to the utility poles standing in the middle of the roadway, result to additional costs that should be considered regardless of scale.

The research is founded on the conceptual framework shown below.

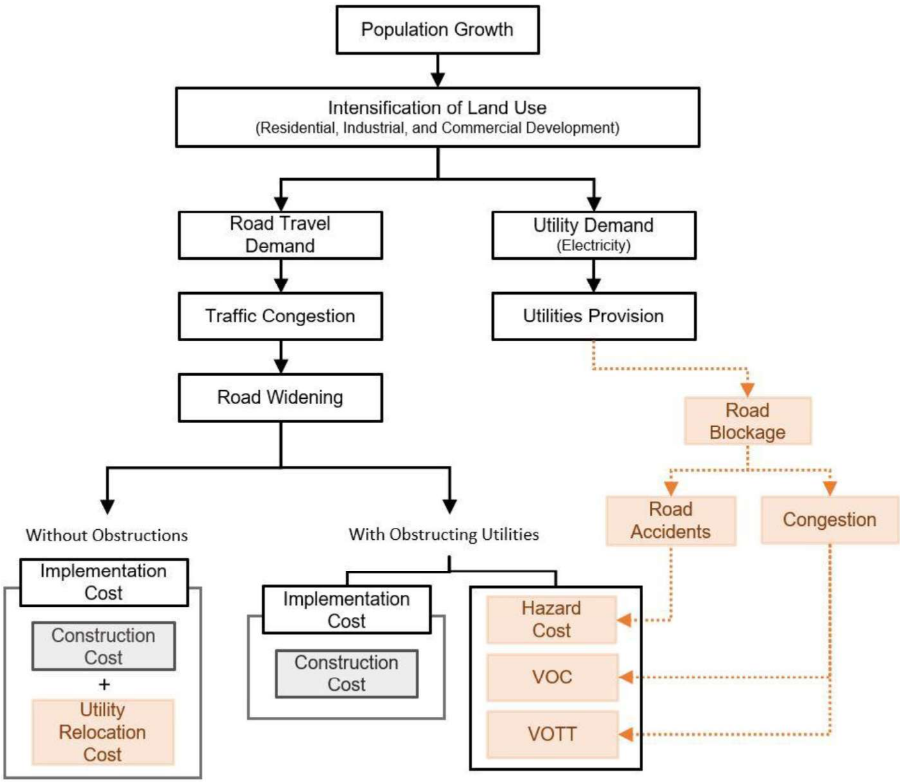

Figure 6. Conceptual Framework

3.2 Analytical Framework

Upon the collection of all necessary primary and secondary data, the processing and analysis of quantitative data were done with reference to the framework below:

