Doctoral Dissertation

Study on the Feasibility of Cross Sector Cooperation Approach towards Road Traffic Safety

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Abstract

There is an increasing demand for a non-traditional approach to solving transportation problems such as road traffic accidents, road congestion, and air pollution in developing countries. The norm that different government agencies solve the same problem on their own schedules brings about fragmentation in the decision-making process and strain on the scarce resources. To realize an integrated and inclusive process, this study introduced a new cross sector cooperation approach, and developed frameworks to adopt this approach to suit different social dynamics.

Chapter 1 described the research background, objectives and the framework of the study.

Chapter 2 illustrated how the new cross sector cooperation approach was innovated from two approaches. These approaches were the 3Es, a technical approach including engineering, education and enforcement and the PSC principle, a social approach encompassing priority, speed and compactness/ comprehension. Road safety policies of countries with low annual road traffic accidents were reviewed. These were evaluated by accounting for how much the policies related to each 3Es and PSC criteria. Furthermore, the policies were examined to determine how different sectors collaborated towards the formulation of the policy. Based on this the safety hexagon was introduced as a visual representation of the proposed cross sector cooperation approach.

Chapter 3 conducted an in-depth study on how to realize the ideal cross sector cooperation. Two highly motorized cities, in Japan, faced with road accidents involving vulnerable road users were examined to reveal the process of gathering resources and information, and planning various activities to obtain desired outcomes. The two pillars of cross sector cooperation approach in transport machizukuri were found. Based on these, a Theory of Change (ToC) was proposed as a planning methodology to map the process on how to utilize the different scarce resources to achieve desired road safety goals.

Chapter 4 focused on developing frameworks to implement cross sector strategies to sustainably improve the safety of moto-taxi riders, also known as, boda boda riders in some African cities. The data on rider behavior and attitudes towards safety were analyzed using Structural Equation Modelling, to identify how the 3Es and PSC interact to affect the attitudes. The results were used to propose cross sector strategies that diverse stakeholders could plug into to sustainably implement integrated transport and spatial strategies for African cities with underdeveloped public transportation systems and high numbers of riders.

Chapter 5 proposed an SDG-oriented framework that cities with limited resources could use to create solutions to collectively overcome the road traffic-related problems. This chapter examined two regional cities in India that have made advances towards collectively achieving certain targets in SDGS 3, 9 and 11, despite having a small budget, limited human resources and less international exposure. The Plan, Do, Analyze, Report and Utilize (PDARU) cycle and logic framework were used to explain the process that these cities used. The results showed that

localizing SDGS by defining relevant SDG targets to overcome these problems promoted cross sector cooperation. In addition, the PSC principle was used to further explain the SDG pillars in a bid to present the type of society that should be aimed at as the world strives to achieve various SDG goals. Based on this, a framework was proposed using ToC to create solutions in regions that face similar problems yet they have limited resources.

Chapter 6 was an overall discussion of this research that also proposed recommendations for further studies.

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3Es – Engineering, Education, Enforcement

ASEAN – Association of South East Asian Nations

BBFZ – Boda boda Free Zone

CBD – Central Business District

EC – European Commission

ETC 2.0 – Electronic Toll Collection 2.0

EU – European Union

IATSS - International Association of Traffic and Safety Sciences

KCCA – Kampala Capital City Authority

MLIT – Ministry of Land, Infrastructure, Transport and Tourism

PSC – Priority, Speed, Comprehension/Compactness

SDGs – Sustainable Development Goals

SEM – Structural Equation Modelling

UN – United Nations

VRUs – Vulnerable Road Users

WHO – World Health Organization

1 Chapter 1 Introduction

Statistics from various databases of developed countries show that accidents rates and fatalities have fallen since 1970s, when many of these countries experienced the second traffic war. In contrast, many developing nations are currently experiencing the highest number of accident rates and fatalities. According to WHO[1] Global status report on Road Safety 2018, the rate of fatalities in Africa, South-East Asia, Europe and the world are 26.6, 20.7, 9.3 and 18.3 respectively (refer to **Figure 1-1** and **Figure 1-2**). Many reports indicate that this is because of increased motorization and economic growth in developing countries.

Accident patterns have also changed over the years with about 54% being vulnerable road users (pedestrians, cyclists and motorcyclists). Taking a closer look at regional numbers, pedestrians and cyclists account for 44% of fatalities in Africa, 2-3 motorized wheelers account for 43% of fatalities in South East Asia while in Europe drivers account for 48% of fatalities.

The World Bank[2] reported that road accidents bite into economic growth and if governments invested in reducing them by 10%, there would be a 3.6% increase in Growth Domestic Product (GDP) over 24 years. Simiao Chen et al[3] also estimated that between 2015 and 2030, the global macroeconomic loss due to road injuries would be $1.797 trillion. East Asia and Pacific would experience a 31.1% loss in GDP; Sub Saharan Africa would lose 2.1% while Europe and Central Asia would lose 19.2%. The disparity in different aspects of road accident fatalities and injuries indicate that road safety is not only a technical problem but also a huge social problem affecting the lives of millions of people in the world.

This has led organizations such as the United Nations (UN) and the European Union (EU) to set stringent traffic safety targets for its member states. Both the UN and EU are looking at achieving a 50% reduction in road accidents among respective member countries. The UN has included road safety under the 2030 agenda for Sustainable Development Goals (SDGS). These targets are SDG no. 3 (Target 3.6) and SDG no. 11 (Target 11.2).

1.1 Research Background

Over the years, various measures have been employed to reduce the number of road accidents. Many of the measures can be collectively put into three groups Engineering, Enforcement and Education measures.

Engineering measures are those that bring physical change to vehicles, roads, roadside environments or road environments. These include the introduction of Anti-locking braking system (ABS) or lane-keep assist technologies in cars, humps, rumble stripes on the road etc. The authorities responsible for engineering measures differ from country to country. For example, in Germany [4], the Ministry of Transport and Digital Infrastructure and the Federal Highway Research Institute are responsible for improvements in road infrastructure. Vehicle improvement is the responsibility of federal motor transportation authority and Federal police. In Japan [5], the Ministry of land, infrastructure, transportation and tourism (MLIT) and the

prefectural police are responsible for improvements in road infrastructure while MLIT is responsible for vehicle improvement. In Uganda [6], the Uganda National Roads Authority and local governments are responsible for improving the road infrastructure while the Ministry of works and transport provide guidelines for vehicle inspection and the police is responsible for enforcing the guidelines.

Enforcement measures are those that are designed to either impose a law or foster the use of new technological devices or systems. For example, the use of traffic police in controlling traffic on roads or carrying out impromptu tests such as alcohol tests on drivers. In Germany [4], the Ministry of transport and digital infrastructure, the German road safety council (DVR) and federal states are responsible for formulating national road safety strategy, setting targets and developing the road safety program. While the highway patrol and Federal police are responsible for enforcing the road traffic laws. In Japan [5], the responsibility of formulating the national road safety and developing the road safety program falls to the Central Traffic Safety Policy Council and the cabinet while the national police agency is responsible for enforcement of the law. In Uganda [7,] the formulation of national road safety strategy and its development is the responsibility of the parliament and the implementation falls to the police. Recently, the department of transport regulations and safety [8] was restructured to play a role in initiating and developing transport policies and strategies in Uganda.

On the other hand, Education measures are those that inform, teach or motivate traffic participants to follow traffic rules and regulations. These may include driving or riding lessons, traffic display boards, road safety campaigns etc. In terms of responsibility in different countries; in Germany [4] the DVR, police, the Ministry of tranport and digital infrastucture and other stakeholders are responsible for publicity campaigns and improvement in road user education. In Japan [5], the Japan traffic safety association, national/prefectural police agency and the Ministry of education, culture, sports, science and technology are jointly responsible for improvement in road user educaiton and publicity campaigns. In Uganda [8], the department of transport regulation and safety is repsonsible for publicity campaigns and road user education.

Various government authorities/agencies work together or independently to achieve one or more road safety targets. Nonetheless, individual or combined measures have been put in place depending on the prevailing road safety situation in a locality. However, many of these measures look to assigning roles to particular road safety stakeholders while leaving out the biggest road safety stakeholder, which is the community. In addition, such practices can deter the development of hybrid solutions that may play a role in fostering sustainable road safety. This can be achieved by involving the community in decision-making processed and also encouraging different road safety stakeholders to work together as opposed to working in isolation. Based on the examples above, Germany is one of the countries that has taken this approach to improve road safety.

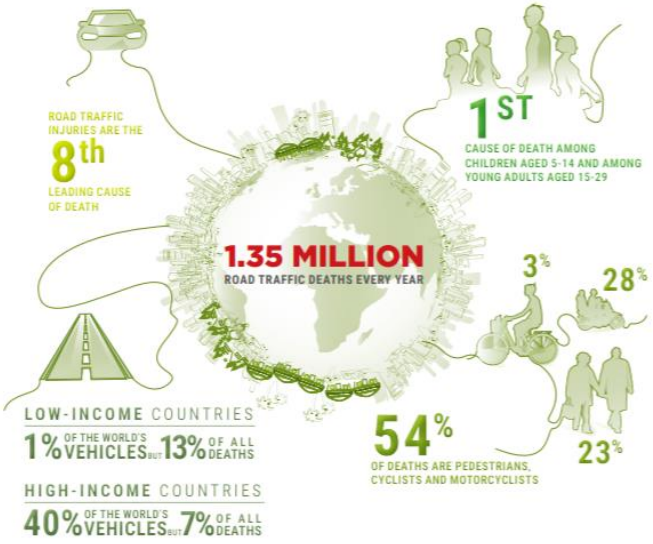

Figure 1-1: Global Road Safety Situation

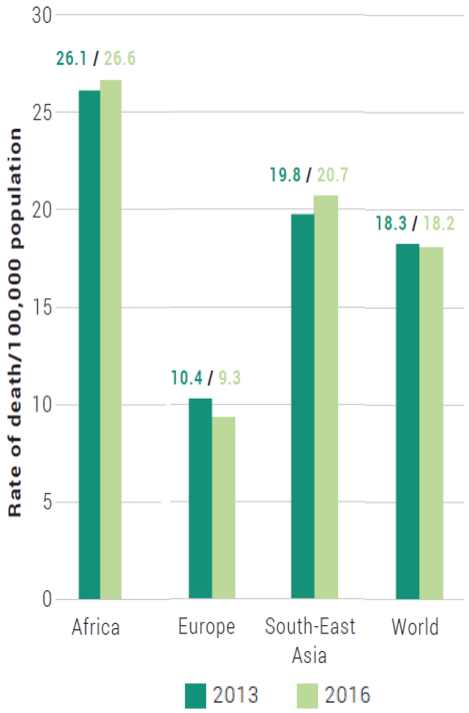

Figure 1-2:Road accident deaths per 100,000 population

Ref: WHO Global Status report on Road safety situation, 2018

1.2 Literature Review

1.2.1 Engineering measures and road safety

Engineering measures such as rehabilitation, widening or resurfacing have been effective in improving the road safety on various roads all over the world. One such undertaking is the upgrade of the 50km Thika-Nairobi highway to multi carriageway (8-12 lane) and multi-grade intersections. This improvement led to a 34.9% decrease in driver fatality [9] between 2003 and 2012. Despite the fact that pedestrian footbridges were provided, many preferred to take their chances at crossing whenever it was convenient for them. This unfortunately led to an increased rate of pedestrian causalities. Gichaga [9] noted that the majority of the accidents were due to human factors. Many of his recommendations for improving safety on this highway pointed to a kind of cross-sector where engineers needed to do more to curb black spots especially those involving pedestrians, police needed to have stricter enforcement and all road users needed to be given basic road safety education.

Hauer Ezra [10] acknowledged that evidence-based practice has boosted engineers' contribution towards road safety. However, he pointed out that in America, the interests of road users and tax-payer are usually compromised by opinion based practice. His recommendation was the restructuring of the road safety decision-making processes to include road users and political representatives. Due to lack of enough resources, it is possible that developing nations

also suffer similar problems. This is because there are more opinion-based practices that compromise the end users' needs. This can be remedied by involving communities and their leaders in road safety discussions.

On the contrary, some researchers have opted for the safe system approach, which eliminates fatalities by focusing on improving design of the road system rather than behavior of the individual. This was done by making roads self-enforcing and shifting the responsibility of road safety to design and policy. Michael et al [11] preferred this approach to traditional approaches of relying on laws and enforcement as a way to improve road safety and reduce racial segregation in some American communities. This is an excellent example of road safety approaches that directly address the social situations of communities. However, this approach may not work well in communities that have underdeveloped 3Es systems.

The improvement in road safety has also been attributed to vehicle improvement over the years. Farmer and Lund [12] found that the improvement in different car models led to a significant decline of driver deaths. For example, "the risk of driver death in 2009 model passenger vehicles was 8% lower than that in 2008 models and about half that in the 1984 models".

Bhalla and Gleason [13] estimated that if improved vehicle designs were introduced in the Latin America and the Caribbean (LAC) region, there would be 28.1% fewer deaths and 29.1% disability adjusted years (DALYs). Electronic stability control including antilock-brake systems would have the largest impact on the road safety situation in LAC.

Research and testing of different vehicle technology is a continuous process that needs to be understood well in order to meet the safety needs. Furlan et al [14] carried out a scoping study on Advanced Vehicle Technologies (AVTs), their main recommendation was that the design of studies must put into consideration participants' age, level of driving and technology experience, as well as different environments. In so doing, the AVTs that meet the safety needs of the population will most likely be implemented in the future. This conclusion points to the fact that although technological advancements are being tried and tested, emphasis should be on individuals, their needs and environment.

These studies show that despite the fact that engineering measures have reduced road accident fatalities more can done. Engineers working together with the police and community to develop area-specific interventions can achieve this.

1.2.2 Enforcement measures and road safety

Implementation of laws and police activities are known to be effective in improving the safety of road users. Since 2008, the Bloomberg Road Safety Program (BRSP) has championed the implementation of different laws and traffic safety regulations such as drink driving, motorcycle protection, fines and penalty points, safety belts. A study carried out by Miller et al [15] showed that this program was responsible for saving 19,000 lives in six different countries between 2008 and 2013. It was estimated that the laws will save about 90,000 lives between

2014 and 2023. This was attributed to road safety being advocated for as a public health concern rather than a technical one. This thought process enables the different stakeholders to view road safety as a social problem that can be overcome by working hand in hand with the community.

Enforcement not only saves lives but brings about savings in the economy. In the study carried out by Bishai et al [16], in addition to a 17% drop in road deaths during a police intervention, the estimated annual cost-effectiveness of four police squads in Uganda was $603 per death averted or $27 per life year saved. This is an effective approach for developing nations with limited resources. However, the authors noted that police intervention had to be done alongside other measures such as functioning seat belts and compliance among road users. This therefore shows that a relatively small investment in police patrolling reduces road accidents deaths, but if implemented alongside other interventions the reduction maybe greater.

One of the behaviors that call for strict enforcement is drunk-driving. A variety of police activity have been utilized such as alcohol levies, increased traffic offenses, penalties and fines. In Botswana [17] a combination of the above methods was used and this led a 22% decrease in crashes between 2004 and 2010. However, it was reported that it was unclear which activity was most effective and to what extent. Nonetheless, the success of the program was partly attributed to community outreaches carried out to educate people on the dangers of alcohol abuse and other road safety programs.

Another intervention was installation of checkpoints especially those targeting behaviors such as drink –driving, helmet use and driving license. Erke et al [18] found that there was a 17% reduction of crashes involving alcohol use. They however noted that the effects of the checkpoints were felt in the first half of the year. In addition, the effect of publicizing the checkpoint caused a different effect for various locations. They also noted that testing each driver rather suspicious ones was a more effective approach. This meta-analysis shows that the method of testing and the presence or absence of publicity affected the effectiveness of checkpoints. Therefore, it is important to collaborate with the community and other stakeholders to find the best way to implement such interventions.

Another form of enforcement that is effective in reducing road accidents is implementation of driving licenses based on point systems. This is popular in developed countries and quite unheard of in many developing nations. Although, the effectiveness of this intervention is felt only in the short term. Researchers [19] agree that this is due to lack of complementary enforcement to back up this intervention.

Overall enforcement measures are effective in reducing the number of road accident fatalities, but their effectiveness increases when coupled with other interventions such as community engagement.

1.2.3 Education measures and road safety

Education measures come in different forms, these maybe hands on trainings, workshops, campaigns or even simulations. Some measures focus on hazard perception, driving/riding skills, risk perception, behavioral change and many other aspects.

A classroom [20] based training was held for older drivers, many who attended voluntarily because they wanted to gain knowledge and increase their confidence in their driving. Although their confidence did not change much after the class, their knowledge improved and about 80% of them said they would change their driving behavior. This study showed that driving is important for the elderly to live comfortably especially in areas where public transport is not convenient.

Another group of road users that benefits from road safety education programs is the young children. In a study in Tanzania [21], high school students were given a 2-hour lesson to enable them to recognize hazards. The results of the simple Static Hazard Perception Task (SHPT) showed that the students could identify more hazards after the training exercise. It is also reported that although there was no other test carried out to ascertain if this led to reduced fatalities, this simple exercise made the students reflect on their experiences as road users. This study like the previous one shows that people are willing to change behavior if they are given practical knowledge such as this.

Other vulnerable road users (vrus) also benefit from education measures that aim to "increase their visibility" among drivers. One such study [22] was carried out in a car-driving simulator where the participants were tasked to detect pedestrians and motorcyclists. Results showed that motorists were able to detect the vrus at a greater distance and drive more carefully in areas where the risk of colliding with pedestrians was high.

Workshops are another way of imparting knowledge. Barajas et al [23] noted that community based workshops are beneficial in "identifying community needs, developing partnerships between stakeholders and changing perceptions of safety in historically disadvantaged communities." In addition, such interventions bring about other results such as new ways of approaching problems in the community, funding for the safety programs and constant improvement of existing interventions. This highlights why community participation is important in the road safety decision-making process.

Many of these studies rely on "before and after" questionnaires to illustrate the impact of the program. In addition, they form a basis for future education programs or other 3Es interventions. This shows that for any new intervention, the target group or audience has to be educated. In some cases, the target group maybe engineers or enforcement units. Education is therefore a backbone of cross sector cooperation that looks to bring different stakeholders together to create new solutions to the current road safety problems. In this study, this aspect will be statistically supported.

In conclusion, it is better to have approaches that combine two or all the 3Es interventions.

In a conference held in 1996, Goldenbeld and Noorzij[24] argued that Engineering, Education and Enforcement produce better results when working as a unit than in isolation. At the time, this was the common practice, though over the years, we have seen combined interventions.

1.2.4 Policy and road safety

Many of the aforementioned solutions are created based on an international or local policy. Thus shaping the future of road safety in a given area or country. Therefore, it is important to have an in-depth study of current road safety policies as a basis for this study.

WHO[1] has reported progress in planning, designing and operation of roads and roadsides in many countries. However, it was noted that many countries still lack legislation to address risks such as speeding, drink driving and use of helmets. Risks like these are particular to a group of people or community and must be dealt with at individual or community levels. As is currently the norm, blanket rules or interventions may not be effective in dealing with this aspect of road safety.

In 1996, Asian Development Bank (ADB) [25] published a report that emphasized the need to have an integrated approach where road safety plans were created and coordinated across different sector within and without the governments of Asian countries.

In 2019, the Economic and Social Commission for Asia and the Pacific (ESCAP) [26] supported the aforementioned statement when they emphasized that not only did road safety involve a variety of sectors but also each country needed a lead agency to facilitate multi-sectoral collaboration and lead national road safety plans. In the same report, it was noted that the main goal for African countries was to make road safety a policy priority by creating road safety strategies, designating a lead agency and implementing a plan of action.

This stand is similar to a 2013 African Development Bank (AfDB) [27] report that pointed out the lack of multi-sector road safety action plan and a designated lead agency among many African countries as a major constrain to the improvement of road safety in the region.

In addition, a 2014 Sub-Saharan African Transport Policy program (SSATP) [28] report on managing road safety in Africa noted that the African context of a safe system would be to "learn from mistakes elsewhere and adopt a modern and effective model for sustainable improvement in road safety".

All these reports re-echo the need to have a localized cross sector cooperation approach but they do not give guidelines on what to consider when considering such an undertaking. Previous studies show that some developed countries have created different approaches that combine the 3Es and other human factors, to improve road safety. Therefore, this study will propose a cross sector cooperation approach towards road safety based on a combination of the 3Es and PSC principle (Priority, Speed, Comprehension/Compactness), a social based approach.

One such approach is the sustainable road safety approach that was introduced in the Netherlands in the early 1990s by Wegner [29]. He emphasized that sustainable road safety would

be achieved if road safety was looked at as a component of other sectors instead of a stand-alone issue. This led to the drafting of the first Sustainable Safety guideline in the Netherlands. In 2018, a third edition was published and this focuses on human factors such as psychology, responsibility and learning.