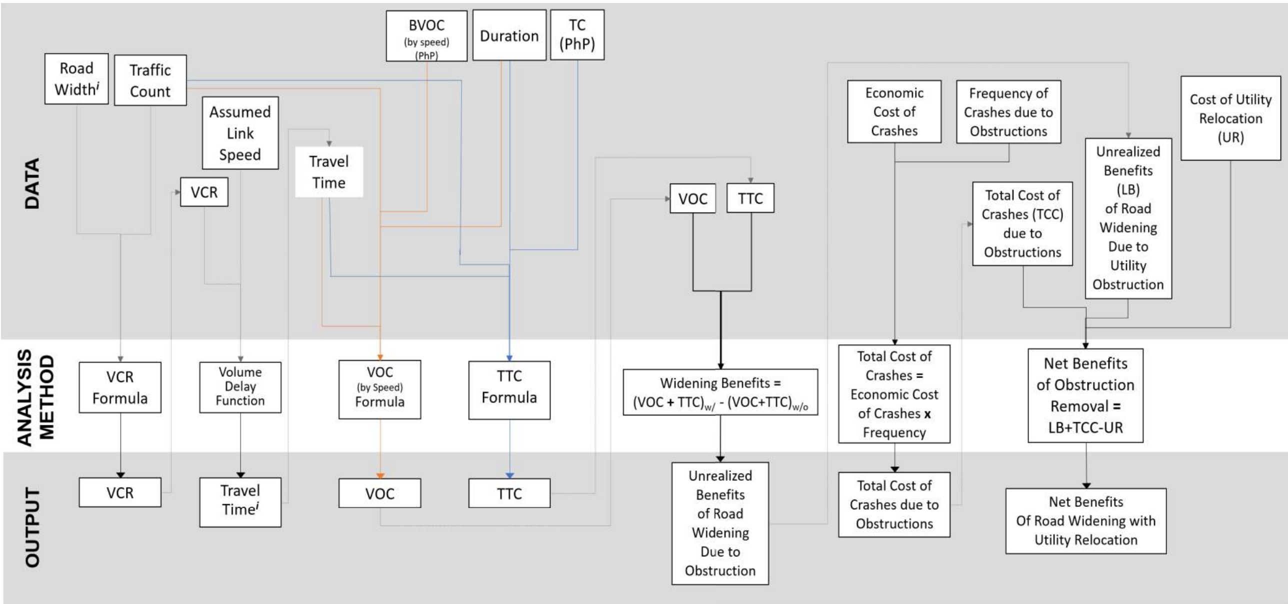

Figure 7. Analytical Framework

The study involved a Cost-Benefit Analysis in order to present the difference in expected economic outcomes when roadway obstructions are present. Data inputs needed for the computation of Volume-Capacity Ratio (VCR) include road width and traffic count. Travel time was determined by applying the computed VCR into the DPWH Highway Planning Manual formulas (discussed in the next section). VOC and TTC were calculated using the VOC formula and TTC formula, respectively. Factors include the computed travel time, traffic count, BVOC, EVOT, and period covered. References for BVOC and EVOT were taken from the DPWH. These concepts are further discussed in the following section.

Expected benefits from road widening projects are based on projected savings in VOC and TTC. These savings are to be generated by shorter travel time due to the addition of new road lanes, thereby increasing the capacity of roads. Foregone benefits would be the estimated economic losses due to the unrelocated roadway obstructions. The obstructions effectively decrease the number of functional road lanes, leading to the non-realization of benefits.

Aside from the direct costs (including construction costs), indirect costs are also included in the analysis. In this study, indirect costs refer to traffic disruption costs and safety hazards brought about by the decreased number of functional lanes and occurrence of crashes, respectively.

Safety hazard costs are applied to obstruction-related crashes that had already happened in the past, as well as possible crashes that may occur in the future, should the electric poles be left standing along the roadway. The economic cost of crashes to be applied in the evaluation is based on available related literature.

3.3 Calculation of Costs and Benefits

Volume-Capacity Ratio (VCR)

The first step in computing the VCR is by translating the collected data on traffic counts into Passenger Car Units (PCU). Applicable Passenger Car Equivalent Factors (PCEF) are applied to each corresponding vehicle type. The resulting annual average PCU per day in a particular road section or segment is the summation of the PCUs for all vehicle types. Afterwards, Basic Hourly Car Capacity (BHCC) in PCU is calculated depending on the observed carriageway widths of the subject road sections.

The DPWH, through its Department Order No. 22 series of 2013, came up with standard BHCC values (in PCU) for different road widths, as follows:

Table 3. Hourly Road Capacity in Passenger Car Units (PCU), DPWH (2013)

Carriageway Width	Hourly PCU	
	Rural	Urban
single < 4 meters	600	600
4-5 meters	1200	1200
5.1 – 6.0 meters	1900	1600
6.1 – 6.7 meters	2000	1700
6.8 – 7.3 meters	2400	1800
2 x 6.7 or 2 x 7.3 meters	7200	6700

VCR is inversely proportional to the BHCC. The road capacity is determined by the functional width of the road. In effect, this means that as lane width increases, capacity increases.