Similarly, in 1997, the Swedish parliament adopted the Vision Zero policy [30] whose philosophy is that "no one should be killed or seriously injured as a result of a road traffic accident". The motivation behind this is that human beings will make mistakes but death or injury is too big a punishment for these mistakes. Since its introduction, there has been a change in injuries of pedestrians and cyclists. Varnild et al [31] noted that head injuries decreased and the probability of the cyclists getting serious injuries to more than one body part was reduced especially on Vision Zero roads.

Under this system, the road safety responsibility was shifted from the person to engineers and policy makers. While in the sustainable system, everyone is equally responsible for road safety. In this study, the proposed approach looks to involve the community in road safety decision making as an equal partner rather it being viewed as a mere end user. By doing so, the responsibility of the decisions taken or road safety interventions implemented will depend on the situation at hand. This approach ensures that certain social and cultural norms are not used a method to deter the progress of road safety, which is sometimes the case in some developing countries.

The aforementioned approaches are at national level. However, at city level, Mohan et al [32] clearly stated that Indian cities may have similar problems but the intensities differ. Therefore, different policies would have to be introduced at city level to meet the needs of that locality. They went ahead to note that a combination of motorcycle safety technologies, speed control and traffic calming may be more effective than the introduction of safer cars. This example shows that while Germany and Japan are fast tracking the use of autonomous vehicles, India and perhaps other developing nations are looking to promote other technologies and road safety interventions. This is a good example on the importance of understanding a local problem and proposing suitable solutions rather "copying and pasting" policies and interventions.

Technology is an important aspect in our lives today and currently affects how we travel. Peter Jones [33] argued that policies in non-transport sector may impact transportation policies so he suggested that cross sector synergies be encouraged in making policies. He argued that if structural changes within governments and private sector were implemented to streamline the objectives of various sectors, this would result in changing from car-based travel patterns to other modes of transport. There is no evidence to this study; however, it creates a basis to consider the role of other non-transport sectors such as information technology in this study.

The role of private sector was re-echoed by Albalate and Bel-Pinana [34] in their study that showed that highways under the public private partnership (PPP) schemes are positively correlated with better road safety outcome especially if it was a build-operate-transfer PPP.

Such partnerships especially in initial stages of infrastructure development may guarantee construction of safer roads which is cheaper than redesigning existing roads to meet certain safety criteria. Therefore, private sector is an important stakeholder in improving the safety of roads.

The importance of involving community in decision-making has been highlighted in many studies above however the "how to" is quite broad. Doi et al [35] emphasized the need to co-create to develop community-rooted solutions by designing roads as social spaces that appropriate priority among traffic participants. This can be achieved by communities and governments working together to narrow the gap in the discipline of traffic engineering, vehicle engineering, psychology etc. This study did not give a detailed guide on how to develop such frameworks that prioritize particular road users. Therefore, this study will also focus on developing frameworks on implementing the proposed cross sector cooperation approach.

In conclusion, stand-alone technical solutions or a combination of these has been very instrumental so far, but in order to foster sustainability, a combination of both technical and social solutions is essential. This is in a bid to narrow the gap between the current road safety policies and the current road safety situations. Therefore, the purpose of this study was to propose a new cross sector cooperation approach towards road traffic safety, and to propose frameworks for its implementation. This approach was developed as a combination of technical interventions (3Es) and a social intervention (PSC principle). The PSC principle will be expounded upon in chapter 2. The implementation frameworks were developed on a case study basis because of the difference in situations in the world.

1.3 Research Objectives

The road safety goals set by many organizations are ambitious and must have equally audacious means to meet them. One of the ways is to critically review the current road safety policies and propose modification that suit the current situation. Therefore, this study had two main objectives namely; to propose a new approach to cross sector cooperation towards road safety and to propose frameworks to implement this approach for the specific conditions in both developed and developing countries.

1.3.1 Proposing a new approach to cross sector cooperation approach towards road safety

The policies that have brought us here may not be sufficient to meet the road safety goals that have been set. Multi-sectoral collaboration stretching beyond conventional sectors is one aspect to consider in creating a new approach. Secondly, the need to look into social oriented interventions is important to empower communities to understand local root causes of accidents and to work together towards creating tailor made solutions. In so doing, communities will gain a sense of ownership of the solution and actively participate in bringing about change. This will birth sustainability and move the world closer to meeting the SDG targets related to road safety.

1.3.2 Proposing frameworks to implement the new approach to cross sector cooperation approach

Road safety is a global problem albeit with varying root causes depending on the locality. To make cross sector cooperation approach relevant and applicable to different localities, it was important to create frameworks for implementation that matched the local situation and resources. The localities chosen for an in-depth study were Japan, Uganda and India.

Despite the fact that Japan is a developed country with well-developed 3Es systems, these systems are still operating as stand-alone. Therefore, it was important to propose a way to unify the systems to meet the social needs that arise from an ageing population and declining birth rate.

Uganda is a developing country that has fragmented 3Es systems and an underdeveloped public transportation system. As a result, there is high usage of boda boda (moto-taxi) transportation, which has exacerbated the road safety situation in the country. This situation is similar to that in many other African cities. Therefore, a localized cross sector cooperation framework was proposed to address this problem. This framework can be modified to fit the local needs in other African cities with high boda boda transportation usage and fatalities.

India was chosen because it not only has a high road accident rate coupled with an underdeveloped public transportation system but also a huge air pollution problem. This sets it apart from other developing nations and hence makes an interesting case study. In some countries, air pollution accounts for more deaths than road accidents. Therefore, the cross sector cooperation framework proposed in this study to collectively tackle air pollution, road accidents and traffic congestion would be beneficial to other communities facing similar challenges.

1.4 Research framework

1.4.1 Overview of the research plan

In order to meet the aforementioned research objectives, the main body is organized into four chapters (chapter 2-5) while the overall conclusion is in chapter 6. In chapter 2 a new approach to cross sector cooperation approach was proposed and defined by combining the 3Es technical approach and the social approach PSC principle. In the same chapter, the proposed approach was evaluated by comparing national road safety policies of three (3) countries. The purpose was to study their successful approaches in order to validate the proposed new approach toward road safety.

Chapters 3-5 fulfilled the second objective of proposing frameworks to implement cross sector cooperation approach. Each chapter was a case study that represented a different local situation, and based on this, framework/methodologies to implement cross sector cooperation were proposed. Chapter 3 looked at how cross sector cooperation approach was utilized by highly motorized cities in promoting transportation machizukuri in Japan. Chapter 4 proposed various frameworks that different road safety stakeholders could plug into to improve the safety

of boda boda riders (moto-taxi) situation in Kampala-Uganda. Chapter 5 explored the use of cross sector cooperation approach in creating localized solutions in small cities in India so that the communities could collectively tackle various social problems. See **Figure 1-3** for the research flow.

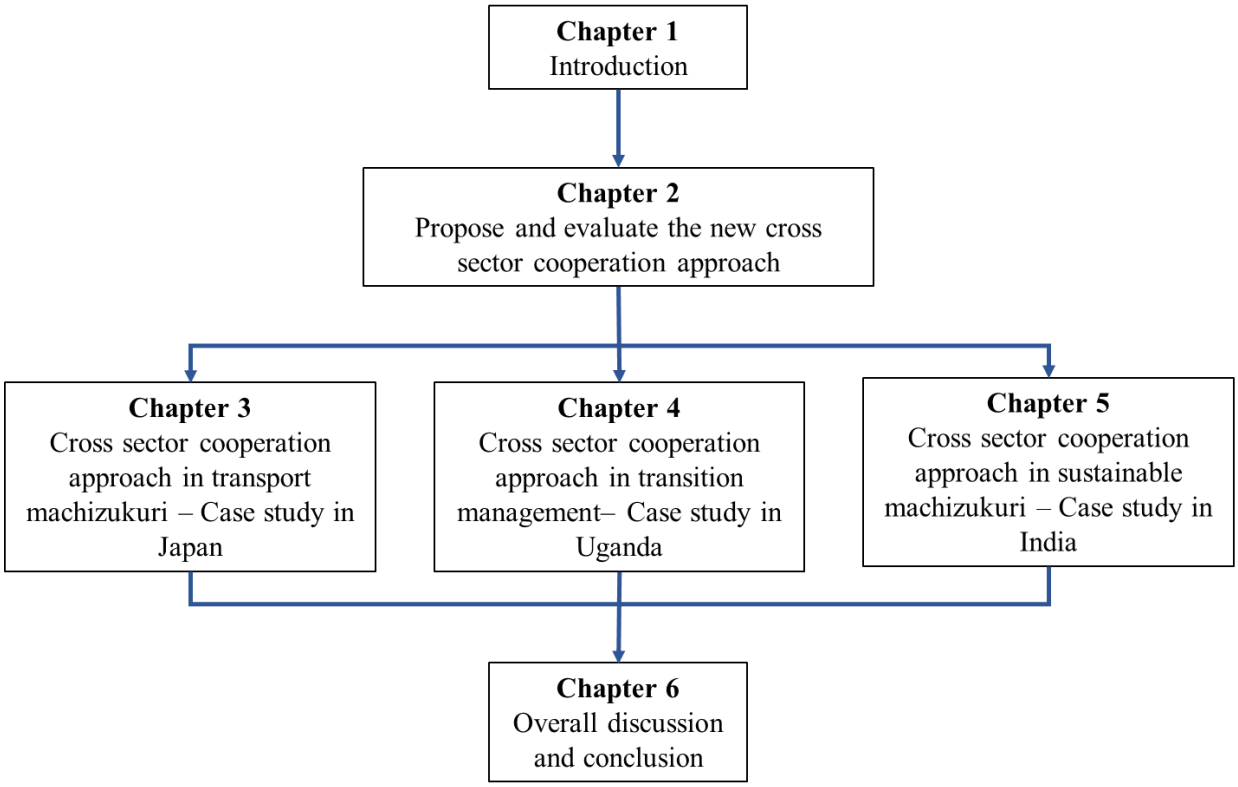

Figure 1-3: Research Flow

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2 Chapter 2: Development of the Cross Sector Cooperation Approach towards Road Safety

2.1 Brief summary on the PSC principle

The nature of traffic accidents has changed over the years, this calls for new approaches to tackle the current situation. So far, the 3Es has been instrumental in improving road safety; however, this approach only considers the technical aspect. Therefore, this study looked into the PSC principle, as an option to bring a social perspective to road safety. PSC principle stands for Priority, Speed and Comprehension or Compactness.

Priority refers to giving particular traffic users priority in the road space. It looks at what the social norm or perspective of priority is in a community. For example, at intersections of keep-left countries, the "through car" has the right of way over the "turning car." On the other hand, many African and Asian countries seem to give cars a higher priority than other road users for all types of roads. Yet, over the years, WHO and other organizations have been advocating for vulnerable road users to be given the utmost priority on roads other than highways.

Speed on the other hand refers to speed at which traffic participants move their motorized and non-motorized vehicles. Speed may be dictated by an individual's experience or skill though many at times the law may dictate the speed at which vehicles can move. In many studies, it is shown that novice drivers are prone to high speeds and tend to be more reckless as opposed to more experienced drivers who may drive at similar speeds but more carefully. In addition, the law for example in zone 30 areas dictates that vehicles move at 30 km/hr while the speed on highways often exceeds 120km/hr depending on the country. This shows that speed truly depends on an individual or a community.

Comprehension is defined as a traffic participant's ability to understand the traffic rules and regulations, road signs and symbols. Traffic rules and regulations are specific to a locality, for example, many countries have the stop sign as a red octagon with the word "stop" in white. While in Japan, the stop sign is an inverted red triangle with the Japanese word "tomare" in white. This causes a lot of confusion for foreign drivers in Japan. In addition, comprehension also looks at the information that road users are given while on the road. This maybe traffic related information displayed on information boards on the road or instructions given by a traffic officer on the road. The method and the messaging is vital to enable the road users to make informed decisions that may affect their safety and the safety of other road users. On the other hand, compactness refers to measures that aim to manage the dimensions of space on the road.

Yoh[36] et al expounded upon the PSC principle when they classified the type of traffic violations that different foreign drivers are prone to in Japan. It was found that North and South Americans foreign drivers are prone to violating rules related to speed. Asian foreign drivers are prone to violating rules related to priority in the road space. While South East Asian drivers are prone to violating rules related to comprehension of traffic rule, road signs and priority.

Sunagawa[37] et al emphasized the need to have social usability (P), road speed management (S) and road management (Compactness) as part of a holistic framework to improve road safety of road crossing facilities.

Therefore, PSC principle brings a new dimension to road safety by introducing aspects that directly involve the traffic participant hence being a good representative of a social approach. In this study, PSC principle and the 3Es are combined to create the new approach to cross sector cooperation approach.

2.2 The relationship between the PSC principle and the 3Es approach in road safety

Figure 2-1 below is a representation of PSC principle and 3Es approach as stand-alone approaches while **Figure 2-2** represents the combination of PSC principle and 3Es. The combination of these two ideas stems from the definition of "state of safety". Doi et al[35] explained that a system can either be inherently safe or functionally safe. Inherent safe systems are systems that remove hazards right from the source. For example, restricting cars from using school roads (Enf → P) ensures that school going children are safe from reckless drivers. Designating an area as a zone 30 (Enf → S) ensures that speeds used within an area are safe for all user.

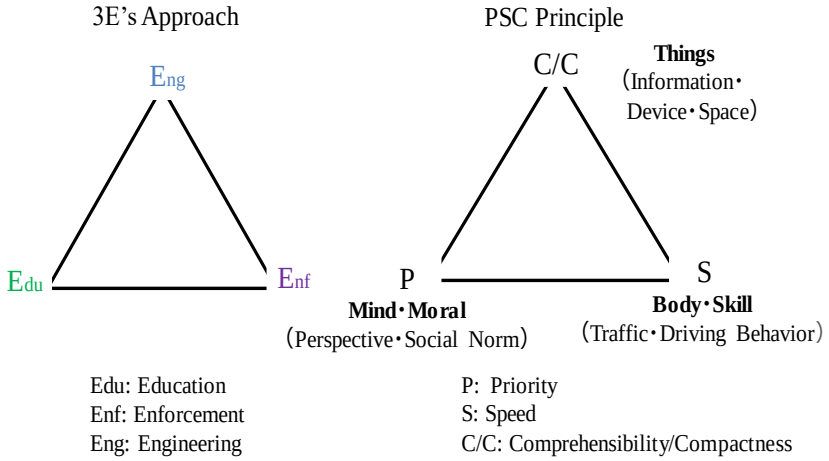

Figure 2-1: The 3Es approach and PSC principle as stand-alone approaches to road safety

Functionally safe systems are those whereby the probability and magnitude of an accident occurring is reduced. For example, putting rumble strips on roads (Eng → S) is an engineering method that ensures that drivers move at slower speeds hence reducing risk and fatality of collision with people or other cars. Every safety intervention is a mixture of PSC and 3Es component and therefore the two can be combined to create the safety hexagon. See **Figure 2-2** below.

The safety hexagon shows that each E is an intervention for either P, S or C aspect of safety. For example, when drivers take driving lessons, they will be able to interpret the road signs and symbols (Edu →C) and they will also know that at an intersection "through cars" are given

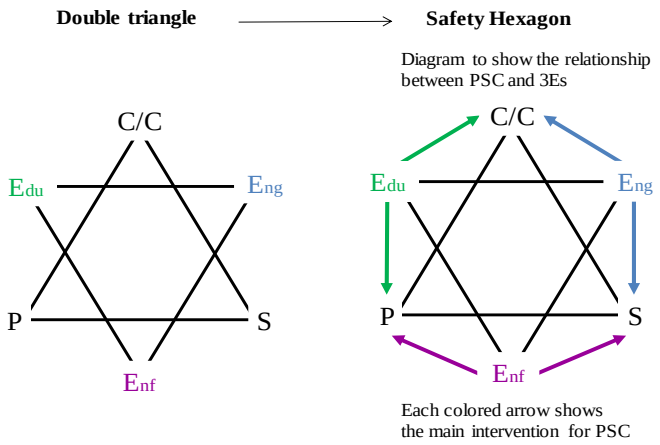

Figure 2-2: Safety Hexagon a combination of PSC principle and the 3Es

priority (Edu →P). Police officers can control the traffic on the road to ensure that pedestrians area given priority (Enf →P) at zebra crossing. The law (Enf →S) determines speed limits of roads, for example, in Uganda the speed limit of highways is 120 km/hr while in urban settings, the speed in 50-70 km/hr. Humps is one way of reducing the speed of vehicles (Eng→ S). While designating a 3-lane road for BRT, bicycles and cars is a way of making a former triple carriage road compact (Eng→ C). The safety hexagon not only highlights the diversity in road safety-related problems and solutions, as described above, but also shows role sharing (who is responsible for what aspect of safety). See **Figure 2-3** below.

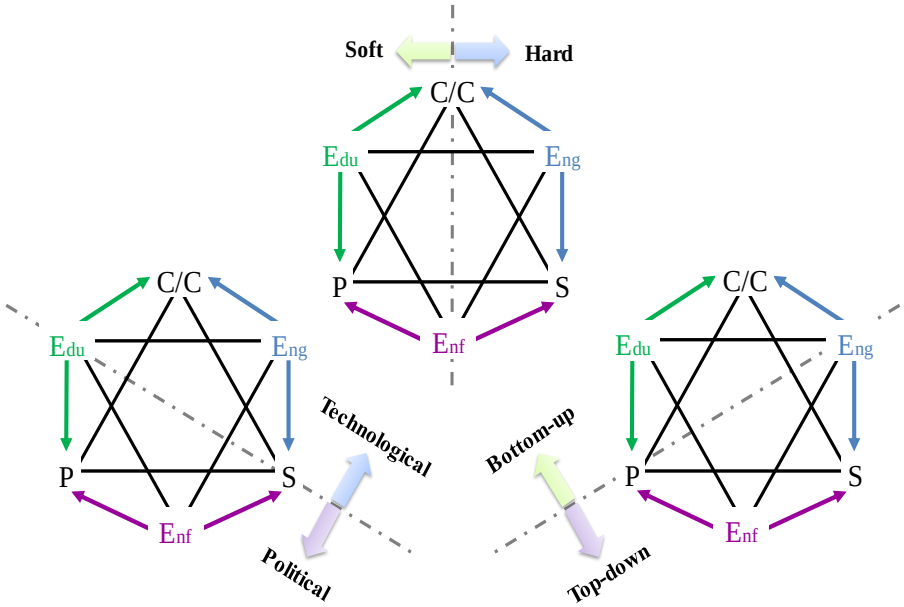

Figure 2-3: Role sharing explained by the Safety Hexagon

Road safety solutions can be hard or soft in nature, they can also be technical or political, and they can be approached from the bottom-up or top-down as shown in **Figure 2-3** above. This figure can further be explained as follows;

- Soft (intangible) solutions look to impart skills or knowledge and are hence Educational in

nature. For example, in 2014, India [38] embarked on a massive road safety campaign led by university students after their colleagues were killed on the way to school. The activities included sensitizing future drivers on road safety aspects, making technical innovations and enabling students use technology to tackle road safety issues. On the other hand, hard (physical) solutions are visible and usually engineering in nature. In Sweden's Vision zero [39], central medians and roundabouts became common in built up urban areas as a way to control speed.

- Top-down approaches are those that come from government and trickle down to the communities while bottom-up approaches are the reverse. Top-down approaches are usually enforcement in nature, for example, in the 2008-2020 Dutch road safety strategic plan [40], increase of enforcement of seatbelts, helmets, and alcohol is one of the strategies the government considered to improve safety. While in Germany [41], the government converted the "Accompanied Driving from 17" campaign into permanent legislation, in order to reduce the risk of novice drivers getting involved in road accidents.
- Technical solutions are engineering in nature while political solutions are enforcement in nature. In 1997, the Swedish parliament adopted Vision Zero policy [39] as a way to improve road safety. While in 2016, Japan [42] accelerated the installation and use of ETC 2.0 as a way to deal with traffic congestion. This system not only enables safe and comfortable driving on highways but also provides important information especially during disasters.

From the above explanations, we can conclude that some countries are already embracing the logic behind the safety hexagon to improve road safety. To establish the extent to which this is happening, three countries' national road safety policies were evaluated using the method described below.

2.3 Preliminary study – International comparison of Cross Sector Cooperation approach among selected countries

2.3.1 Methodology

Road safety policies of three countries were selected and reviewed on the basis of their guiding principle as shown in the **Table 2-1** below. A multi-criteria analysis of PSC and 3Es indicators was used to analyze the policies.

The road safety policies were reviewed and the road safety measures were then classified into 5 categories (PSC, 3Es, Hard and Soft measures, Top-Down and Bottom-Up measures, Technological, Political and Technical measures) and 15 components, as shown in the safety hexagon in **Figure 2-3** above. The classification of each measure under the various categories was based purely on the policy statement and not the impact or time of the measure's implementation.

In order to make a tangible comparison across the selected road safety policies, the

percentage proportion for each component under a given category for each country were calculated. For instance, the percentage of priority-related measures under the PSC and "Other" categories were calculated, the percentage of Engineering-related measures under the 3Es cluster were also calculated, and so on (see **Table 2-3** and **Table 2-4**).

Table 2-1: National Road Safety Policies for comparison

This simple method was used because each country's situation is unique, which means that

Country	Guiding principle of road safety	Pertinent road safety policy
Germany	The principle is that every road fatality is one too many.	German Road Safety Programme 2011 [41]
Japan	Under the transport safety school of thought, people are prioritized so that the number of traffic accidents fatalities can be reduced to a quarter the number of the highest fatalities ever recorded.	The 10th Transportation Safety Plan, 2016 [43]
Netherlands	Road safety is everyone's responsibility because it affects everyone, benefits everyone, and depends on everyone (Road safety from, for, and by everyone).	Road Safety Strategic Plan 2008–2020 [40]

the measures are very diverse and thus complicate scientific comparison. In addition, it enables better understanding of the safety philosophy of each country therefore; some lessons can be picked from each policy (see **Section 2.5- 2.7**). Furthermore, the respective proportions within each policy provide a basis that paves the way for the new road safety cross-sector cooperation approach. The study used the following abbreviations and definitions as shown in **Table 2-2**.

Table 2-2: Definitions of keywords

Abbreviation	Unabbreviated equivalent	Definition
P	Priority	Measures aimed at prioritizing a particular traffic participant in the road space
S	Speed	Measures aimed at speed management
Cct	Compactness	Measures aimed at road space management
Cr	Comprehension	Measures aimed at motivating or enabling traffic participants to understand road safety rules and regulations, or measures/activities that demonstrate that the traffic participants understand the road safety rules and regulations
O	Other	Measures not directly related to PSC but are rather auxiliary

Abbreviation	Unabbreviated equivalent	Definition
	component	measures aiding in attaining road safety
Edu	Education	Activities that either inform, advise, instruct, teach, or motivate traffic participants to follow traffic rules and regulations
Eng	Engineering	Measures that bring about physical change to vehicles, roads, roadside environments, or road environments
Enf	Enforcement	Measures designed to bring about road safety by either imposing a law or fostering the use of new technological devices or systems
Sf	Soft	Intangible methods or systems used to enhance road safety
H	Hard	Physical items or devices installed in vehicles or road space to foster road safety
Tec	Technological	Inventions that use technology to realize safer roads, safer vehicles, or safer movement of traffic participants
Pol	Political	Measures passed or enforced by a government or representative authority
Tekn	Technical	Measures that are neither technological nor political in nature but used as suggestions from scientists, doctors, academics, or other professionals
BU	Bottom-Up	Measures suggested or implemented by target groups, communities, or special-interest groups not directly run by a government
TD	Top-Down	Measures suggested or implemented by a government or a representative body; the chain of command is from government toward the community or a particular target group

**The measures considered for the study represent what the policies intend to implement, not the actual implementation thereof.*

The results from the method described above were used to demonstrate cross-sector cooperation within each country and thereby illustrate the type of cross-sector cooperation that this study is aiming to introduce.

2.4 Results and Analysis

This section provides the results of the above country-specific categorization and a corresponding analysis.

2.4.1 Analysis

Table 2-3 shows an overall percentage comparison of PSC components and 3Es components per country policy statement, while **Table 2-4** shows a similar breakdown of Soft and Hard components, Technological, Political, and Technical components, and Bottom-Up and Top-Down components. The values in the **Table 2-3** and **Table 2-4** are the component percentages per category. Every measure in each policy was allocated a count under a suitable designation. For example, a measure like, "target group specific communications" was counted under comprehension, education, soft and bottom-up because it satisfies the definition of the classification in **Table 2-2**. This was done for every measure in every country policy; thereafter the counts under each category were totaled. In addition, the total numbers under each measure where calculated as percentages of the category. For example, Education (Edu)-related measures were calculated as percentages of the total numbers of measures that fell under the 3Es category. The same was done for the other 13 components under the 5 categories. Compactness-related measures were not tabulated because the percentage of this component, across all the countries, was almost zero. **Sections 2.5-2.7** provide additional illustrations of **Table 2-3** and **Table 2-4** using graphs, which provide the basis for our analysis of each county's situation.

Table 2-3: Percentages of safety measures in each country's road safety policies (I)

Category	**PSC measures**				**3Es measures**		
Component (%)	**P**	**S**	**Cr**	**O**	**Edu**	**Eng**	**Enf**
Germany	2	12	21	63	28	27	45
Japan	0	0	12	88	31	50	19
Netherlands	6	10	29	54	32	30	38

Table 2-4: Percentages of safety measures in each country's road safety policies (II)

Category	**Soft and Hard measures**		**Technological, Political, and Technical measures**			**Bottom-Up and Top-Down measures**	
Component (%)	**Sf**	**H**	**Tech**	**Pol**	**Tekn**	**BU**	**TD**
Germany	55	45	17	65	18	27	73
Japan	72	28	40	37	23	41	59
Netherlands	77	23	29	58	14	40	60

2.5 Germany

One of Germany's biggest concerns is an anticipated demographic change whereby senior citizens (65+ years) will significantly outnumber young people (18–29 years) by the year 2050. This transformation, in itself, alters the dynamics of road accident risks and countermeasures. In addition to traditional road safety measures, other non-traditional measures have to been formulated. This explains why the ratio of the "Other" component is the highest among the various components of the PSC category (**Figure 2-5**). Some of such measures include; encouraging voluntary health checkups of the elderly, implementing new findings on drug-driving etc.

German policymakers believe that people are willing to follow rules once they understand them, a process possible through the dissemination of traffic safety-related information. This partly accounts for the Education measures representing more than 25% of the 3Es category (**Figure 2-4**).

Germany is a highly technologically advanced country, but that reality is not entirely evident in the share of Engineering among the 3Es or the share of Technology in the Technological, Political, and Technical category (**Figure 2-6**). This is partly because the German government's main aim is to support research that will ensure that the existing technology is safe, efficient, and environmentally friendly. In addition, the government would like to foster the spread of standardized technological methods on a broad, countrywide basis and also across EU member states. These two conditions explain why the Enforcement and Political ratios are relatively high in their respective categories.

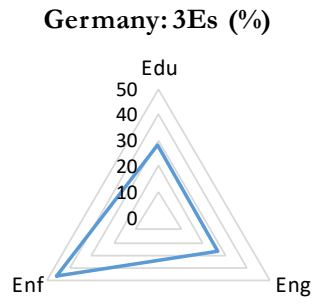

Figure 2-4: Germany 3Es ratios

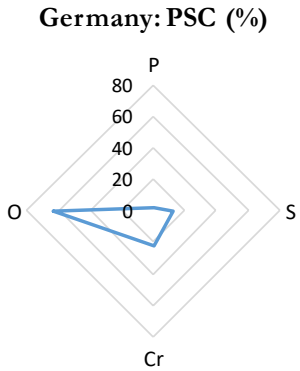

Figure 2-5: Germany PSC ratios

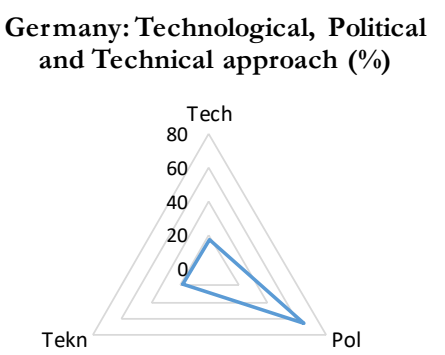

Figure 2-6: Germany Technological, Political and Technical ratios

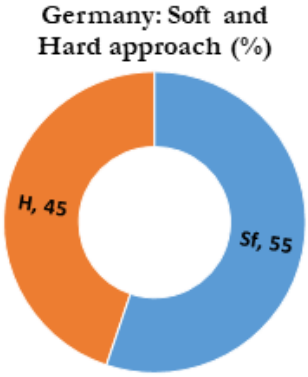

Figure 2-7: Germany Soft and Hard ratios

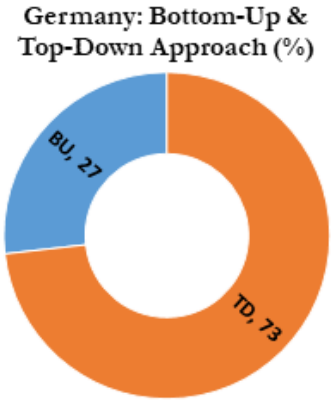

Figure 2-8: German Bottom-Up and Top-Down ratios

According to the Road Safety Programme 2011, the German government is setting aside a budget to upgrade and/or convert its roads (especially rural roads) to standards that are more "forgiving" toward people. While pursuing this initiative, it is also focusing on various road safety campaigns tailored to improving the safety of vulnerable road users. This explains the slight gap between the Soft and Hard measures (**Figure 2-7**).

The Ministry of Transport and Digital Infrastructure and the German Road Safety Council are responsible for formulating the national road safety strategy. Germany being a federal state means that each state has to make an input towards the formulation of the road safety strategy, based on the unique situation in each state. This might explain why the top-down measures are significantly greater than the bottom-up measures in **Figure 2-8**.

2.6 Japan

As a country, Japan's three main concerns are its aging society (and infrastructure), the need to prepare for natural disasters, and the improvement of road service through ITS. The first two concerns dictate the implementation of many non-traditional methods for ensuring a

sustainable society. This explains why the "Other" component has a greater weight than Priority, Speed, and Comprehension-related measures (see **Figure 2-10**). Some of these measures include; expanding new technologies into the market and increasing its safety.

In addition, the "machizukuri concept" has been widely implemented across the country. Machizukuri refers to community-government engagement whereby technical personnel such as engineers work hand in hand with local residents to create solutions for problems in society. This approach explains why:

- Engineering and Education measures occupy larger proportions than Enforcement measures do, as **Figure 2-9** shows;
- The great disparity between Soft and Hard measures, as shown by **Figure 2-13** ; and
- The Technical aspect (see **Figure 2-12**), having a higher weight than technical aspects as compared to other countries.

It should also be noted that the disparity between soft and hard measures is also attributed to budgetary constraints. Relative to the situations in Germany, Japan's gap between the bottom-up approach and the top-down approach is considerably small (**Figure 2-11**). The government of Japan is looking to utilize the existing infrastructure through the use of ITS[43] which makes the Engineering and Technological components the largest components of their respective categories.

The results also show that although Japan is still lagging behind in terms of its fundamental road safety education in schools and homes, the Education component plays a relatively large role in the country's policy. This is mostly due to the substantial investments going towards research that will enable citizens to understand road rules and regulations more fully. Therefore, the Education component for Japan is not a direct effect like in the case of the Netherlands or Germany.

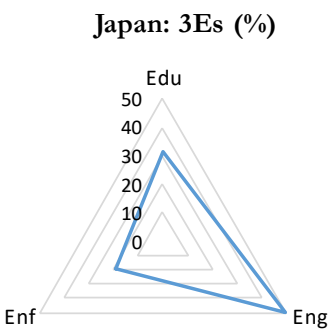

Figure 2-9: Japan 3Es ratio

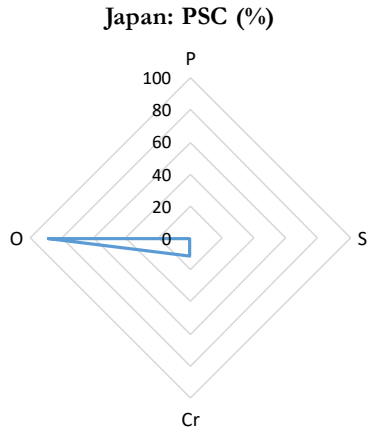

Figure 2-10: Japan PSC ratio

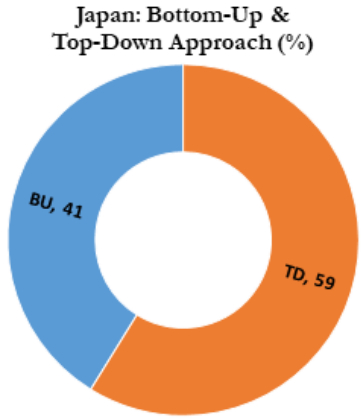

Figure 2-11: Japan Bottom-Up and Top-Down ratios

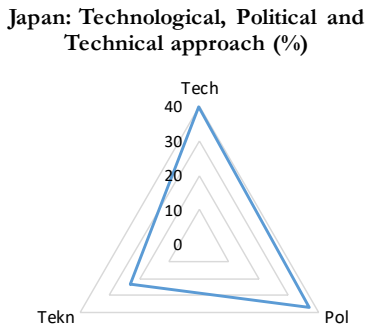

Figure 2-12: Japan Technological, political and Technical ratios

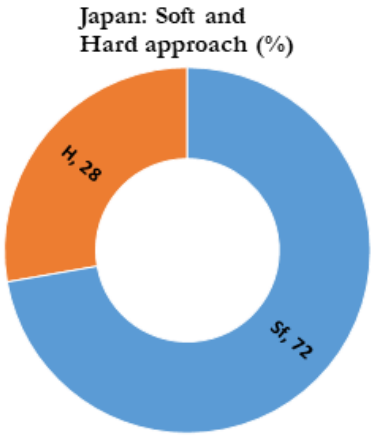

Figure 2-13: Japan Soft and Hard ratios

2.7 The Netherlands

The Netherlands, like Japan and Germany, is facing the problem of an aging population and increasing fatalities of vulnerable road users such as children, cyclists, and motorcyclists. There are also great concerns about individuals who jeopardize safety on the road, these include novice drivers and drunk drivers.

The Netherlands decided to focus on vulnerable groups by extending traffic safety lessons in and out of schools, mainly aiming to make sure that each citizen would realize that road safety is everyone's responsibility and that failure to comply with traffic rules would lead to more consequences that are direct for offenders. Therefore, the Comprehension aspect is larger for the Netherlands than it is for the other two countries.

The process of formulating and implementing road safety policies involves various professionals and organizations (engineers, doctors, politicians, associations for cyclists, associations for the elderly, academicians, etc.). This approach, one of the most outstanding

characteristics of policymaking in the Netherlands, is the main reason for the following results:

- Relative to the conditions in other countries, the 3Es ratio is almost equal in magnitude (**Figure 2-14**);
- The ratio of Soft measures is more than triple that of the Hard measures (**Figure 2-16**)
- When compared to other countries, the "other" component among the PSC components is just as high (see **Figure 2-15**); and
- The margin between Bottom-Up and Top-Down measures is smaller than the same margin in Germany (**Figure 2-18**).

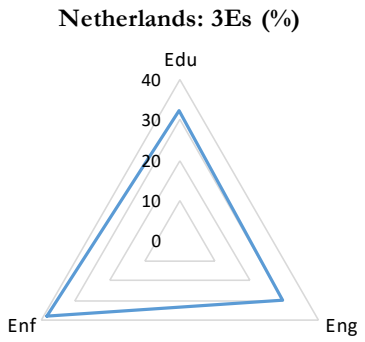

Figure 2-14: Netherlands 3Es ratio

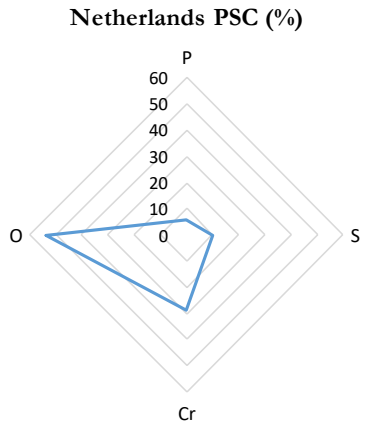

Figure 2-15: Netherlands PSC ratios

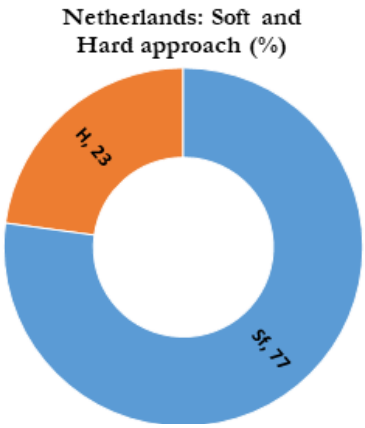

Figure 2-16: Netherland Soft and Hard ratios

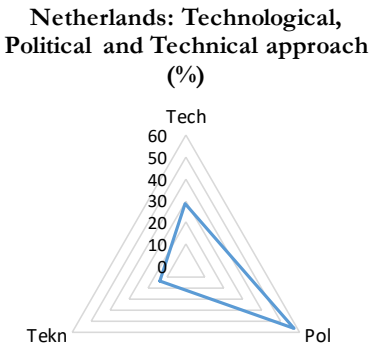

Figure 2-17: Netherlands Technological, Political and Technical ratios

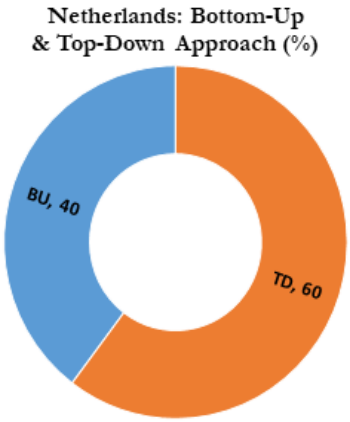

Figure 2-18: Netherlands Bottom-Up & Top-Down Approach

The Political component occupies a larger-than-expected share, while the Technical component is surprisingly small (see **Figure 2-17**). This might be attributed to the fact that the Netherlands realized that international cooperation (through the European Commission) was vital for various road safety innovations to take root. Secondly, the minister for Transport, Public Works and Water Management at the time, issued a letter to parliament suggesting people who cause unsafe situations on the road should be subject to stricter consequences. This meant tightening the rules and regulations on road users such as novice drivers.

2.8 The New Approach to holistic Road Safety

Section 2.2 describes the relationship between PSC and the 3Es and how other approaches, such as "soft and hard measures," have been incorporated into the road safety policies of various countries. The concept of cross-sector cooperation described here used the relationship between PSC and the 3Es as a basis to show how the components in the safety hexagon (see **Figure 2-2**) were synchronized to work together as a seamless mechanism in achieving holistic road safety.

Drawing on the explanation for **Figure 2-2**, the number of Education measures targeting either Priority or Comprehension as a percentage of all Education measures by country, were calculated. The same was done for Engineering measures targeting the attainment of either Compactness or Speed, as well as the Enforcement measures aiming at either Priority or Speed. The objective in doing so was to determine:

- If the representative countries were already incorporating road safety measures that merged PSC and the 3Es concept; and
- If so, the extent to which the countries have merged the two concepts into a unit.

Table 2-5: Measures from both the PSC principle and the 3Es approach

Country	Edu/Cr (%)	Edu/P (%)	Eng/Cct (%)	Eng/S (%)	Enf/P (%)	Enf/S (%)
Germany	61	0	0	29	0	10
Japan	40	0	0	0	0	0
Netherlands	61	0	5	10	4	19

The investigation revealed that, indeed, the representative countries had incorporated road safety measures that were both PSC and 3Es in nature (see **Table 2-5**). Considerable fragmentation was found, as some measures seemed to fall on only one side of the "merger spectrum." Based on the definition for the safety hexagon (see **Figure 2-2**), Education measures should aim to achieve Priority and Comprehension; Engineering measures should aim at achieving Compactness and Speed; and finally, Enforcement measures should aim to achieve Priority and Speed management.

As the results in **Table 2-5** indicate, however, all the countries used Education to achieve Comprehension but did not use it for the Priority component. Similar results were evident in Engineering efforts, which went toward Speed management goals but not road Compactness goals. Enforcement, likewise, served as a tool to enhance Speed management but not Priority goals. The Netherlands and Germany tried to have measures that fell on both sides of the "PSC and 3Es merger spectrum," while Japan only did so for one out of six aspects. This maybe because, these countries have already tackled these aspects in previous national policies or that these aspects are covered in other policy documents that were not examined in this study.

In the near future, there may arise different road safety issues from the introduction of autonomous vehicles or rapidly ageing societies. For example, now in Japan [44], older drivers account for about 14% of the fatal accidents. In view of this, the highlighted aspects in **Figure 2-19** represent the road safety features that we need to focus on now before such problems become too big to handle. This is in a bid to close any other loopholes that may be present now and in the near future.