Aside from the number of lanes and lane width, the hourly capacity of roads is influenced by other factors such as gradients, roadside friction, etc. based on DPWH (1982).

$$VCR = \frac{PCU \times PHF}{BHCC} \quad (1)$$

where:

VCR = Volume-Capacity Ratio (%)
PCU = Passenger Car Unit
PHF = Peak Hour Factor
BHCC = Basic Hourly Car Capacity (vehicles per hour)

Travel time

In the absence of actual travel time and delay surveys for the "with obstructions" and "without obstruction" scenarios, the maximum speed on the subject road sections were calculated using the Link Travel Time formula of the DPWH (1982). Using the resulting maximum speeds, travel time was computed using the Volume Delay Function from the MMUTIS Study which was updated by JICA (2014). The Volume Delay Function is illustrated in Section **Error! Reference source not found.**

$$Tx = T0 \left\{1 + \alpha \left(\frac{V}{C}\right)^{\beta}\right\} \quad (2)$$

where:

Tx = Travel Time at a Volume/Capacity Ratio ***x***;
T0 = Travel Time at Maximum Speed;
V = Traffic Volume in PCU, ***C*** = Road Capacity in PCU; and
α and ***β*** = Calibrated Parameters with values: α=3.0, β=4.0

Vehicle Operating Cost (by speed) and Travel Time Cost

Vehicle Operating Costs (VOCs) are composed of fixed costs and running costs of vehicles. Savings in VOCs per kilometer is determined by surface quality based on the International Roughness Index (IRI). As a general principle, a vehicle running on a good pavement incurs less cost (in terms of fuel consumption, tire wear, etc.) than that steering over a poor-quality pavement. Improving the road pavement conditions result to increased speeds and shorter travel time.

Another benefit considered in the analysis is the savings in Travel Time Cost (TTC). There are several approaches in computing for the TTC, including the wages or income approach and the willingness-to-pay model.

Data on basic vehicle operating costs and travel time costs are available with the Department of Public Works and Highways.

Total transport benefits

This is taken as the difference between the respective VOC and TTC cases of 'without project' minus 'with project' estimates, where 'project' refers to road widening. This difference is described as the "transport cost savings" incurred due to the addition of new road lanes.

$$Transport\ Benefits_{widening} = (VOC_{without\ widening} - VOC_{with\ widening}) + (TTC_{without\ widening} - TTC_{with\ widening}) \quad (3)$$

These savings in transport costs are considered as the benefits of road construction projects (e.g. road widening). With the utility obstructions in position, these lost savings are considered as the 'unrealized benefits' from the obstructed areas which entail a significant loss to the economy and society.

An obstructed area is hereby defined as an unutilized length of the new lane that is assumed to provide motorists enough space to maneuver before and after avoiding an obstructing pole. In calculating for the obstructed areas in the newly constructed road lanes, this study adopts the method of calculating unutilized road lengths as used by the US Department of Transportation (2009) in its comprehensive discussion of various Temporary Traffic Control Elements.

Tapers, as described by the US Department of Transportation (2009), are "*usually created by using a series of channeling devices and/or pavement markings to move traffic out of or into the normal path*". A *merging taper* is the longest, as it considers the length required by drivers for merging into common road space. This shall also provide for "*adequate advance warning and sufficient length to adjust their speeds and merge into an adjacent lane before the downstream end of the transition*". A *shifting taper*, on the other hand, is used when a lateral shift is needed, especially starting at points where the vehicles diverge into more functional lanes.

Figure 8 illustrates how the same concepts of the U.S. Department of Transportation (2009) were adopted by and applied in this study.