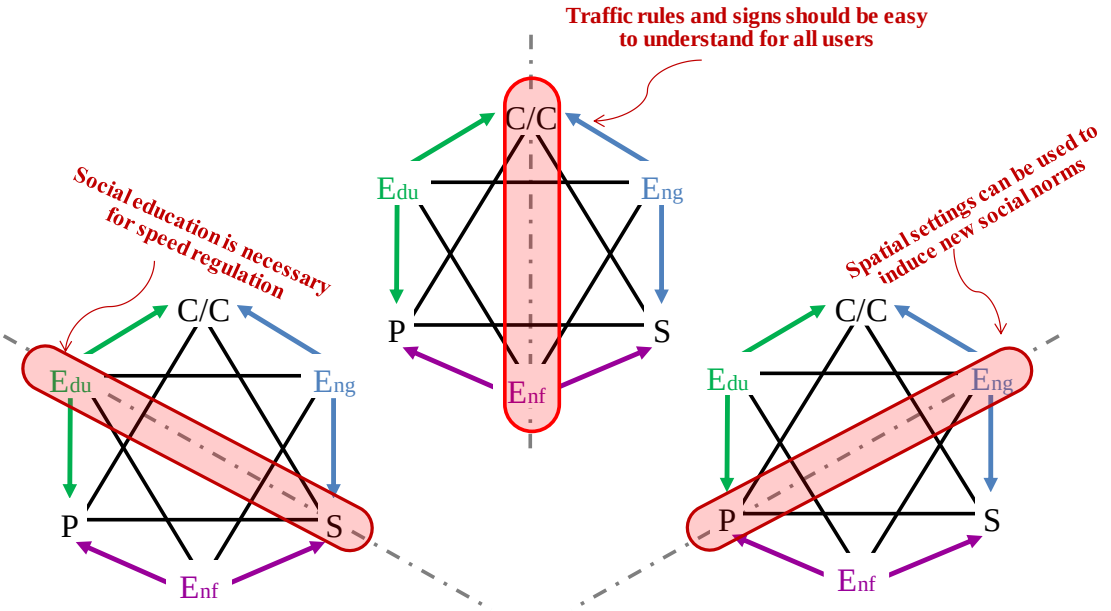

Figure 2-19: Areas where cross-sector cooperation is still required

The next investigation was to find out whether the highlighted features were represented in the road safety policies. **Table 2-6** below shows the results from the analysis. These results were arrived at the same way as those in **Table 2-5**. Despite the fact that these highlighted aspects are non-traditional, two of the representative countries seem to have already incorporated them in their road safety policies. This shows that the concept informing the safety hexagon is not only applicable but also achievable.

Table 2-6: The third dimension in the safety hexagon

Country	Edu/S (%)	Eng/P (%)	Enf/C (%)
Germany	0	9	7
Japan	0	0	0
Netherlands	0	19	19

The extent of the fragmentation evident in **Table 2-5** and **Table 2-6** further emphasized the importance of understanding and exploring the latent relationship between the PSC and 3Es approaches. Therefore, **Figure 2-20** was created to represent all the aspects that road safety policies need to incorporate as well as the parties that are vital in the policymaking process.

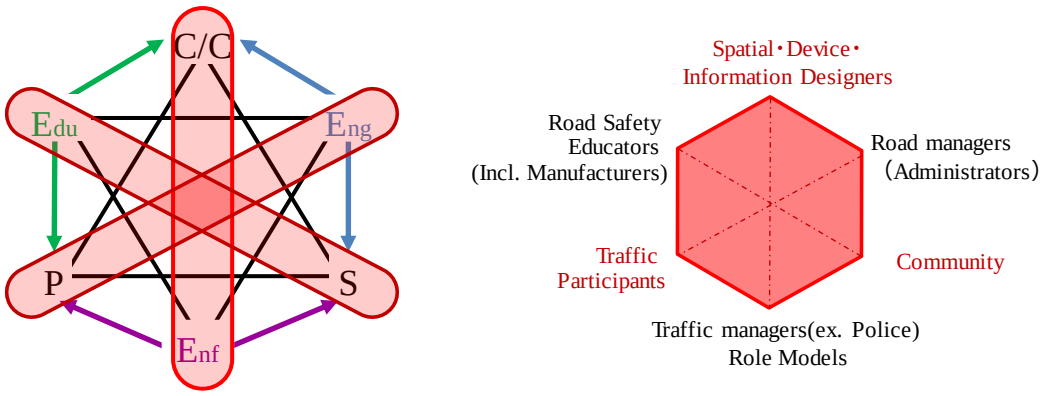

Figure 2-20: Desired Cross Sector Cooperation Approach in road safety

Cross-sector cooperation seeks to involve all relevant parties because the traditional norm has left some parties out of the policymaking process. For instance, the parties in black text in **Figure 2-20** are usually involved in these proceedings, while the ones in red text are most times excluded. This may stem from the fact that the 3Es concept is better understood than the PSC concept is. From **Figure 2-20** one can see the direct link between the 3Es and the parties in black text and the link between PSC and the parties in red text.

In addition, these two pillars can further explain cross sector cooperation towards road safety;

a) The first pillar is the relationship between road accident causes or risky behavior and the road safety measures. Risky behaviors and/or causes of accidents are related to the poor understanding of PSC concept among road users. PSC classifies road accidents as either a lack in priority (P) hierarchy or lack of speed (S) management or a lack in comprehension (C) of traffic rules and regulations. For example, in keep left countries, a driver at a T-junction may decide to join the main road yet he must give priority to cars on the main road to pass. This is an example of a lack of priority and this may lead to increased risk of accidents at this junction.

   On the other hand, road safety solutions revolve around 3Es and the most appropriate solution should be proposed after identifying which PSC aspect is being violated. Using the same example of the zone 30 area, the solutions to drivers over speeding would be to either educate drivers about what a zone 30 area means (Edu →S) or install road furniture to give them a cue to slow down when in this area (Eng →S) or restrict cars from accessing zone 30 areas (Enf →S).

b) The second pillar is the key players or stakeholders that are vital for co-creation in road safety discussions. Road safety has become a social problem that requires not only technical personnel but also involvement of the individuals directly affected by road accidents. Many at times, stakeholders from other sectors such as agriculture, manufacturing or tourism sectors are more involved in road safety discussions yet the community maybe left out of these discussions.

The world is moving towards holistic road safety, therefore, co-creation is of paramount importance and attainable only if the roles of each party are recognized. Failing to consider these roles invariably leads to irregularities in the system as shown in **Figure 2-21** below.

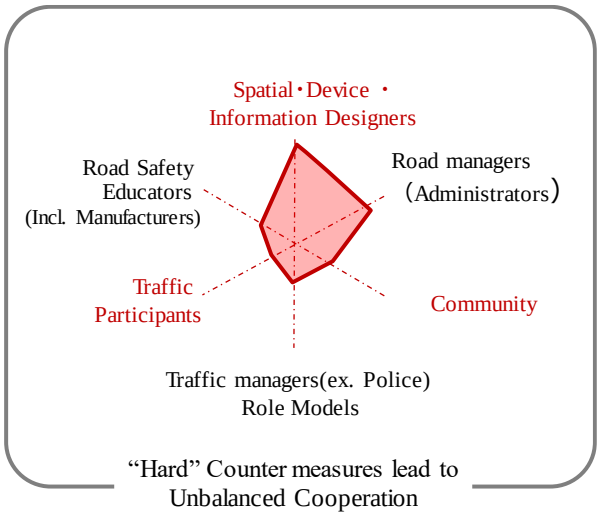

Figure 2-21: Irregularities caused by unbalanced cross-sector cooperation

Researchers such as Rahman et al. [45] have observed this kind of situation during their research into the public acceptance survey for evaluation of the traffic-calming process. The researchers found that the community rejected some traffic-calming measures after implementation simply because it had not been involved in the decision-making process.

Figure 2-22 –**Figure 2-24** further demonstrate the aforementioned irregularities within the representative road safety policies.

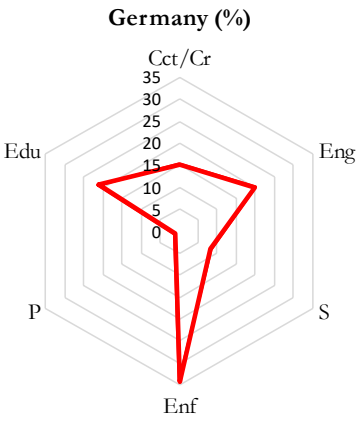

Figure 2-22: The situation in Germany

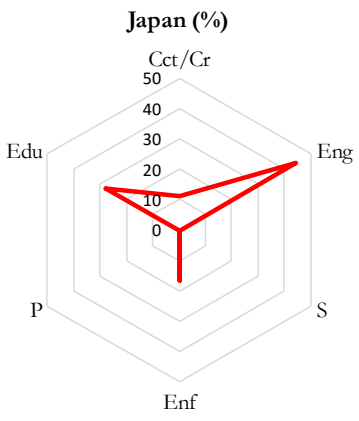

Figure 2-23: The situation in Japan

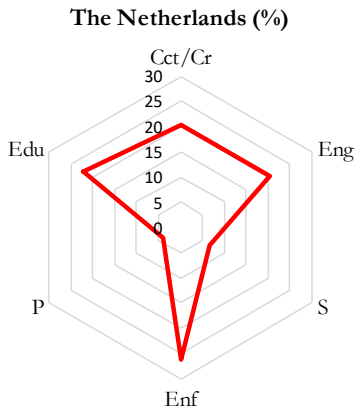

Figure 2-24: The situation in the Netherlands

The figures above show that policies in the different countries are directly or indirectly based on the 3Es. As expected, the Netherlands and Germany have a somewhat more inclusive approach compared to Japan because they involve various parties in decision making.

Such irregularities in policy may account for the stagnation in the rates at which traffic accidents should be decreasing. This lack of balance among approaches might also explain why fatalities among some vulnerable road users (elders, cyclists, etc.) have increased over the years despite several government interventions.

2.9 Summary

A road policy is defined as a course or principle of action adopted or proposed by an organization or individual. In this chapter, the road safety policies were those proposed by different governments in a bid to improve the road safety situation in their respective countries. In reality, road safety policies are based on past achievements and research, with the hope that if fully implemented then the set goals will be met. In other words, national road safety policies represent the government's stand on tackling road safety problems.

The aim of this study was not to show which national policy is better or more efficient but rather, how different guiding principles affect the eventual direction of policy. This is the reason, current road safety policies of these countries were utilized to expound on the new approach of cross sector cooperation approach towards road traffic safety.

It was evident that Germany and Netherlands already started including PSC principle in the formation of their policies while Japan is a work in progress. This can be attributed to the fact that Germany and Netherlands involve numerous stakeholders in making policies while in Japan, it is mostly politicians that get a say in the policies.

However, it is important to note that because only national road safety policies were evaluated, this might explain why the analysis did not fully reflect the impact of speed measures such as zone 30 in Germany and the Netherlands. This might also explain why there was fragmentation in some comparisons because other complementary policies or past policies may

have already tackle the “missing components”.

Nonetheless, when the different components of 3Es and PSC were compared, in many of the countries, the components were biased towards one element. **Table 2-5** showed that Education was biased towards comprehension and not priority. Engineering was biased towards speed and not compactness while Enforcement was biased towards speed and not priority. If these fragmentations have not been addressed in earlier policies or other complementary policies, then they may require attention in the near future.

Another pertinent result was that compactness interventions were not included in this study because their percentage values were negligible, pointing to another point of interest for further consideration if it has not been tackled before.

Overall, this study showed the relationship between the 3Es and PSC which was a basis of introducing a new more inclusive cross sector cooperation approach towards road safety. In this chapter, the extent to which existing road safety policies were embracing the proposed cross sector cooperation approach were identified. It was also discovered that the representative countries were embracing it both directly and indirectly.

As a result of fragmentation in the traditional understanding of PSC-3Es, a third dimension (see **Figure 2-19**) was introduced in a bid to plug possible loop holes that may arise in the future especially as new technologies (electric vehicles, autonomous vehicles) are developed and implemented.

In addition, the stakeholders that play key roles in co-creation for road safety were also identified. This too was based on the relationship between PSC-3Es. The irregularities shown by **Figure 2-22** - **Figure 2-24** illustrate the importance of having diverse stakeholders in policy decision making. The desired cross sector cooperation is visually represented by the safety hexagon in **Figure 2-20**.

It should be noted that different localities experience different road safety challenges. The next chapters, therefore, illustrated how the proposed cross sector cooperation approach could be utilized to address road safety problems in different localities. This was done by identifying a particular road safety problem and a gap in the cooperation. Thereafter, a framework to implement cross sector cooperation was proposed to overcome this problem.

2.10 References

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3 Chapter 3: Utilizing the cross sector cooperation approach in Transport Machizukuri

3.1 In-depth study of two highly motorized cities in Japan

When compared to other representative countries, (see **section 2.8**) Japan is yet to embrace the proposed new cross sector cooperation approach at a national level. Although a number of government agencies and research institutions are involved in road safety, this is not to the scale of countries like Germany and Netherlands. Implementation of traffic safety measures follows a top-down approach. However, there have been cities in Japan that have realized the need to explore bottom-up approaches by utilizing a form of cross sector cooperation to resolve the road safety problems in their localities. **Section 3.2** gives a brief background of the road traffic situation in Japan. **Section 3.3** gives a background of the case studies that were chosen, while **section 3.4** and **3.5** give details about each case study. **Section 3.6** is an overall discussion of this chapter.

3.2 Brief background of the road traffic situation in Japan

According to Global Health Observatory data repository [46], the estimated road traffic death rate per 100,000 populations for Japan in 2018 was 3.6. Japan is among the top countries with a rapidly aging community with about 28% of its population above the age of 65 and 12% of its population between the age of 0 and 14. The elderly population is estimated to continue rising while the trend of children below 14 years is estimated to continue falling. The current population growth rate was estimated to be -0.18% and is constantly hitting a low every consecutive year.

The 2018 Japan police report [47] on traffic accidents showed that the fatalities of the elderly people (over 65 years) are about twice those of other age groups. Persons aged 5-9 years and those over 65 years make up the biggest portion of injured pedestrians. For the first time in 15 years, Japan recorded a significantly high number of fatalities involving children below 15 years in 2016. Many of these fatalities occurred to and from school with 44% on foot and 23% while riding a bicycle. This prompted many local governments to take action to safeguard the children.

The “Special feature: Progress and Future prospects regarding traffic safety measure” [48] detailed how road safety interventions in Japan have changed to accommodate the prevailing situation. During the 1st traffic war (1951 – 1970), the majority of casualties were pedestrians and children, so the government focused on improving traffic safety facilities and educating road users. In the 2nd traffic war (1980 – 2007), the majority of casualties were pedestrians and motorcyclists so the focus shifted towards improving driver education and driver license systems, mitigating traffic accident damage and tackling illegal parking of vehicles and bicycles. After 2008, the focus was on promoting measures for elderly drivers, traffic enforcement/speed regulation targeting safety on school roads and preventing traffic accidents.

The 10th transportation safety plan focused on the aging society and infrastructure, the need to prepare for natural disasters and expanding ITS in the road infrastructure. This led to some academicians proposing different concept to improve the safety of the vulnerable road users. One example was the development of a guide for the integrated safety management of school roads and zones (March 2018) whose aim was to reduce road accidents involving school going children to zero [53]. This case study was one of the two case studies that were discussed in the preceding sections.

3.3 Case studies of two highly motorized cities in Japan

The two cities that were chosen were Takamatsu city, Kagawa Prefecture and Niigata city, Niigata prefecture. In Takamatsu city, many of the causalities were bicyclists and for a very long time, they had tried many interventions but there was not a significant change in causality numbers so the city authorities called for a town meeting to forge a way forward.

In Niigata city, two elementary schools were closed and all the children transferred to another school that was very close to prefectural highway. This worried many stakeholders as they envisioned that many children might lose their life because of the increased risk of exposure because the distance to school had increased. In addition, this also increased the possibility of the children mixing with many vehicles. The International Association of Traffic and Safety Sciences (IATSS) organized workshops to brainstorm how to safeguard the children on their way to and fro school. These case studies were chosen because of the following reasons;

- Both cities had high road accident deaths rates as compared to the national averages (see **Table 3-1**)
- Both areas are located in highly motorized cities in Japan (see **Table 3-2**)
- Both areas held social experiments aimed at influencing implementation changes for improving road safety.
- Both areas addressed a road safety problem targeting a vulnerable road user.

Table 3-1: Road accident deaths statistics

	Road accident deaths (no.)			**Road accident deaths (per 100,000 population)**		
	2015	**2016**	**2017**	**2015**	**2016**	**2017**
Japan	4117	3904	3694	3.24	3.07	2.91
Kagawa Prefecture	52	61	48	5.3	6.25	4.94
Niigata Prefecture	97	107	85	4.19	4.64	3.72

Ref 49: 平成 29 年中の交通事故死者数

Table 3-2: Transportation mode split for people above 15 years of age

	Use of one transport mode (%)					Use of 2 modes (%)		>3 Modes (%)
	Walking	Rail/ train	Bus	Car	Bike/ Bicycle	Rail/Train/ Bus	Rail/Train/ Bike/Bicycle	
Japan	7.1	16.1	2.5	46.5	14.6	3.8	3.4	1.1
Kagawa Prefecture	5.3	3.9	0.6	65.2	4.9	0.2	1.9	0.4
Niigata Prefecture	6.9	3.5	2.9	72.0	8.2	0.6	1.1	0.5

Ref 50: 平成 22 年国勢調査交通分担率

From the tables above, Kagawa and Niigata prefectures consistently had higher road accidents per 100,000 persons as compared to the national average. They had higher car usage as compared to the national average while all other modes of transportation were significantly lower than the national average. With such higher accidents rates and high motorization rates, something different had to be undertaken to change the road safety situation.

3.4 Case Study 1: Takamatsu City, Kagawa Prefecture

3.4.1 Understanding the problem: Nakanochou area, Takamatsu city

Kagawa prefecture is an important entry point to Shikoku region and is also the location of both national and international trade points such as Takamatsu, Sakaide etc. Takamatsu city, its capital, houses many regional branches of Japan's biggest corporations.

Kagawa prefecture is known to have the highest road accident deaths per 100,000 populations in Japan (see **Table 3-1**). Takamatsu city's road safety situation was not very different from that of the rest of Japan, because majority of accidents occurred at intersections and in residential areas and many involved bicycles.

Nakanochou area was the designated case study area chosen by officials in Kagawa prefecture. The main issue was the increasing number of accidents involving bicycles. Over the years, many interventions had been implemented but Kagawa prefecture as a whole still faced a high road accident rate. In this case, three main study areas were chosen area A, B and C (see **Figure 3-1**), surveys were carried out prior to setting up surveillance cameras and picking probe data from ETC 2.0 machines.

In order to understand the situation better, a town meeting was held on 26th November 2017. It was a first of its kind as it involved various stakeholders especially the community [51]. The meeting kicked off with a field visit, whereby residents showed other participants, areas they felt were risky and explained why they thought so.

The norm is for engineers or the police to formulate traffic safety measures independent of the community's input. The variety of participants in this town meeting was a great example of

what cross sector cooperation looks like. **Figure 3-2** below is an illustration of the suggested key players that were present at the meeting. These were categorized based on the roles and regulations from their job descriptions.

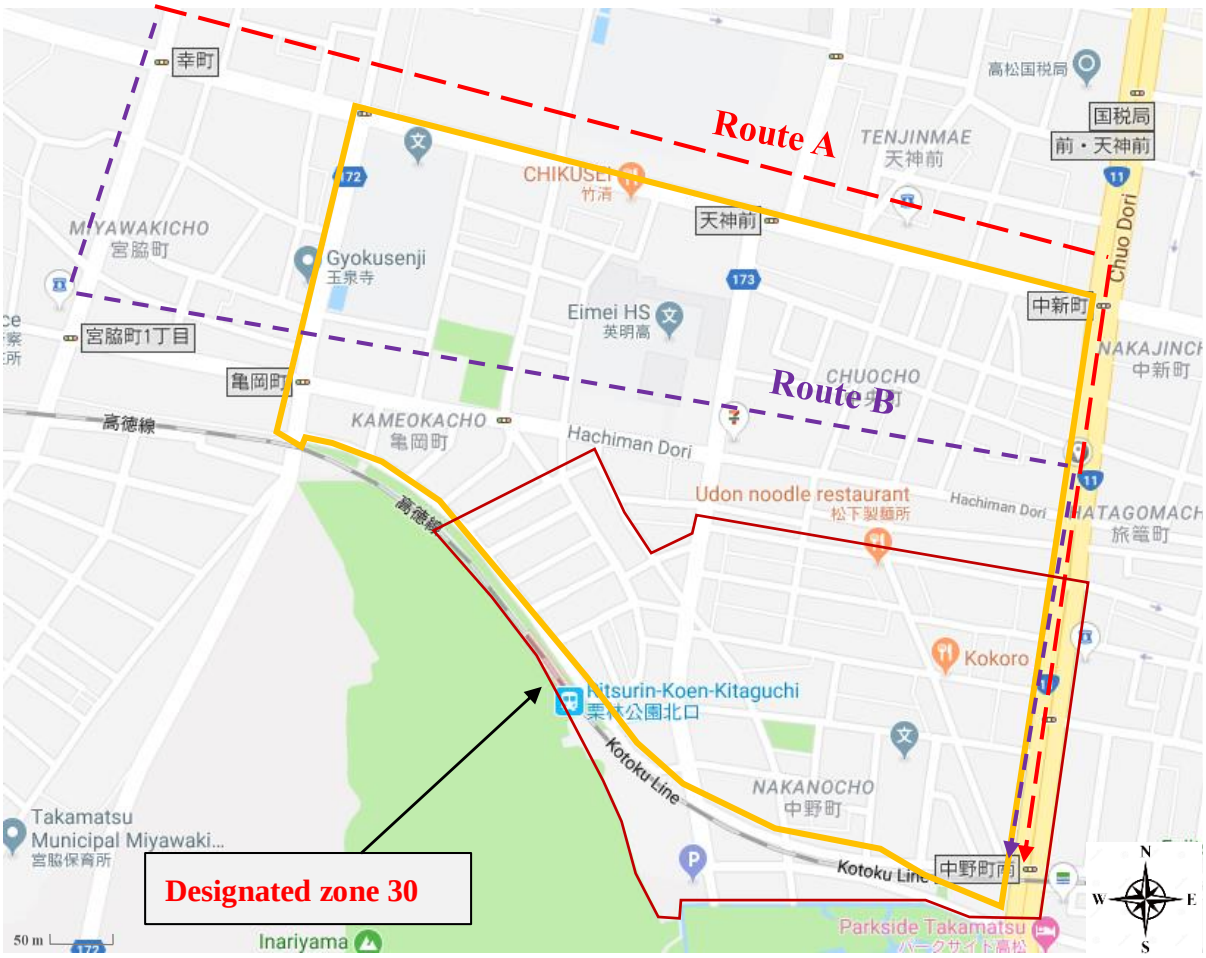

Figure 3-1: Designated study areas in Nakachou, Takamatsu City

Another meeting was held in January 2018, to forge a way forward based on the studies done in 2016 and information gathered from the town meeting in 2017. Based on the publication from the Kagawa prefecture committee responsible for road safety of Takamatsu city (July 2018), implementation of the various measures was still underway.

3.4.2 Results of the town meeting

One of the biggest complaints from residents was that drivers over speed even within the designated zone 30 area. In order to verify this, and pinpoint the areas where over speeding was taking place, a consultancy firm and the local government used ETC 2.0 to ascertain this.

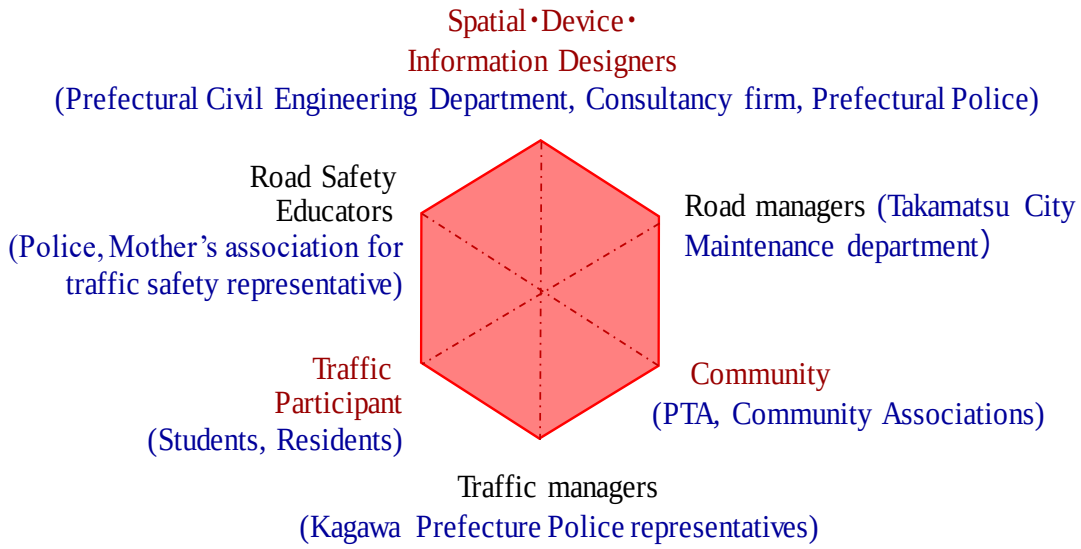

Figure 3-2: Participants at the Takamatsu city town meeting

At the town meeting discussion, it was discovered that the drivers preferred using route B as they claim that it is faster than route A which has traffic lights (see **Figure 3-1**). On the contrary, the results from the probe data showed that route A despite having traffic lights was faster than using route B. Based on this, it was agreed that among the road safety measures, providing the wider community with such information was vital to curb the risk of over speeding in this area.

It is through such cross sector cooperation endeavors like this town meeting that all those involved understood the root of the problem and together they found community customized solutions. Such interaction also made it easier to convince other authorities such as politicians to allocate more funds for such education campaigns. **Figure 3-3** is a visual representation of the discussion that took place during the town meeting.

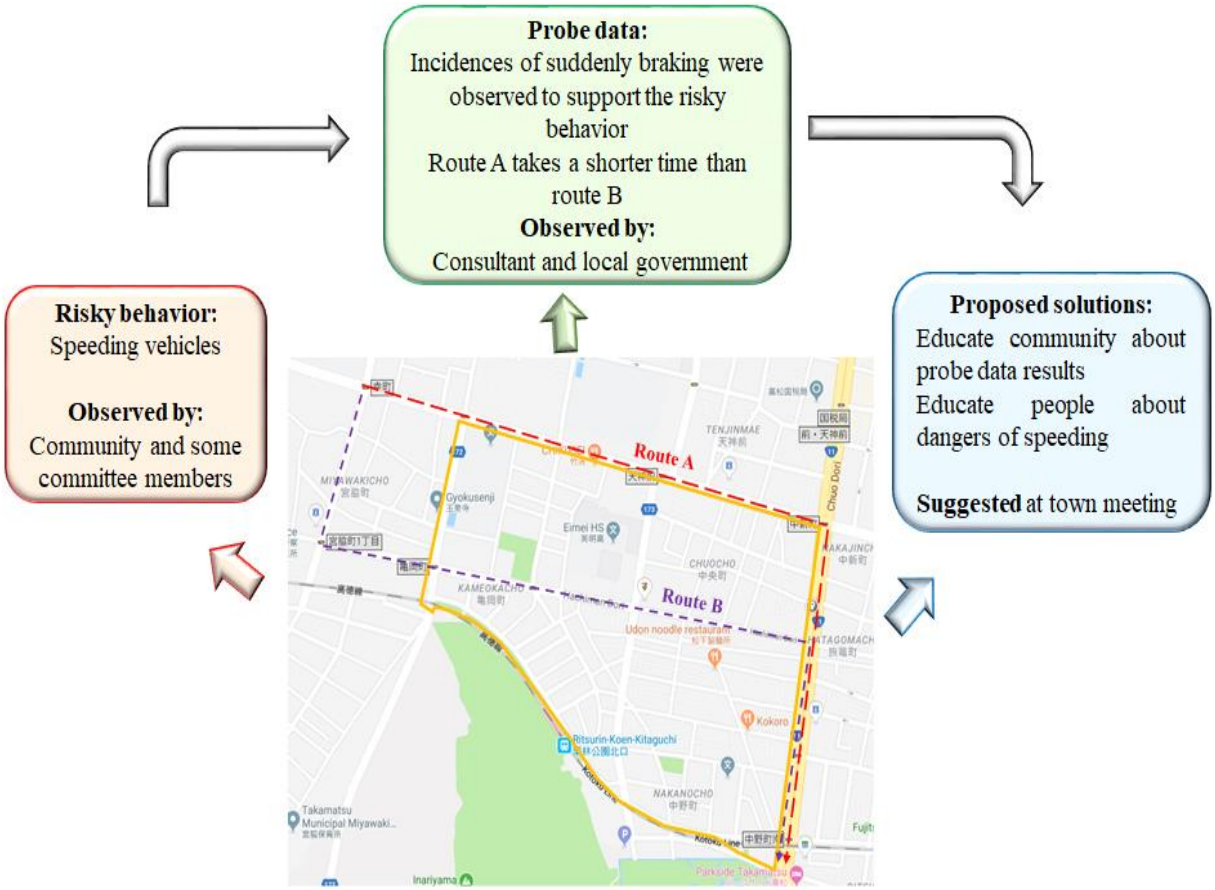

Figure 3-3: Merits of cross sector cooperation approach at the Takamatsu town meeting

3.5 Case Study 2: Niigata City, Niigata Prefecture

3.5.1 Understanding the problem: Nakanochou area, Takamatsu city

The number of fatal accidents involving elementary school children suddenly spiked from 3 deaths per 100,000 persons in 2009 to about 10 deaths per 100,000 persons in 2011, therefore this issue had to be addressed with immediately effect. Just like many areas in Japan, Niigata city is also experiencing low birth rate which led to several elementary schools closing.

In the academic year ending in March 2017, 2 elementary schools were scheduled to close and all the students were expected to join Hiyoriyama elementary school. Hiyoriyama elementary school was chosen to receive other students, but the problem was its location. It is located near the road leading to the port tunnel and is therefore an unsafe place for students to mix with drivers who are rushing to and from work (see **Figure 3-4**).

In view of this, three workshops were held with various stakeholders to discuss how to formulate a guideline for improving safety of school routes [52]. The first workshop (WS1) was held in July 2016 to discuss the general road safety situation, including the results from traffic data that had been collected prior.

Two months later, another workshop (WS2) was held to discuss the probable solutions, and to also avail the local government with information that could be used to estimate the cost of implementation. During the last workshop (WS3) in November 2016, both short and long-term measures were decided upon.

Figure 3-4: Location of Hiyoriyama Elementary school and the schools that were closed

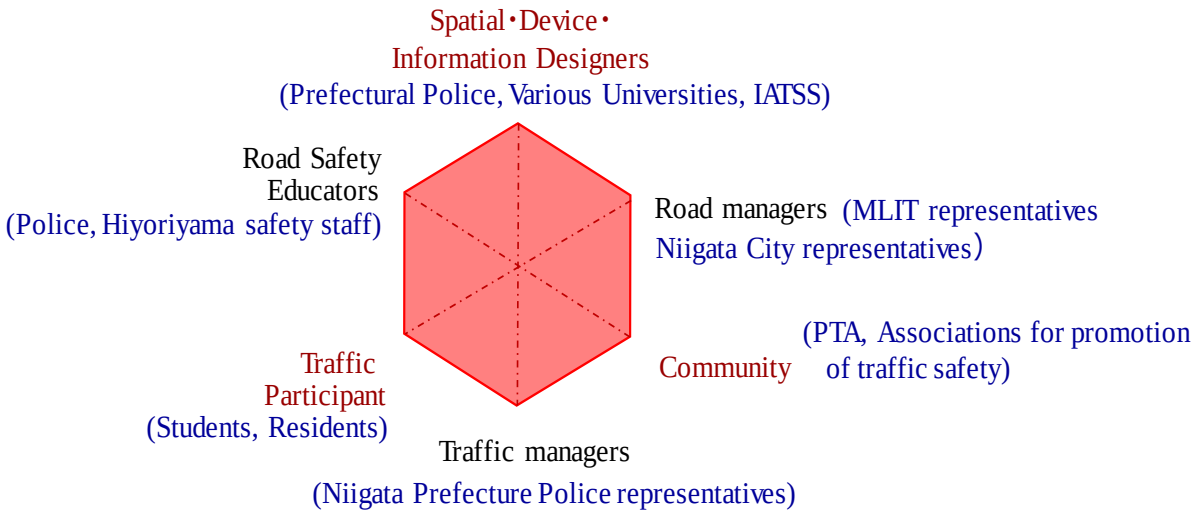

Figure 3-5: Participants at the Takamatsu city town meeting

Figure 3-5 above illustrates how the participants of the workshop fit into **Figure 2-20** context. The classification in the figure above were done after reviewing the job description of each participant in their respective organizations. The fact that all participants were catered for based on **Figure 2-20** shows that the key player categories suggested in this study are universal.

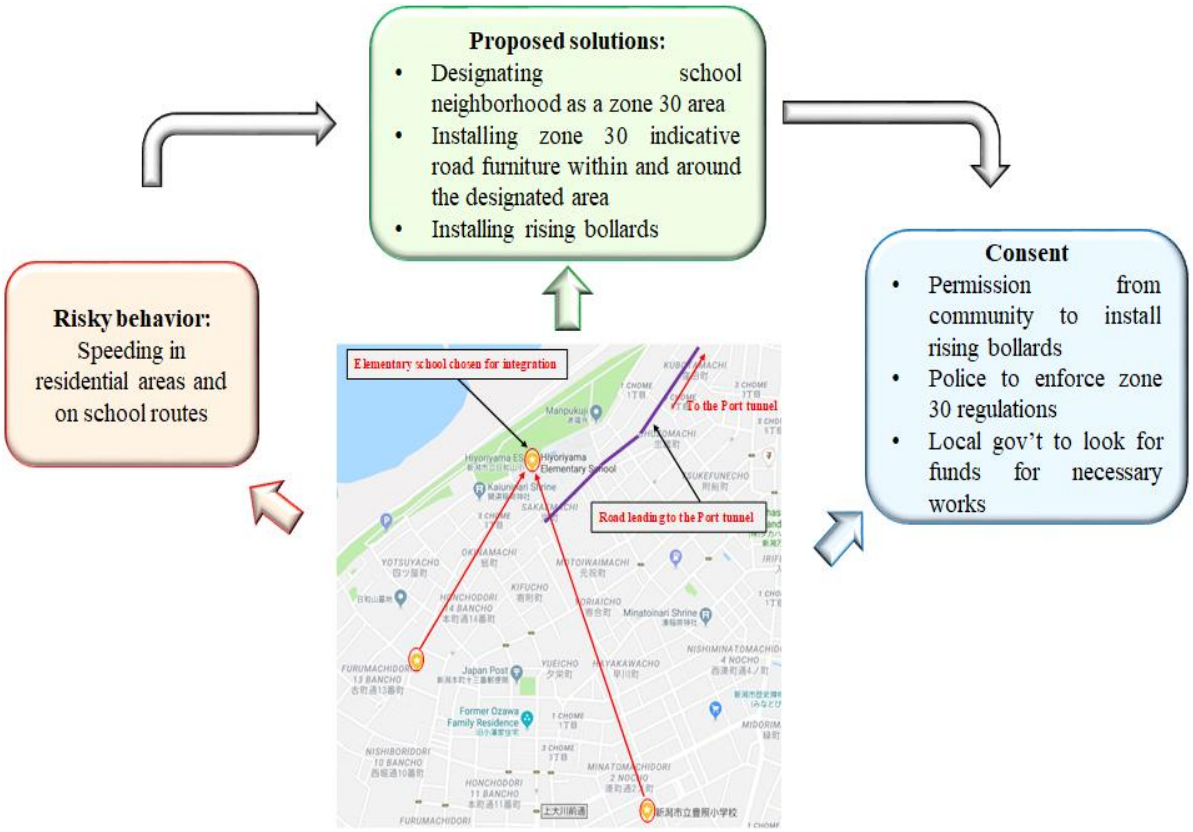

Figure 3-6: Merits of cross sector cooperation approach at the Niigata city workshops

3.5.2 Results from the workshops

One of the biggest road safety issues surrounding the Hiyoriyama elementary school neighborhood was over speeding. During the discussions, it was suggested that the school neighborhood be designated as a zone 30 area. Other supplementary suggestions were installation of zone 30 indicative road furniture as well rising bollards.

Demarcation of an area as a zone 30 is something often carried out by local government officials in conjunction with residents whose consent is necessary. All these decisions were made rather quickly without so much resistance because everyone whose consent was needed was present at the workshop. This demonstrated the benefits of cross sector cooperation, which is to help various people understand each other's perspective and therefore make a conscious decision to play their respective roles. This makes implementation of road safety measures easier. **Figure 3-6** above illustrates this point further.

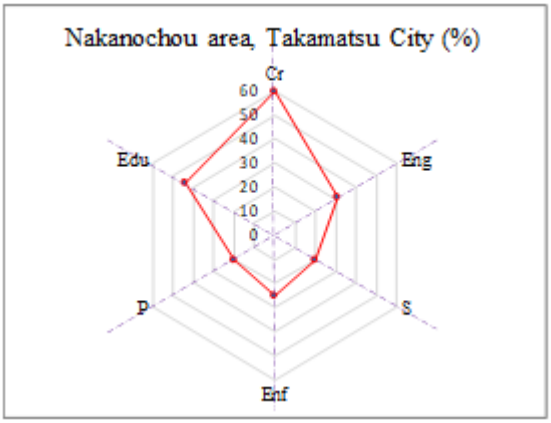

Figure 3-8: The situation in Takamatsu City

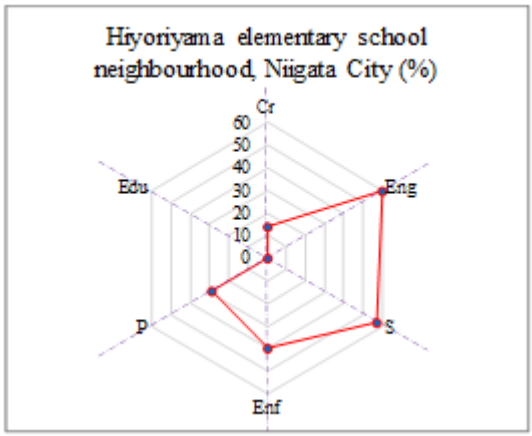

Figure 3-7: The situation in Niigata City

3.6 Discussion

Both of these areas are socially and economically different but their road safety situation can be summarized by the PSC-3Es relationship illustrated by **Figure 3-8** and **Figure 3-7** above. From a simple evaluation, based on the multi-criteria analysis of 3Es and PSC indicators, the results showed that the biggest problem faced by Nakanochou area was a lack of comprehension of traffic rules and regulations among many road users. While in the Hiyoriyama elementary school neighborhood, the biggest problem was speed related.

At the time, the town meeting was held; Takamatsu had started designating bicycle lanes among other engineering related measures. Nevertheless, the results of the meeting, leaned towards Education related measures because it was identified that bicyclists and drivers were not conversant with traffic rules and regulations. One of the recommendations was "押し歩く (oshiaruku)" whereby motorcyclists are encouraged to push their bicycles especially in areas where there is a risk of knocking down pedestrians.

While those at the Niigata city workshops leaned towards engineering related measures to tackle their road safety problems. The designation of a zone 30 area was the main reason that dictated the change in the road environment hence the focus on engineering measures. Although one would argue that, now that school-going children had to make longer commutes, ensuring that all road users understood the traffic rules and regulations is paramount. This was not the case because education measures work best with a particular target group, which in this case, was not agreed upon at the time.

Overall, this does not mean that the road users in Niigata city fully comprehend traffic rules and regulations or that enforcement by police is flawless nor does it mean that the road environment in Takamatsu city is impeccably engineered or that enforcement is performing at 100%. Rather that these representatives observed that these solutions would help the areas overcome their current road safety issues.

The study of the two cities showed that the stakeholders proposed in **Figure 2-20** accommodated the diversity of stakeholders in reality (see **Figure 3-2** and **Figure 3-5**). Merits of such cross sector cooperation strategies are numerous. From the Niigata workshops, a guideline to manage the safety of school routes was proposed by the IATSS[53]. This was officially published in March 2018 after being tried and tested in other parts of Japan like Okinawa.

Based on the merits of the strategies, it is important to note that a balance among the highlighted features (refer to **Figure 2-19**) is not the goal, but rather stakeholders coming together to establish the root causes of the locality and creating tailor made solutions is. It was therefore important to identify the factors that led to the success of these cross sector cooperation strategies. By doing so, other cities can learn how to utilize various resources in their locale to achieve similar results. This was best illustrated using the Theory of Change (ToC).

3.7 Way forward

3.7.1 The Theory of Change (ToC)

Mayne [139] defines the Theory of Change as models of how change is expected to happen (based on forecasts) or how change has happened (based on results). The most important aspect of a ToC model is the underlying factors or events whose presence or absence explains how the desired changes has occurred (or how the desired change will occur) [138].