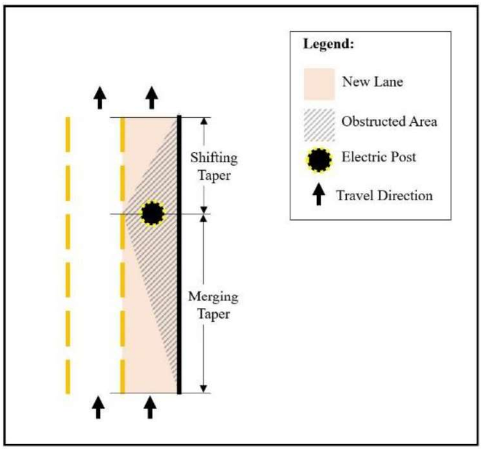

Figure 8 Obstructed area around an obstructive utility pole

The following formulas are used in computing taper lengths, according to the US Department of Transportation (2009):

Table 4. Formulas for determining Taper Length

Speed	Taper Length (L) in feet
40 mph or less	$L = \frac{WS^2}{60}$ (4)
45 mph or more	$L = WS$ (5)

Source: US Department of Transportation (2009)

where:

$\boldsymbol{L}$ = taper length in feet

$\boldsymbol{W}$= width of offset in feet

$\boldsymbol{S}$ = posted speed limit, or the anticipated operating speed in mph

Table 5. Types of taper and corresponding lengths

Type of Taper	Taper Length
Merging Taper	at least L
Shifting Taper	at least 0.5 L
Shoulder Taper	at least 0.33 L
One-Lane, Two-way Traffic Taper	50 feet minimum, 100 feet maximum
Downstream Taper	50 feet minimum, 100 feet maximum

Source: US Department of Transportation (2009)

This study uses the following formula in calculating the obstructed lengths per each utility pole on the new lane.

$$Obstructed\ Length = Merging\ Taper\ Length + Shifting\ Taper\ Length \tag{6}$$

In the case where the sum of lengths of the merging and shifting tapers are greater than the distance between two poles, and where there is not enough space between the poles thus preventing the drivers to maneuver until there is enough clearance to return to the new lane, the following formula is applied:

$$Obstructed\ Length = Merging\ Taper\ Length + Shifting\ Taper\ Length + distance\ between\ consecutive\ poles \tag{7}$$

The calculated unrealized benefits from these obstructed areas are then subtracted from the total benefits from the entire new lane. The net total transport benefits from the road widening project, considering the unoptimized use of the new lane due to the present of utility obstructions, are computed as follows:

$$Total\ Transport\ Benefits = Transport\ Benefits_{widening} - Transport\ Benefits_{obstructed\ areas} \tag{8}$$

Vehicular crash cost

De Leon (2007) studied the Socio-economic Costs of Road Vehicular Accidents/Crashes in the Philippines. He adopted the Gross Output Methodology/Human Capital Approach developed by the Transport Research Laboratory (TRL) of the United Kingdom. This methodology is being recommended by the Asian Development Bank for developing countries in order to assess the economic loss due to crashes. Aside from property damage, medical costs, and administration costs, this methodology also considers the value of lost production of the casualty.

The following shows the costs of crashes (in PhP) according to severity as calculated by De Leon in 2007:

Table 6. Cost of crashes according to severity, based on De Leon (2007)

Fatal	Serious	Minor	Property Damage Only (PDO)
3,472,008	734,867	71,483	42,671

3.4 Presentation of Results

1.1.1 Travel time on all segments ("with" and 'without obstruction" scenarios)

Using Formula No. 2, travel time for each road segment (both in the With and Without Obstruction scenarios) were calculated. The study road area is divided into eighteen (18) segments based on the DPWH highway inventory, with varied lengths ranging from 12 to 533 meters. Traffic volume (in PCU) for 2017 and 2018 were also used in the computation. Without obstruction, average travel time in 2017 and 2018 was calculated at 10.52 minutes (10m31s). However, with the actual presence of the obstructions, travel time was calculated at 11.00 minutes. A difference of 0.48 minutes (29s) in travel time was observed.

1.1.2 Estimation of benefits

Using Formula Nos. 1-3, where the time savings from the previous section were input into the equation, the VOC and VOT savings were calculated as shown below. In the more favorable scenario, where there are no obstructing utilities, the road widening would have generated an annual average of PhP 32,539,599.73 VOC and VOT savings in the two-year period.