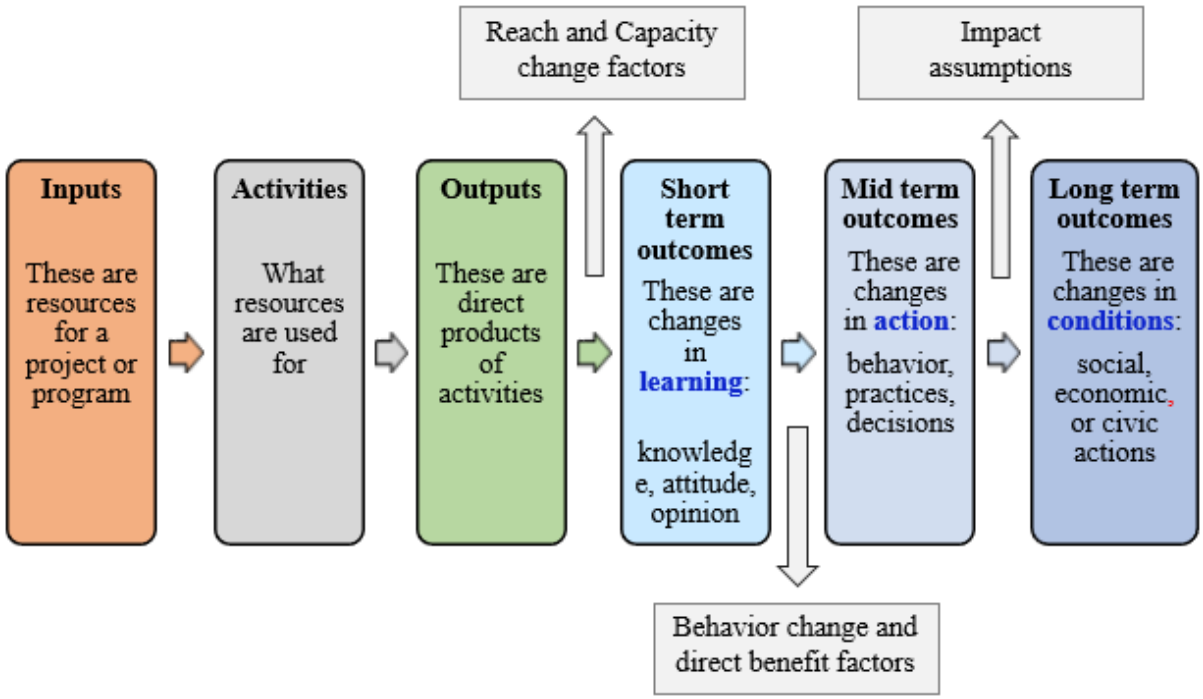

Figure 3-9: Simple Illustration of a Theory of Change

Figure 3-9 above is a representation of a basic ToC. The definitions used here are adapted from Mayne, however the term "assumption" was replaced with "factor" in this study because the goals have been achieved.

Reach factors are events or conditions that had to be present if the outputs were to be positively received by stakeholders. Capacity factors are events that had to be present or conditions that had to change so that the outputs would bring about a change in attitude, knowledge, opinions etc. Behavior factors are events or conditions whose presence led to change in practice and decisions of the stakeholders. Finally impact assumptions are events and conditions whose presence will enable direct benefits to be realized as long term outcomes. The Theory of Change was further expounded upon in chapter 5.

3.7.2 The Theory of Change models for Takamatsu and Niigata cities

In order to better understand these underlying factors, **Figure 3-10** and **Figure 3-11** were created as visual representation of what transpired during the town meeting and workshops. It should be noted that two other factors might have contributed towards the success of these strategies. One was that both the town meetings and workshops were organized to enable a conducive environment for open discussions. The second was that appropriate activities were chosen to identify the core problems. It is important to define relevant activities from the start; otherwise, the discussions can lead to a different set of outcomes.

Although, majority of the underlying factors were similar for both cities, a few distinct differences may have ultimately led to different conclusions. This showed that by manipulating some underlying factors, it is possible to have a different set of outcomes. This is the main merit of using ToC for planning and evaluation purposes in cross sector strategies.

In conclusion, getting various stakeholders to embrace this approach is quite challenging. However, when there are visual representations of how different factors interact to achieve a desired goal, it becomes easier to get many stakeholders to collaborate. In the end, the community becomes more open to proposed solutions because they have been a part of the decision making process.

Cross-sector cooperation approach towards road safety is a new aspect with tangible benefits. However, we have seen fragmentation within countries that have well-developed 3Es systems. On the other hand, it is well known that many of the developing countries do not possess such streamlined 3Es systems and often have limited resources. This exacerbates the fragmentation in both the decision-making process and implementation process of road safety solutions in developing countries. Therefore, the next chapters proposed cross sector frameworks that harnessed limited resources to enable the developing countries to overcome specific road safety situations.

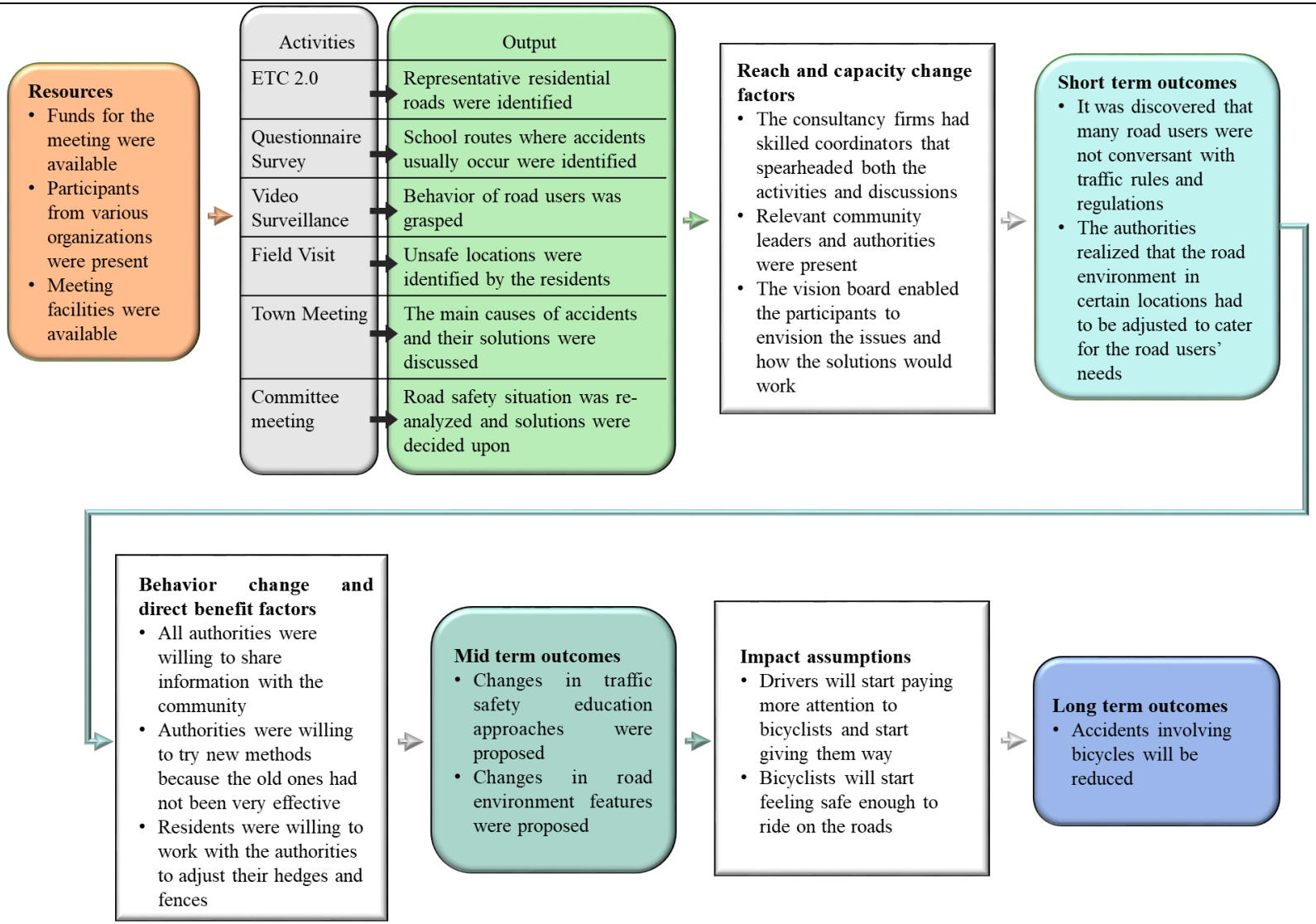

Figure 3-10: A Theory of Change model for Takamatsu city

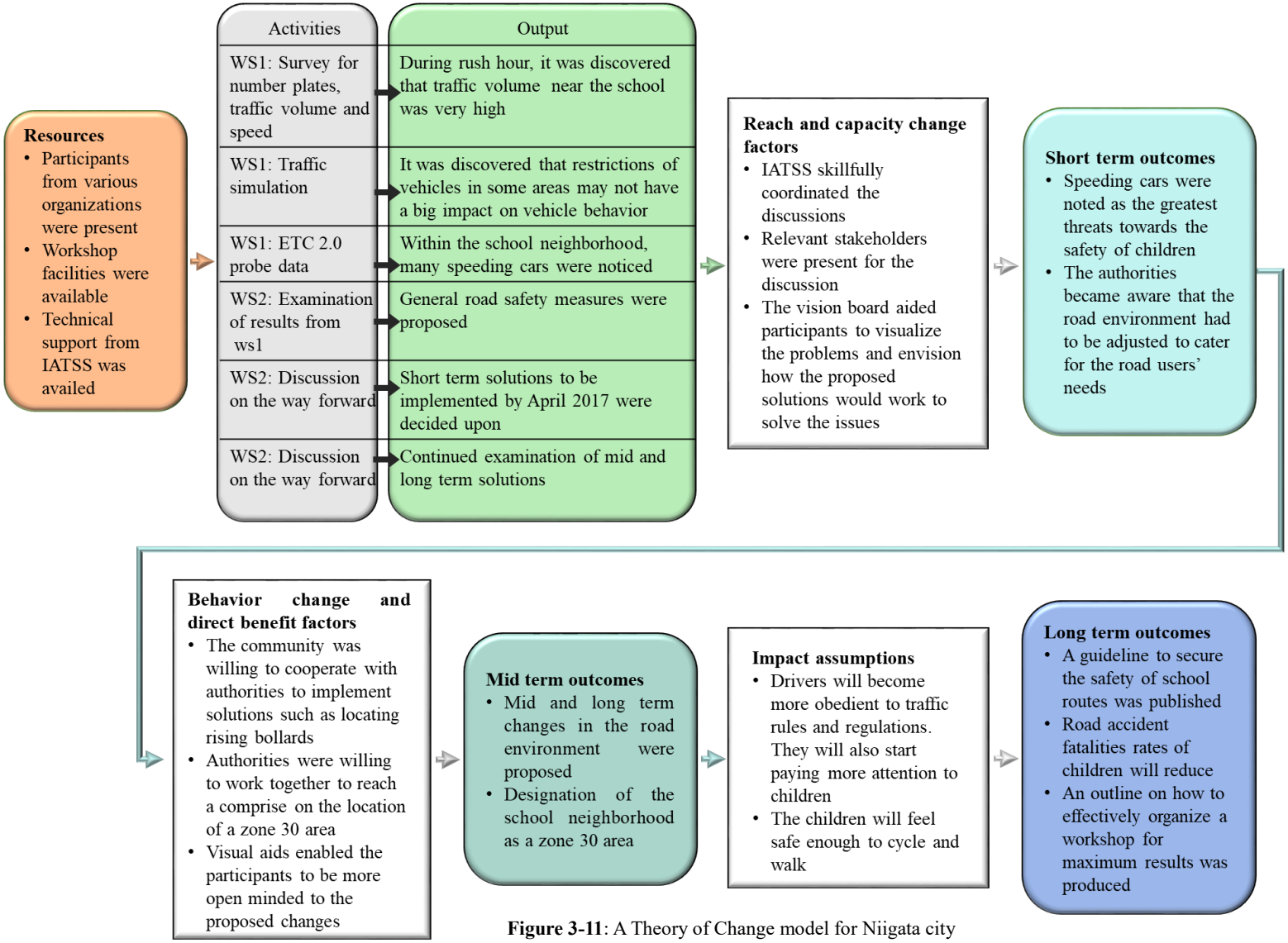

Figure 3-11: A Theory of Change model for Niigata city

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4 Chapter 4: Utilizing the cross sector cooperation approach in creating a Transition Management framework – Case study of boda bodas in Kampala, Uganda

4.1 Road safety situation in Uganda

Uganda is an East African country whose capital city, Kampala is divided into 5 divisions; Kawempe, Rubaga, Central, Makindye and Nakawa (see **Figure 4-1**). Uganda has an estimated road traffic death rate[1] of 29 per 100,000 populations. About 73% of the fatalities are vulnerable road users with 40% being pedestrians and 33% being boda boda riders (see **Figure 4-2**). Of the fatalities in the country, more than 50% of them are people below the age of 35. Apart from road accidents, other challenges include; traffic congestion and flooding (see **Figure 4-3** and **Figure 4-4**).

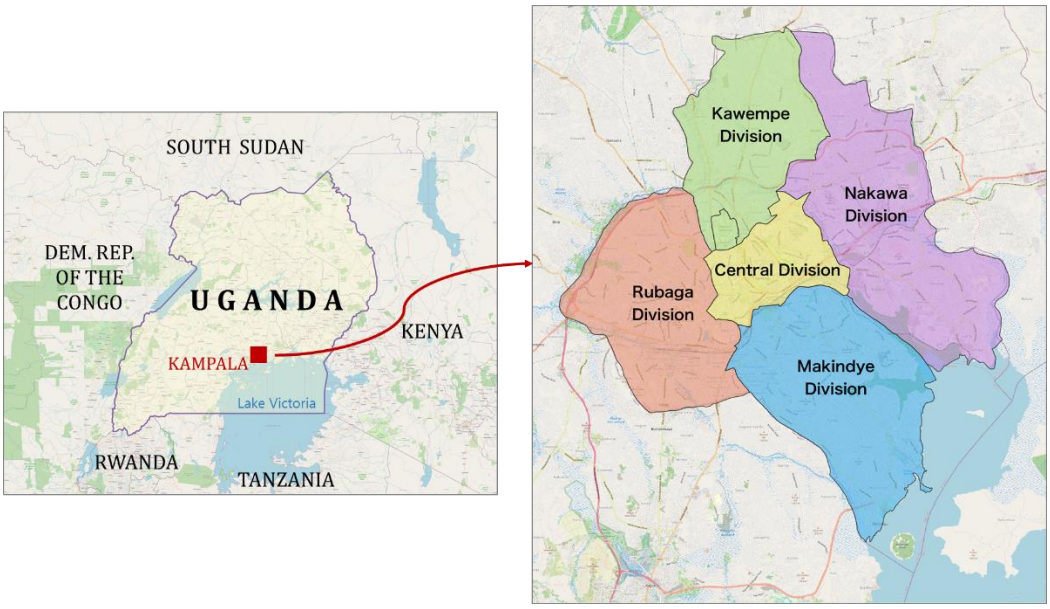

Figure 4-1: Location of Kampala and its divisions

The government has implemented different policy instruments to regulate traffic on roads and to improve the safety of all road users; riders inclusive (see **Table 4-1**, **Figure 4-5** and **Figure 4-6**). The focus of this chapter was the safety of boda boda riders because they form a crucial part of the public transportation in Uganda. In addition, they are the vehicle that is commonly involved in accidents with pedestrians. Improving their safety would most likely lead to the reduction of fatalities among pedestrians.

Another peculiar characteristic of boda bodas is that majority are used as a source of income in many parts of Africa, unlike Asia where majority of motorcycles are a means of private transport. This dictated that securing the safety of riders would have to be delicately balanced so that the livelihood of the riders is not tampered with, but rather increased if possible.

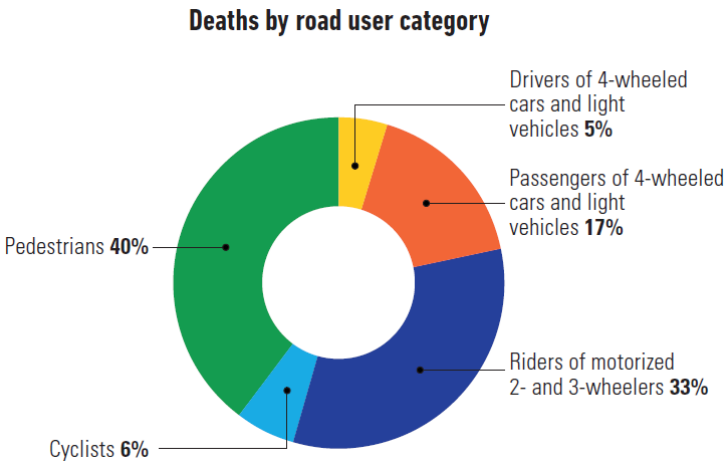

Figure 4-2: Death by road user category

Ref 1: WHO Global Status Report on Road Safety, 2018

Figure 4-3: Traffic Congestion at an intersection

Figure 4-4: Flooding near a market place

Figure 4-5: One of the upgraded intersections

Figure 4-6: NMT route in Kampala City

Socially, the occurrence of these accidents not only leads to death of both boda riders and passengers but in some cases, amputation of limbs and loss of income to families when either death or amputation occurs. Road accidents by boda boda riders causes a huge burden to the economy of Uganda. According to Sebaggala et.al [54], as of 2012, Uganda's economic burden due to boda boda accidents and deaths was; about 7 million ugx ($2800) to treat accident victims, economic loss of 3 billion ugx ($1.2 m) due to loss in output and about 350 million ugx

($140,000) in motorcycle repairs. These figures are expected to be higher because the number of riders and fatalities has increased since 2012.

Over the years, many interventions have been introduced to improve the safety of the riders (see **Table 4-2**). These have included; educating the riders on the use of helmets and provision of affordable helmets [55], and road safety training workshops held by private companies like vivo energy [56] and safeboda initiative [57]. Many of the initiatives are centered on road safety training; however, other aspects such as road improvements are "pro-vehicle" and do not necessarily consider the needs of riders. This therefore revealed a gap in the way 3Es are implemented in Uganda. Nonetheless, this created an opportunity to explore the gap and propose cross sector solutions on how different 3Es aspects could be exploited to promote safety of riders.

Table 4-1: Policy Instruments for regulating traffic

Policy Instrument	**Explanations**
Traffic and Road Safety (Motorcycle) Regulations, 2004	• Requires riders to wear a crash helmet • Wear bright colored clothing at all times, • Have dipped lights • Carry 1 passenger who should have a crash helmet too
Fines for violators	Traffic and Road Safety Act, 1998 **amended in Jan 2020**, with increased fines ranging from 1,000,000 to 6,000,000ugx (¥28,000 - ¥170,000) and imprisonment or both
One-way roads	Implemented from **2004**
Street Parking charges	Company to regulate street parking was contracted from **2009**
Bus services around Kampala	MoWT contracted Pioneer Easy Bus (a private entity) in **2012** to provide bus services within Kampala and neighboring towns
Non-Motorized Transport (NMT)	**Adopted in 2012**, construction of a pilot corridor in Kampala ended in **2020**
Boda-boda Free zone [60]	The cabinet approved this and it was to be implemented in **Nov 2020** but because of logistic shortfalls, it was postponed.

4.2 Spatial Segregation in Kampala city

Spatial segregation in Kampala city is uncommon; however, hotels, malls, schools and hospitals restrict boda bodas from accessing their premises. The largest form of spatial segregation was in 2010 when Makerere University [61] banned taxis and boda boda from accessing its premises. In Nov 2020, a boda boda free zone (BBFZ) [60] was proposed in the CBD to restrict boda bodas from accessing this area (see **Figure 4-7**). The proposed area covers a

larger part of the central division, which houses many ministerial offices, the parliament of Uganda, Kampala capital city authority (KCCA) offices, some schools, hospitals and other corporate offices.

Table 4-2: Safety interventions to improve safety of riders in Kampala

Safety Interventions	**Explanations**
Helmet law [58]	• To educate rider on why they should wear helmets.
Global Helmet Vaccine Campaign (2013) [55]	• To educate rider on why they should wear helmets. • To teach riders the traffic rules and regulations.
Police Activity [59]	• Mass arrest of riders without helmets • Mass arrest of riders without driving permits • Mass arrest of riders carrying more than 1 passenger
CSR Road Safety trainings [56]	• Trainings held by various companies to teach the riders road safety regulations • Provide riders with reflectors and sometimes helmets
Road Safety campaign e.g Yambala Elementi [56] (2013) Twedeko campaign [59](2017- to date)	• CSR road safety campaign targeting drivers mostly • Holds rallies and shows video clips on tv of how accidents happen • Bring accident victims to tell their stories

The BBFZ was approved by parliament of Uganda and was to be implemented by Kampala Capital City Authority (KCCA). This is part of KCCA's plan to re-organize the transportation of the city to make it more efficient and free flowing. Some of the reasons, this was done are;

a) To pave way for use of public transport within the zoned off area
b) To encourage walking and cycling within the zoned off area
c) It is a pilot to test how to restrict cars from accessing the zoned off areas
d) To improve the safety of boda boda riders and their passengers

The BBFZ was not only restricting boda bodas from accessing the zoned off areas but with it, new boda boda stages were to be allocated. The newly designated boda boda stages are the red dots with yellow numbers on **Figure 4-7**. Ordinarily, the riders organize themselves and form a stage with an appointed leader. They pay a monthly welfare fee, which is used for the welfare of the members and their families in case they fall sick or die. This amount depends on the members and the location of the stage. Every new member is asked to bring valid identification cards and a letter of introduction from village they reside at.