1.1.3 Costs

The input costs in the evaluation were calculated as follows:

Table 7. Costs for Evaluation

	Cost (in PhP)	Unit	Quantity	Total Cost (in PhP)
Road Widening	28,483,000.00	km	3.196	68,102,853.00
Pole Relocation	800,000	pole	27	21,600,000.00
Maintenance Cost	76,000.00	km/yr	3.196	181,716.00
TOTAL				76,129,716.00

1.1.4 Frequency of crashes (self-accidents, road blockage)

Data on crashes were provided by the local government units. There were 11 and 14 self-accidents on the road due to road blockages in 2017 and 2018, respectively. With the lack of data as regards the classifications of these "road blockages", this study considered a 50% factor. Other causes include collision with highway median barriers and curbs. Nonetheless, key informants from the local government units reported that vehicular crashes against obstructing utilities such as electrical poles are frequent.

Table 8. Frequency of Crashes (Self Accidents and Road Blockages)

Year	Number of Self-Accidents due to Road Blockage	Estimated Number of Self-Accidents due to Obstructions
2017	11	6
2018	14	7
	Total	13

1.1.5 Percent share of crashes based on severity

To further categorize the calculated number of crashes according to the extent of injury and damage, this study applied the average percent share in number of crashes according to the Philippine Statistical Yearbook's Comparative Statistics on Road Traffic Accidents (from 2001 to 2014). For the two-year evaluation period, the occurrence of crashes was classified as fatal (1 count), non-fatal (4 counts), and property damage only (8 counts).

Table 9. Percent Share of Crashes and Total 2019 Cost of Road Crashes based on Severity

Severity Classification	Percent Share in Number of Accidents	Frequency	Cost per Road Crash	Total Cost (in PhP)
Fatal	5.80%	1	5,423,339.12	5,423,339.12
Non-fatal	29.26%	4	1,147,875.51	4,591,502.03
Property Damage Only	64.94%	8	66,652.87	533,222.97
				10,548,064.13

Since the study of De Leon was done in 2007, the values were escalated to 2019 price levels for use in the computation. Applying these categorized and escalated costs of road crashes according to De Leon (2007), the total cost of road crashes summed up to PhP 10,548,064.13 for the two-year period, or an average of PhP 5,274,032.05 per year.

1.1.6 Net Benefits from Utility Relocation

Table 10. Net benefits from utility relocation, Road Section S01598LZ, in PhP

Total Economic Losses due to Obstructions*	Utility Relocation Costs	Net Benefits from Utility Relocation*
(A)	(B)	(C) = (A) - (B)
37,813,631.79	21,600,000.00	16,213,631.79

* Average per year

The combined unrealized benefits and cost of vehicular crashes constitute the total economic losses incurred due to the presence of obstructions. From the period of 2017 to 2018, an average of PhP 37,813,631.79 economic losses per year were incurred due to the obstructions in Road Section S01598LZ. While it is expensive, the *one-time* additional direct cost for the relocation of all obstructing utility poles in each road section was found to be less costly than the value of economic losses covered within only *a year*.

3.5 Stakeholder Analysis

This section explains the analysis of existing problems and the corresponding possible solutions. One objective of this research is to come up with policy recommendations in order to improve the coordination between the highway and utility sectors. This stakeholder analysis is aimed to harmonizing the needs of the primary stakeholders in the lingering highway-utility conflict.

Table 11. Key Stakeholders Analysis

Sector	Problem	Possible Solution	Responsible Entity
Road Users	VOC and VOT Road Crash Costs	Ensure timely removal of obstructing utilities along the roadway	DPWH, Utility Sectors
		• Practice more effective, multi-sectoral, long-range planning • Collaboratively explore possibilities of underground utility tunnel systems (or other approaches) for future settlements	DPWH, Utility Sector
		Pending relocation, install safety devices on the obstructing posts	DPWH
Affected consumers of electric companies	Interruption of electric services during utility relocation	Strengthen technical capacity to relocate the facilities more efficiently	Utility Sector
Utility Sector (Electric Companies)	Relocation Cost	Include budget for utility relocation during highway planning stage of the DPWH	DPWH
	Limited availability of human resource, equipment, and materials	DPWH to augment capacity of utility sector in terms of human resource, equipment, and materials	DPWH
		Augment in-house capacity of human resource, equipment, and materials	Utility Sector
		Capacitate and jointly certify other private contractors to undertake relocation activities	DPWH, Utility Sector
	Difficulty in land acquisition for relocation site	DPWH to include the utility relocation site in the ROW acquisition process (government acquisition) and costing	DPWH
Highway Sector (DPWH)	Delays in Implementation and Utility Relocation	• Practice more effective long-range planning • Explore benefits of "land banking" based on accurate travel demand forecasting • Update the Department Order No. 73, Series of 2014	DPWH
		• Revisit the provisions and implications of existing policies for necessary amendment	DPWH, Utility Sector, Legislative Branch (e.g. Congress)
		• To establish a new office dedicated for conducting utility relocation activities (dismantling, land acquisition of utility relocation site, etc.) • Institutionalizing analysis of utilities in project preparation stage (e.g. feasibility studies)	DPWH

	Additional Roadworks – reconstructing portions of roadway where the utility poles stand	Institutionalize budget mechanisms for utility relocation during highway planning stage	DPWH

4. CONCLUSION AND RECOMMENDATIONS

Road widening is a critical public investment that is aimed at alleviating traffic congestion and to bring about economic benefits in terms of savings in vehicle operating costs and travel time. Obstructions of electrical poles along the highways, including the recently-widened portions, inhibit the full realization of these benefits, and in addition, expose the travelling public to unnecessary hazards.

This study estimated that significant economic losses result in the form of forgone transport cost savings brought about by the road obstructions. In addition to these unrealized (lost) benefits, additional costs are incurred due to the road crashes with these obstructions. An average of PhP 37,813,631.79 economic losses per year were calculated to be incurred due to these obstructions.

The Cost-Benefit Analysis yielded positive net benefits from the relocation of the utilities as directed by existing policies. It was confirmed that the additional direct costs for the transfer or relocation of the obstructing utility poles after road widening is less costly than the value of unrealized benefits plus the road crash costs both covered within a year. These road crash costs account for potentially *avoidable* economic and social losses due to injuries and death, aside from the inherent value of life that no monetary price can be ethically placed upon. The calculated net benefits from relocation amounts to an average of PhP 16,213,637.79 per year.

To account for the forecasted growth in traffic and population, the road transportation sector of the government as well as the utilities sector (public and private) should strengthen existing strategies on long-range planning in order to prevent future inconveniences. The road infrastructure sector has been adopting strategies such as acquiring contiguous right-of-way of road projects to provide for possible expansion in the future. The utility sectors should therefore collaboratively explore possibilities of underground utility tunnel systems (or other approaches) for future settlements.

In order to prevent delays in road widening and utility relocation, it is recommended that closer collaboration of both the highway and utility sectors be enhanced. The study suggests that the existing policies be modified to provide better strategies in addressing the issues observed in the previous implementation, as well as the identified institutional weaknesses of both highway and utility sectors.

Highway agencies, such as the DPWH, may further develop capacity to assist the utility sector in utility relocation activities. To expedite the delivery of public service, the government may consider the inclusion of all utility relocation costs in the project budget, as well as assuming the acquisition of the site for relocation of said utilities through the same government process of roads right-of-way acquisition. Both sectors may pool their resources such as equipment, materials, and human resource, so that the obstructions may be removed in the shortest possible time. While solving the problem has always been challenging to both sectors, may the unceasing motivation to improve the quality of life of the Filipinos introduce more possibilities and opportunities for cooperation.

REFERENCES

American Association of State Highway and Transportation Officials (2005) *AASHTO Strategic Highway Safety Plan*. Washington, D.C.