With their own stage system, the riders were dissatisfied with KCCA's directive to have them "forcefully" registered and allocated to the newly designated stages. The riders and other

stakeholders strongly opposed [62] KCCA's proposals so the city authority indefinitely halted plans to enforce the BBFZ partly due to logistic reasons. Despite, it being put on hold, a survey was carried to identify a combination of factors that different stakeholders can contribute to streamlining its re-introduction.

Another form of spatial segregation that has been recommended in various studies but has not been implemented before is exclusive lanes to separate other cars from boda bodas. The purpose of this chapter was to identify factors that may aid the re-introduction of the BBFZ and the introduction of exclusive lanes. This was done by proposing a transition management framework for a locality like Kampala. To identify the factors, an in-depth literature review was done followed by questionnaire surveys. These will be discussed in the next sections.

In the past, many interventions have been implemented by either government or private sector. However, majority have been fewer stakeholders and often at times, the views of the riders are sometimes not considered. Therefore, this chapter set out to propose ways the relevant road safety stakeholders (including riders) can cooperate to improve safety on the road.

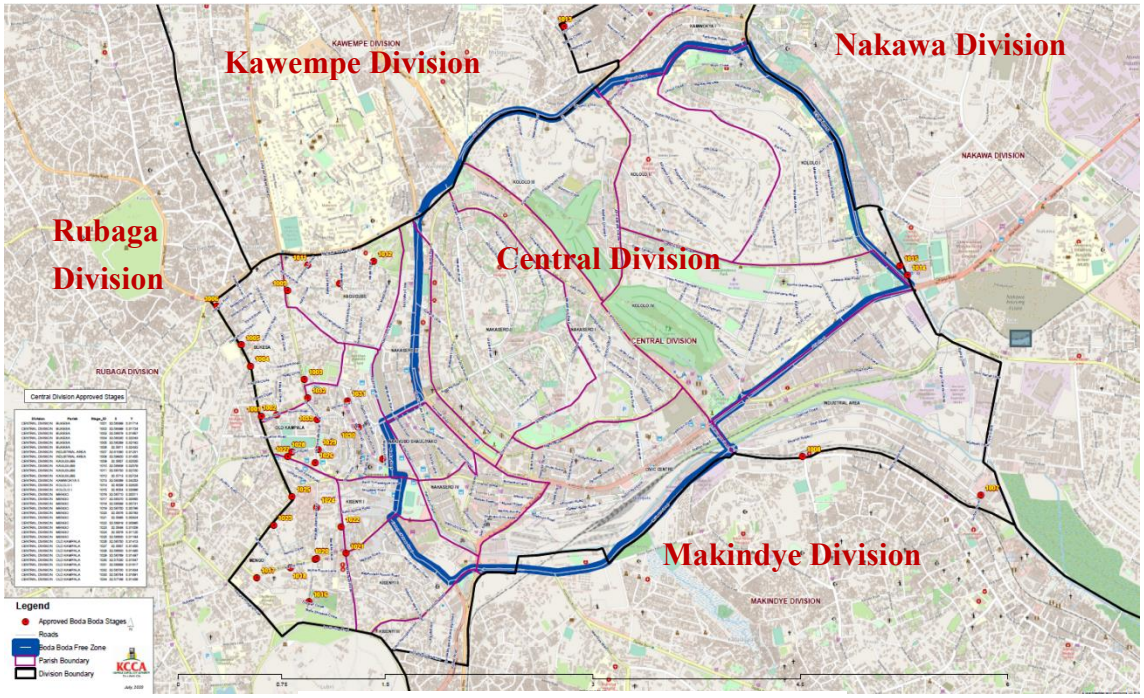

Figure 4-7: Proposed boda boda free zone in Kampala

4.3 Literature review

This section looked at literature explaining how different factors affect the behavior of riders on the road. The perceptual factors affecting riders were discussed first; other aspects such as training, enforcement, presence of other road users, customers/passengers and road environment, followed after. All these factors are a representation of the 3Es or a combination of these measures to improve safety of drivers or riders on the road.

4.3.1 Riders and other road user perceptions

A study conducted in Australia assessed the psychosocial factors influencing motorcycle riders' intentions to perform both safe and risky riding behaviors [63]. The intention for riders to engage in safer behaviors such as better awareness of traffic and road environment, and refusal to ride when tired, were consistently predicted by the theory of planned behavior. That is, riders' perceived control influences their engagement in safer behavior. When it came to engaging in riskier behaviors, attitudes and sensation seeking were better predictors of riders' intentions. The authors further noted that the presence of riders together with the relationship they share is an important influence on intention to engage in either safe or risky behavior.

In terms of risk-taking intentions, Cordellieri et al [64] suggested that motorcyclists complied with road rules depending on the specific driving context; however, they were more prone to violating traffic rules than drivers. This was attributed to riders' lower concern for risk compared to drivers. In contrast, Nguyen-Phuoc et al. [65] found that riders and drivers, whose perception of getting in an accident or paying a fine was high, were more likely to increase the frequency of using the turn signals. Accordingly, riders tended to follow the traffic rules and regulations more strictly, if a rider thought they were prone to penalties.

For some riders, riding is a form of identity and expression or freedom hence the tendency to over speed, weave in and out of traffic, and take other risks on the road [66]. However, riders actually recognize the risks and try to prioritize this in all they do. Overall, how riders perceive their identity or skill affects the way they will behave on the road. Many of the negative perceptions can be dealt with through experience and different forms of education and training.

In additional, other road users' perception is also related to accident involving the motorcycle riders. The safety for vulnerable road users increases as traffic composition became diverse [67]. To ascertain the blameworthiness of crashes at intersections [68] carried out a survey considering both drivers' and motorcyclists' opinions about junction crashes. Both drivers and riders agreed that the driver would be at blame because riders have a stronger awareness of dangers at intersections. This corroborated a viewpoint from a previous study that there was a problem with the way other road users viewed motorcyclists [69]. At junctions, drivers "looked-but-failed-to-see" the riders were considered resulted from their "poor perceptual schema for motorcycles". That is, drivers did not see motorcyclists as "dangerous obstacles". As miss seeing the rider or miscalculate how fast the riders are moving would enhance the risk of collision, it was suggested that engaging riders in defensive riding and engaging the drivers in more empathetic driving to reduce these crashes.

Regarding the collision risks of motorcycles, Robbins et al. [70] concluded that motorcycle accidents at unsignalized junctions resulted from the fact that drivers accept smaller and riskier maneuver gaps with motorcycles as compared to four-wheelers. On the other hand, a study conducted in Paris [71] found that the main causes of motorcycle accidents were falling or skidding due to avoidance of other road users and pedestrians crossing haphazardly on the road.

The latter is regarded as a common occurrence in Uganda and is, therefore, a big concern for riders. To improve the safety of riders, it is important to consider the behavior of other road users since this directly affects how riders act or react.

4.3.2 The role of Education/training

The accumulation of on-road experience enhances not only motorcyclists' riding skills but also their hazard perception abilities. These include the abilities to recognize obstacles, pay attention to other road users, and adapt to road furniture [72,73,74]. Lack of experience is usually addressed formally through a range of rider training and education programs.

Many studies have confirmed that the provision of knowledge and riding practice is an effective way to promote road safety. To examine the effectiveness of a pc-based training program, Di Stasi et al. [75] compared first-time riders before and after training in different riding scenarios to advanced motorcycle riders. Although the authors noticed that novice riders' inability to adjust speed to the different road conditions would increase the probability of having a crash, their riding ability improved to match the performance of experienced riders after taking part in the training.

Regarding riders' adjustment to road speed limitation, it was found that rider training enabled the riders to adapt speed or position when need arose [76]. Riders were more likely to recognize hazards and react appropriately. Another study showed that the advanced riders reported fewer traffic errors and speed violations than novice and experienced riders in the MRBQ survey [73]. On the road, the advanced riders drove more slowly in 40 kph areas and stayed closer to the centerline as compared to novice riders. The authors attributed this to the riders adjusting as road environment and other road users' situations changed.

In terms of risk identification, training helps riders identify and react to hazardous situation much faster when driving on the road [77] Chapman et al. [78] emphasized that driver's ability to scan the roadway scene increases with experience while training can improve the scanning behavior. Similarly, a study conducted by Underwood [72] showed that expert drivers scanned the scene of roadways more than experienced drivers, while novice drivers scanned the scene less than experienced drivers did.

In Uganda, Muni et al. [79] compared two groups of riders, one that had undergone a training (safeboda riders) on traffic rules and regulations and the other (regular riders) that had not. The empirical results showed that safeboda riders were more likely to engage in safer activities like wearing a helmet and avoiding use of a phone while riding. Therefore, it was suggested that such training is effective in improving the safety of boda boda riders.

All these studies elaborate the importance of road safety education and skill training. Providing riders with training or education helps them become more aware of the traffic environment and act appropriately as need arises. Therefore, Education can increase the impact of engineering and its activities on the safety of riders.

4.3.3 Effect of road environment (Engineering)

The environmental characteristics (e.g., poor lighting, bad weather conditions, and complicated road geometry) increase the risk of traffic crashes for vulnerable road users, especially for motorcyclists [80, 81, 67]. An investigation of contextual factors suggested that risk after dark is significantly higher for motorcycles compared to four-wheelers, on roads with low-speed limits (≤30 mph), at T-junctions, and junctions controlled by a give-way sign or auto traffic signals [80]

Driver's perception of safety is an important influence on their driving behavior. Nguyen-Phuoc et al. [81] concluded that environmental factors such as poor lighting, bad weather and multiple lanes, had a positive and direct effect on the frequency that the drivers and motorcyclists used their turn signal. This shows that road users are aware of the increased risk of getting involved in a road crash and try to adapt to the environment. This is consistent with previous research conducted by Huth, Füssl, and Risser [82]. It was noted that sudden appearance of animals, barriers not meant for riders or road surfacing that makes braking difficult, would heighten the riders' awareness. In order to protect themselves, the riders opted for strategies like riding away from shoulders, constantly monitoring pavements and infrastructure.

The road environment may affect how riders use the road. The improvement of different road features and furniture could lead to reduced risks of motorcycle on sections of road. It is therefore important that the road environment is made suitable for the riders to follow the new spatial rules and regulations such as staying in their exclusive lane or being able to follow markings leading up to the zoned off areas. To ensure that the riders adhere to this, proper enforcement becomes very important.

4.3.4 The role of Enforcement

The presence of enforcement of road traffic law is an effective deterrent to dangerous behavior. The role of police in safety matters of motorcyclists has been widely studied, especially in Association of South East Asian Nations (ASEAN). To understand how the motorcyclist taxis were able to follow traffic rules and regulations, Tuan and Mateo-Babiano [83] carried out a study in Vietnam and Thailand. The heavy penalties or the banning/cancellation of a riding license were suggested as a way if a rider violated rules or provided an inappropriate service. However, it was argued that the effects of the police enforcement were temporary. Riders' awareness of law enforcement affects their regulatory compliance [84]. Regarding helmet usage in Thailand, Jiwattanakulpaisarn et al. [85] found that in areas where there was presence of checkpoints many riders wore helmets; the reverse was true. In some cases, if riders knew the schedule for police checks, they found ways to dodge them. To make the effects last, the traffic police would have to aim for a higher sense of professionalism, serve severe punishment and dismiss corrupt officers [84].

Similarly, Stanojević, et al [86] conducted a study on driver's attitudes and behaviors in areas

with different police enforcement visibility. The Serbian drivers tendered to follow traffic rules and regulations more frequently as compared to their North Kosovo counterparts because in the former group, police enforcement was stronger.

Road safety campaigns have also been known to be effective in improving the safety of road users. One such campaign is a police campaign "Fika Salama (arrive safe)" initiated by Uganda police in collaboration with Uganda National Roads Authority (UNRA) and Ministry of Works and Transport (MoWT) and several health facilities in response to the increased road accidents that were happening on Kampala-Masaka Highway. After its launch in August 2016, this operation has contributed to a decline in the poor driver behavior and a significant reduction in fatalities, their associated costs among other savings [87, 88].

Police enforcement plays an important role in ensuring that riders follow traffic rules and regulations. However, police conduct is also something that affects the attitude of riders. If the police are corrupt, many riders might use this opportunity not to follow any rules because they know they will get away with it. To make the enforcement effects last, Adnan and Gadzer [84] suggested that the traffic police would have to aim for a higher sense of professionalism, serve severe punishment and dismiss corrupt officers.

In some cases, especially in developing nations, first educating the public about dangers of risky behavior (through public consultations or workshops) may boost the effectiveness of enforcement activities. In a study to understand the trends in motorcycle helmet use in Vietnam, Bao et al [89] argued that although helmet use significantly increased, this could not be fully attributed to enforcement because enforcement levels and initiatives had not changed during the study period. In order to increase helmet use, they suggested increasing riders' awareness of dangers of substandard helmets and how to identify good quality ones then follow this with consistent enforcement activities.

In another study to identify strategies to increase helmet usage among riders in Dehli, the researchers leaned towards interventions that disseminate information on the dangers of unsafe behaviors. This was suggested as a more feasible approach as compared to enforcing helmet law and speed limits [90].

Limitations on the coverage and efficiency of enforcement have been the motivation behind Ratanavaraha and Jomnokwao's study [91]. They argued that although Thailand's enforcement activities are widely spread, the participation of the community in information dissemination activities is a key ingredient in improving safety of riders. In their study, they reported an increase of 13.23% in helmet usage because of community participation activities such as public consultations, meetings and participative decision-making.

4.3.5 On exclusive lanes and zoning

Many articles connected to motorcycles in Uganda have come out to suggest various engineering-and-enforcement-related measures to improve the safety of riders. Siya et al. [92]

concluded that the construction of separate lanes for boda boda riders would not only be a factor in reducing boda boda related accidents but it would enhance public transport.

Manan et al. [93] pointed out that motorcyclists were three times more likely to over-speeding on roads without shoulders. They further noted that because riders cannot find refuge on shoulders, they are forced to weave in and out of the main lanes hence increasing the risk of being involved in a crash. As a result, paved shoulders or exclusive lanes were suggested to enable riders to reduce their speeds as a means to promote riders' safety. On the other hand, the exclusive lanes for two-wheelers were found to be most effective on roads with higher speed limits, bigger volumes of traffic, and areas with bus routes [94]. Lowering speed limits and installing dedicated off-road cycling infrastructure will attract more bicycle traffic because vehicles and high speed are seen as hazards. Such separated motorcycle lanes have been constructed in some parts of Malaysia.

Sukor et al [95] set out to examine the correlation between motorcyclists' psychological factors (attitude, desire, perceived danger, moral obligation, etc.) and their risky riding behaviors (speeding and neglecting to wear a helmet) depending on the type of motorcycle facility they used. It was found that there was a statistically significant relationship between exclusive lanes on speeding behavior. Moreover, psychological factors affected speeding and helmet wearing differently.

Regarding the motorcyclists' compliance towards zoning, Hanan [96] indicated that the visibility of the zoning regulations would encourage riders to adhere to the restrictions. Another observation was that the motorcyclists wanted the public to approve of their compliance behavior (this can be boosted through Education). It was therefore concluded that public promotion of safety would have to focus on reinforcing positive beliefs towards compliance.

4.3.6 Effect of passengers (customers)

The influence of the 3Es has been expounded upon; however, passengers also influence the driver in both negative and positive ways [97]. In the case of business riders such as motorcycle taxi riders, the influence from their customer/passengers is bound to be stronger. Positive aspects include being a navigator, keeping the driver alert, alarming the driver of hazards ahead or risky behaviors. In contrast, the negative influences include urging the riders to break the rules so that they pay a reduced transport fare or get to their destination faster [98]. Raynor [99] made similar reports in his study on boda riders in Kampala. This behavior has been supported by a study carried out by Monash University Accident Research Center [100].

Negative influences were most notable among the 16-24 age group if the driver was also in the same age group [100]. These included encouraging riskier behavior such as speeding and insulting other drivers. In some cases, some passengers were not aware of their negative influence such as distraction caused by passengers who chatted with their driver. The conversation is a distraction to driving performance owing to driving on especially a difficult

track requires more allocation of the driver's attention [101]. These effects are stronger among younger drivers as compared to older drivers. This is derived from the social identity theory where individuals derive identity from membership in a particular group [102]. It is believed that drivers who want their passengers to like them may drive recklessly and be over-dependent on their passengers with the thought that the passengers play specific roles in their driving [103].

Horvath [104] concluded that in some scenarios, active pressure (passengers directly influencing driver's intention to speed) may merely reinforce passive pressure (a driver's intention to speed is from the driver's perception that the passengers want them to) as opposed to solely making the driver more intent on speeding.

These studies show that the presence of passengers (customers) may have significant positive or negative effects on the rider's behavior. Therefore, passengers are an important stakeholder to consider in this chapter.

4.4 Methodology

4.4.1 Document review

The traffic code of Uganda was among the documents that were reviewed. This enabled the author to understand the traffic rules and regulations of Uganda for purposes of reference. The Kampala Strategic plan 2015-2020 was reviewed to understand what KCCA's vision for the city is.

Different journal papers were reviewed to understand the problems faced by the boda boda riders, solutions that have been implemented to improve their safety and future solutions and strategies for road safety. This contributed towards creating the questionnaires for both the road safety stakeholders and the boda boda riders.

4.4.2 Questionnaire survey

Two questionnaire surveys were prepared to collect data. From the literature review above, a questionnaire for the boda boda riders was designed and a sample was picked in March 2020. The results were not satisfactory so a questionnaire directed at road safety stakeholders like politicians, trainers, was designed. This was in the AHP (Analytical Hierarchy Process) format to understand which interventions the stakeholders thought were more effective when compared side by side. AHP is a multi-criteria technique used to rank a set of alternatives in order to select the best alternative. In this method, weights must be established based on a given goal and pairs are compared. For this study a simple programmed excel sheet was used to make this process convenient [151]. The AHP results are not discussed here because they were used as a preliminary preparation to compare with the literature review above.

After the results were analyzed, a meeting was held with each stakeholder to further discuss the results. From these discussions, the questionnaire targeting the boda boda riders was re-designed. A test run was carried out in September 2020; the results were analyzed and then used

as a basis to design the final questionnaire that was the basis of the discussion in next section. A draft of the questionnaire was distributed to 40 randomly chosen boda boda riders and it passed a series of pre-test trials to ensure all materials were accurate and appropriate.

The original questionnaire survey consisted of 4 sections A-E. Section A, B, D and E originally consisted of 14, 18, 20, 20 questions respectively. A Confirmatory Factor Analysis (CFA) was conducted to test the convergent reliability and discriminant validity of the measurement model. Some items in section B and E did not meet the criteria; therefore, they were removed from the final questionnaire.

The final questionnaire was in both English and Luganda (a local language commonly spoken in Kampala city). Section A consisted of 14 questions that were designed to collect general information about the riders such as age and years of riding a motorcycle. Section B consisted of 15 questions, whose target was to understand how police presence, road conditions and driver behavior affect the behavior of riders. Section D consisted of 20 questions, whose aim was to understand how knowledge of the law (traffic rules and regulations), customer, friends and self – belief influence the behavior of riders. While Section E consisted of 12 questions whose aim was to understand how zoning and exclusive lanes would influence their behavior.

Each question in sections B, D and E was designed to reflect a riding behavior and its motivation. The items were measured using a five-point Likert scale (5 = strongly agree, 1 = strongly disagree). The motivation was a form of 3Es (Education, Engineering and Enforcement) while the behavior was a form of PSC principle (Priority, Speed and Comprehension). This is from a study by Mwebesa et al. [105] that defines the relationship between 3Es and PSC principle as a safety hexagon that represents a type of cross-sector cooperation approach. The PSC represent the risks or causes of road accidents while 3Es represents the solutions to these problems.

4.4.3 Sample size determination

Previous studies targeting boda boda riders in Kampala used varying sample sizes depending on the purpose of the study. In a cross-sectional study, the sample size used was 200 boda boda riders [92]. In two studies comparing the behavior of safeboda riders and regular riders, sample sizes of 400 and 342 riders were deemed necessary [79, 106].

Although this study did not seek to compare behavior between safeboda riders and regular riders, a methodology similar that in Muni, 2019 was used to determine the sample size. Helmet use is a behavior whose statistics are easily accessible as compared to other behaviours; therefore, it was used as a basis to calculate sample size. Kamulegeya et al [107] and Roehler et al [55] state that the percentage helmet use among riders is at 18.6% and 30.8% respectively. Based on these studies and others mentioned above, the percentage of riders willing to wear helmets was estimated at 30%. Considering a type error rate of 0.01 using an X^2 test, and the power to

detect a difference between the two groups of riders to be 80%, a total of 300 samples was decided upon according to table A4 in Fleiss et al. [108]. This sample size falls in the range of sample sizes used in previous studies, therefore it is deemed appropriate for this study.