Asian Development Bank (2016) *Pakistan: Post-Flood National Highways Rehabilitation Project: Reports and Recommendations of the President.* Pakistan: Islamabad

Baarslag, Jr., H.S., Kortnik, E.W., Uthus, K., Berkowitz, J., and Damewood, M. (1969) Coordination of Underground Utility Structure Location—Joint Discussion. *American Water Works Association Journal*, 61 (5), 252-256.

Burkhead, Sr., K.E. (1973). Utility Coordination in Kansas City, Mo. *American Water Works Association Journal*, 65 (12), 764-765.

Department of Public Works and Highways (1982) *Highway Planning Manual*, Vol. 5: Road Traffic Costs for Actual Conditions. Philippines: Manila

Department of Public Works and Highways (1982) *Highway Planning Manual*, Vol. 7: Guidelines on Economic Evaluation of Design Standards of Pavement and Bridges. Philippines: Manila

De Leon, Mark Richmund M. (2007) *Socio-Economic Cost of Road Vehicular Accidents*. Philippines: University of the Philippines Diliman, Quezon City

Graham, S., Marvin, S. (2001) *Splintering Urbanism: Networked Infrastructures, Technological Mobilities and the Urban Condition*. England: London

Hunt, D.V.L., Nash, D., and Rogers, C.D.F (2012) Sustainable utility placement via Multi-Utility Tunnels. *Tunneling and Underground Space Technology*, 39 (2014), 15-26.

Jones-Lee, M.W. (1976) *The Value of Life: An Economic Analysis*. London: Martin Robertson and Co. Ltd.

Jung, Y.J. (2012) Evaluation of subsurface utility engineering for highway projects: benefit-cost analysis. *Tunneling and Underground Space Technology*, 27 (1), 111-122.

Jung, Y.J., Sinha, K. (2007) Evaluation of trenchless technology methods for municipal infrastructure systems. *ASCE, Journal of Infrastructure Systems*, 13(2), 144–156.

Kirk, J.E. (1960) Federal-Aid Highway Policies Affecting Utilities. *American Water Works Association Journal*, 52 (11), 1404-1410.

Japan International Cooperation Agency (JICA) and National Economic and Development Authority (NEDA) (2014) *Roadmap for Transport Infrastructure Development for Metro Manila and Its Surrounding Areas (Region III and Region IV-A): Final Report*.

Mooney, Gavin H. (1977) *The Valuation of Human Life*. London: MacMillan Press Ltd.

National Academies of Sciences, Engineering, and Medicine (2004). *A Guide for Reducing Collisions Involving Utility Poles.* Washington, D.C.

OECD/EMCT (2007) *Managing Urban Traffic Congestion*. France: Paris

Saidi, S., Kattan, L., Jayasinghe, P., Hettiaratchi, J.P.A., and Taron, J. (2017) Integrated infrastructure systems—A review. *Sustainable Cities and Societies*, 36 (2018), 1-11.

Stewart, A.E. and Lord, J.H. (2002) Motor Vehicle Crash Versus Accident: A Change in Terminology is Necessary. *Journal of Traumatic Stress*, 15 (4), 333-335

Tighe, S., Knight, M., Papoutsis, D., Rodriguez, D., Walker, C. (2002) User cost savings in eliminating pavement excavations through employing trenchless technologies. *Canadian Journal of Civil Engineering*, 29, 751–761.

U.S. Department of Transportation (2009) *Manual on Uniform Traffic Control Devices*

Vilventhan A. and Kalidindi S.N. (2016) Interrelationships of Factors Causing Delays in the Relocation of Utilities: A Cognitive Mapping Approach. *Engineering, Construction, and Architectural Management*, 23 (3), 349-368.

World Bank Online Databank. Available at www.data.worldbank.org (accessed 9 December 2017)

World Bank Report (2007) *Indian road construction industry capacity, issues, constraints, and recommendations*. Available at: www.worldbank.org (accessed 10 December 2017).

World Health Organization (2018) *Global Status Report on Road Safety 2018.* Paris, France

Wyss, G.A., and Dodson, R.E. (1973) Rights of Water Utilities in Streets. *American Water Works Association Journal*, 65 (12), 795-800.