4.4.4 Data collection method

Ethical approval was obtained from the HDREC, Makerere University School of Public Health. Thereafter, permission to conduct this research from the Uganda National Council for Science and Technology (UNCST) was also obtained. After, this process, a group of 5 experienced research assistants were remotely trained about what the survey was about and what was expected of them. An independent supervisor was also trained to oversee the whole process.

Based on the boda boda stages allocated by KCCA, 70 locations were chosen from three divisions (Nakawa, Central and Kawempe). These three divisions were chosen because they are the Industrial, Administrative and Education divisions of the city respectively. The locations chosen were those near public places like markets, schools, malls, government offices and locations on main roads leading to the Northern by-pass. The Northern by-pass forms a semi-circle along the northern suburbs of Kampala city. It is a major road that was designed to lead traffic away from the city center and connect to roads leading upcountry.

The final questionnaire survey was held between 14th and 24th October 2020. A total of 376 willing boda boda riders were interviewed, though during data cleaning only 319 responses were used. Of these, there were 164 safeboda riders and 155 freelance boda boda riders. The Safeboda riders were considered because it has been proven that the training they get improves their behavior on the road. Their reflective jackets and helmets that have safeboda written on it can identify the safeboda riders. The freelance riders were chosen to represent the bigger percentage of riders in Kampala city. The freelance riders are those, when asked, did not belong to any ride hailing company.

4.4.5 Structural Equation Modelling (SEM) analysis

The variable measurements primarily based on the analytical framework **Figure 4-8** were developed through a detailed review of the relevant literature. From the literature review, different forms of education or training are the basis to influencing riders' behavior. Therefore, education influences enforcement and engineering aspects of the road and its environment. This in turn will influence riders' behavior towards adhering to zoning and exclusive lanes regulations. The SEM analysis was adopted in order to identify dimensions of 3Es that would enable the riders to adhere to the spatial strategies of zoning and exclusive lanes in the city. By identifying the latent structure, a combination of solutions was proposed as a way to promote sustainable mobility.

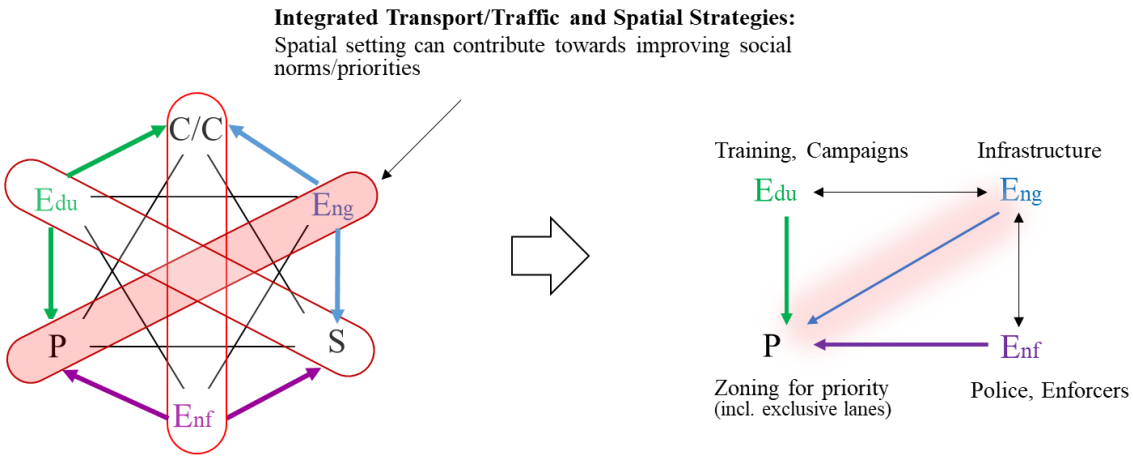

Figure 4-8: Analytical framework for this study

Table 4-3: Definition of factors examined in this survey

SN	Factor	Explanation	PSC factor examined
1	Social Environment	Knowledge about the law For majority of riders, this information is formally or informally through the people who teach them how to rider or their colleagues at the *boda boda* stages or at road safety training they attend.	Priority (P) Speed (S) Helmet (H)
2	Human Influence	Customers or passengers' influence on riders	P, S
3	Sense of Safety	Riders' need for speed and the necessity to wear helmets	S, H
4	Traffic Conditions	The influence of drivers or road features on the riders' behavior	S
5	Road Furniture condition	Absence or presence of road furniture and its influence on riders' behavior on the road	P
6	Enforcement	Presence of police officers or other forms of law enforcers	P, S, H
7	Incentives	Rewards given to model riders	P, S, H

Table 4-3 describes the constructs that were examined in the study. The names are derived from the literature reviewed in **section 4.3**. Before proceeding with the analysis of model specification and causality, the goodness-of-fit indices of the hypothesized structural model were estimated to confirm the model fitness. The SEM analysis was conducted using the package "lavaan" in R program.

4.5 Results

4.5.1 General characteristics of the boda boda riders

Table 4-4: General characteristics of respondents

Characteristic	Category	Sample size	Percentage
Age	18-30 years	119	37%
	31-40 years	140	44%
	41-50 years	55	17%
	Over 50 years	5	2%
Years of riding a motorcycle	Less than 1 year	14	5%
	1-5 years	154	48%
	5-10 years	103	32
	11-15 years	32	10%
	Over 15 years	16	5%
Road safety training	Yes	236	74%
	No	83	26%
How rider learned how to ride a motorcycle	Others	12	4%
	Family	35	11%
	Friends	137	43%
	Myself	135	42%
Own a riding permit	Yes	189	59%
	No	130	41%

Many of the riders are between the age of 18 and 40 years, and many of them have a riding experience of 1-10 years. These results are not far from the results that Raynor [99] got in 2014. Therefore, the samples can be thought to be representative of boda boda riders in Kampala city.

About 85% of the riders interviewed taught themselves how to ride or a friend taught them. This has been cited by many researchers as one of the root causes of accidents among boda boda riders. However, the situation is that there are no known motorcycle riding schools and with no strict limitation to enter the trade, this behavior is bound to continue. To somewhat salvage the situation, private companies like Vivo energy [56] and Safeboda Initiative [57] have provided road safety training to improve the safety of riders. In some of these workshops, riders are not only taught traffic rules and regulation but are given riding basics and shown videos of how some of their behavior can be detrimental to their safety and livelihood. Such campaigns account for the somewhat high number of riders who have had road safety training. **Table 4-4** shows that approximately 74% of the interviewed riders had attended a road safety training before.

4.5.2 Descriptive statistics

Table 4-5 shows the mean and standard deviation of the measurement items of each construct the conceptual model.

Table 4-5: Descriptive statistics of measurement items.

Constructs and Items	Mean	SD
Road Furniture		
B6. I let pedestrians cross the road if the zebra crossing is visible to me	4.188	0.660
B7. I let pedestrians cross the road if the traffic lights are functional	4.069	0.758
B9. At intersections, I stop when the traffic lights are functional, if not I just join the road	2.721	1.298
Traffic Conditions		
B14. Drivers are intolerant and impatient so I try to signal before I overtake	4.182	0.587
B15. I am careful when overtaking because the lanes are narrow and have potholes	4.288	0.518
B18. Car drivers are reckless so I have to ride within the speed limit of that area	4.207	0.664
Social Environment		
D7. I always give way to pedestrians because it is the law	4.364	0.566
D10. Road safety campaigns are a good reminder for me to ride at appropriate speeds	4.229	0.719
D1. I always stop at the traffic lights because it is the law	4.382	0.602
D9. I ride at designated speed limits because the law says so	4.288	0.622
Enforcement		
B8. At intersections, I stop when I see the police	2.379	1.186
B5. At zebra crossings, I let pedestrians cross if I see the police	2.690	1.351
B17. I reduce the speed at which a riding when I see police officers	2.715	1.312
Human Influence		
D11. I usually ride at high speeds because many customers ask me to	4.179	0.976
D2. I run the red lights because customers want to reach their destination quickly	4.414	0.690
D14. Sometimes my customers ask me to crisscross through cars so I do so	4.254	0.859
Zoning		
E3. As I approach the zoned off areas, I will ride within appropriate speeds	4.172	0.603
E7. As I approach the zoned off areas, I will be keen on stopping at traffic lights	4.066	0.735
E14. I will be more careful when overtaking as I approach the zoned off areas	4.110	0.637
Exclusive lanes		
E1. I am willing to ride at the speed limit if we are given exclusive lanes	3.937	0.969
E6. I am willing to stop at the traffic lights if we are given exclusive lanes	3.552	1.238
E12. If we are given exclusive lanes, am willing to overtake more carefully	3.838	1.002

4.5.3 Results from Structural Equation Modelling (SEM)

The results from the SEM analysis were discussed in two parts. In the first part, results related to zoning were discussed while the second part focused on the results related to exclusive lanes. Of the 6 models, 4 were related to zoning while the others were related to exclusive lanes.

4.5.3.1 Results related to zoning

The estimated model 1 (**Figure 4-9**) showed a good fit (CFI = 0.971, TLI = 0.959, RMSEA = 0.043), in addition, the paths are significant. In this model, knowledge of the traffic rules and regulations imparted formally or informally would enable the riders to "read" the traffic conditions and this in turn would enable them to adhere to the traffic rules and regulations related to zoning.

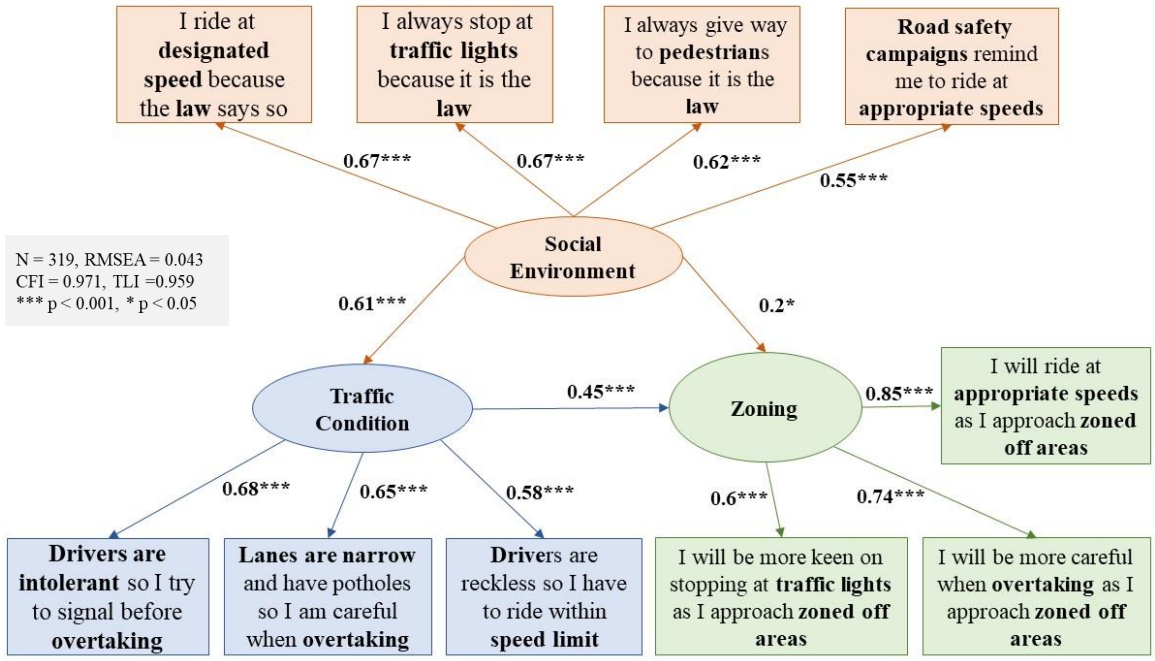

Figure 4-9: SEM Model 1 - Speed Model

Overall, any form of trainings or campaigns has a bigger impact on the riders adhering to the zoning conditions in the city. Studies [76, 77, 74] have shown that riders are able to perceive hazards, adjust their speeds and identify risks after training. About 74% of the riders who participated in this survey had undergone a road safety training; this would partly explain why "social environment factor" has an overall impact on zoning. Training emphasizes the importance of speed limits and stopping at traffic lights would have a greater impact of riders' behavior because of the higher factor loadings of these two observable variables.

As compared to drivers, studies [68] show that riders have stronger awareness of danger because of the unique dangers they face on the road. In many African cities, including Kampala, such instincts may have been sharpened because cars are valued more than other forms of

movement. This is not only evident in the road conditions that favor drivers but it is illustrated by "the drivers' intolerance" having a higher exploratory power towards zoning.

Such conditions may explain why the ability to read the traffic conditions may enable riders to follow the zoning regulations. Furthermore, improvement in road conditions and introducing "emphatic driving" for drivers would improve the riders' adherence to zoning.

Model 1 was referred to as the "speed model" because the highest factor loading for "social environment" and "traffic condition" are all speed related. Therefore, a combination of proper training for riders and drivers and improved traffic conditions would not only increase riders' adherence to zoning regulations but might also result in reduced over-speeding.

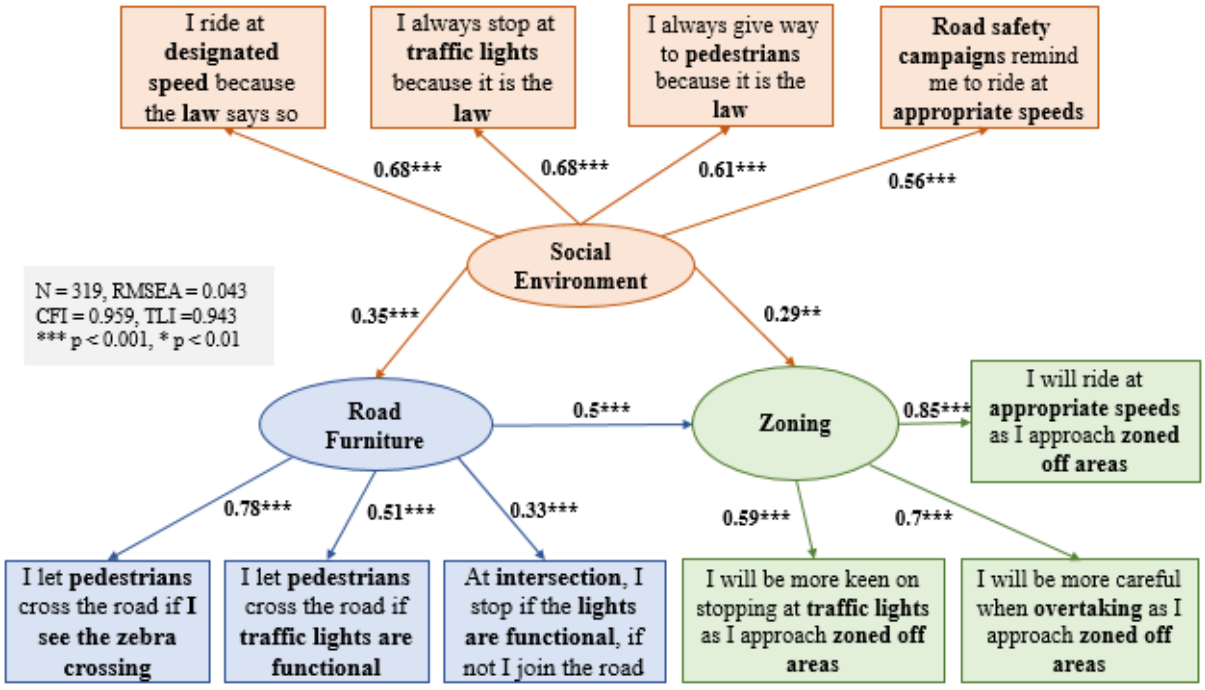

Figure 4-10: SEM Model 2 (Priority Model)

The fit indices of model 2 (**Figure 4-10**) were within acceptable limits (CFI = 0.959, TLI = 0.943, RMSEA = 0.043), indicating that the model is a good fit. Model 2 is similar to model 1 above; the only difference is that knowledge of law (traffic rules and regulations) would enable the riders to be more aware of road furniture, which in turn would enable them adhere to zoning conditions. Overall, the knowledge of the law had a bigger impact on zoning.

Several studies [80, 81] showed that misleading or absence of road furniture affected the riders' behavior on the road. Based on the results above, the absence or non-functional road furniture affected the riders' reaction to pedestrians. Therefore, proper placement of road furniture would not only play a role in the riders' ability to follow zoning regulations but would also enable them to prioritize pedestrians. Overall, the knowledge of the traffic rules and regulations had a bigger impact on the adherence to zoning regulations.

The casual relationships shown in model 3 (**Figure 4-11**) were significant and the model has a good fit (CFI = 0.925, TLI = 0.904, RMSEA = 0.062). Model 3 was a combination of model 1 and 2; this further cemented the importance of imparting knowledge of the law onto the riders. This model also showed that engineering in the form of proper road furniture placement and better roads are important if zoning were to be a successful implemented. As a combination of model 1 and 2, it earned the name "Speed and Priority Model."

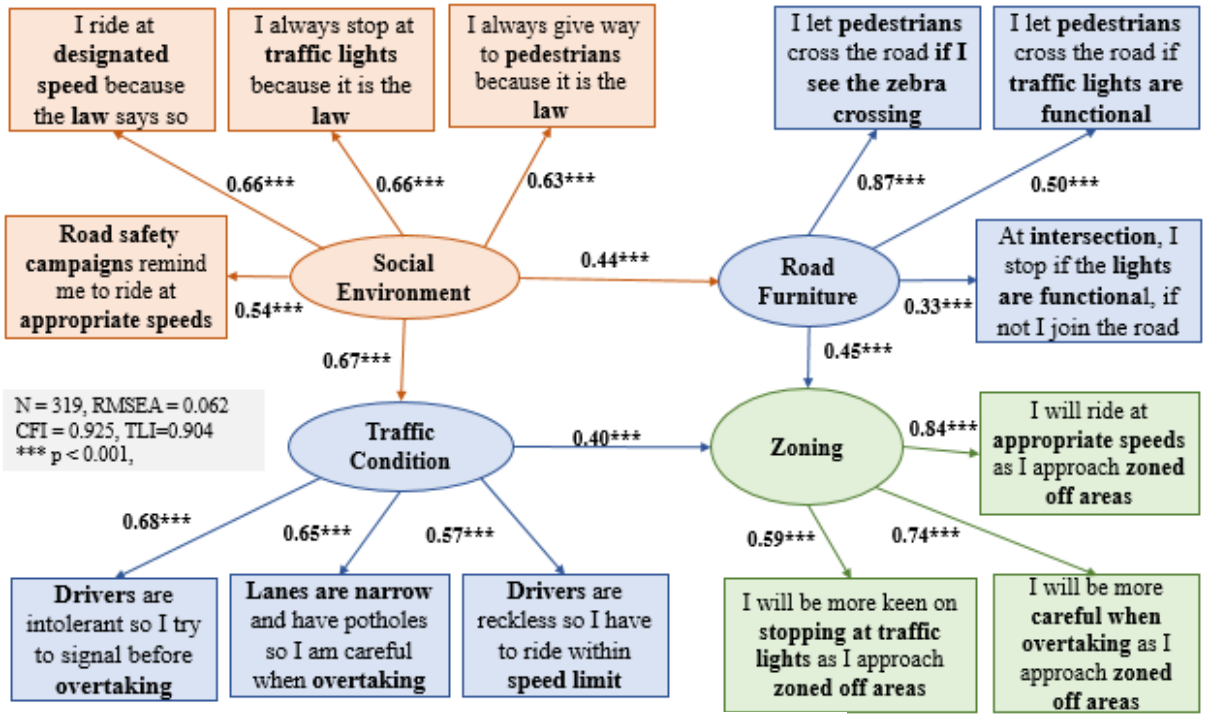

Figure 4-11: SEM Model 3 - Speed and Priority

The fit indices of model 4 (**Figure 4-12**) were within acceptable tolerances, showing a good fit (CFI = 0.944, TLI = 0.928, RMSEA = 0.055). Model 4 above was similar to model 1 and model 3 but in this case, the effect of enforcement was explored. From the results, presence of police or any other enforcement unit would ensure that riders adhere to zoning regulations. One of the reasons as to why riders that belong to the safeboda ride hailing company, adhere to traffic regulations was because there is an enforcement arm of the company whose responsibility is to ensure riders adhere to traffic rules [106]. Those that do not, were penalized and this led to a great improvement in how these riders behaved on the road as compared to their other counterparts.

Many studies suggested that enforcement should be implemented after education because it is the logic way to ensure road users adhere to traffic rules and regulations. The relationship between "social environment" and "enforcement" should therefore have shown a positive covariance however in model 4 it was a highly significant negative value. This is a true reflection of the road user-traffic police relationship in many developing countries. Some

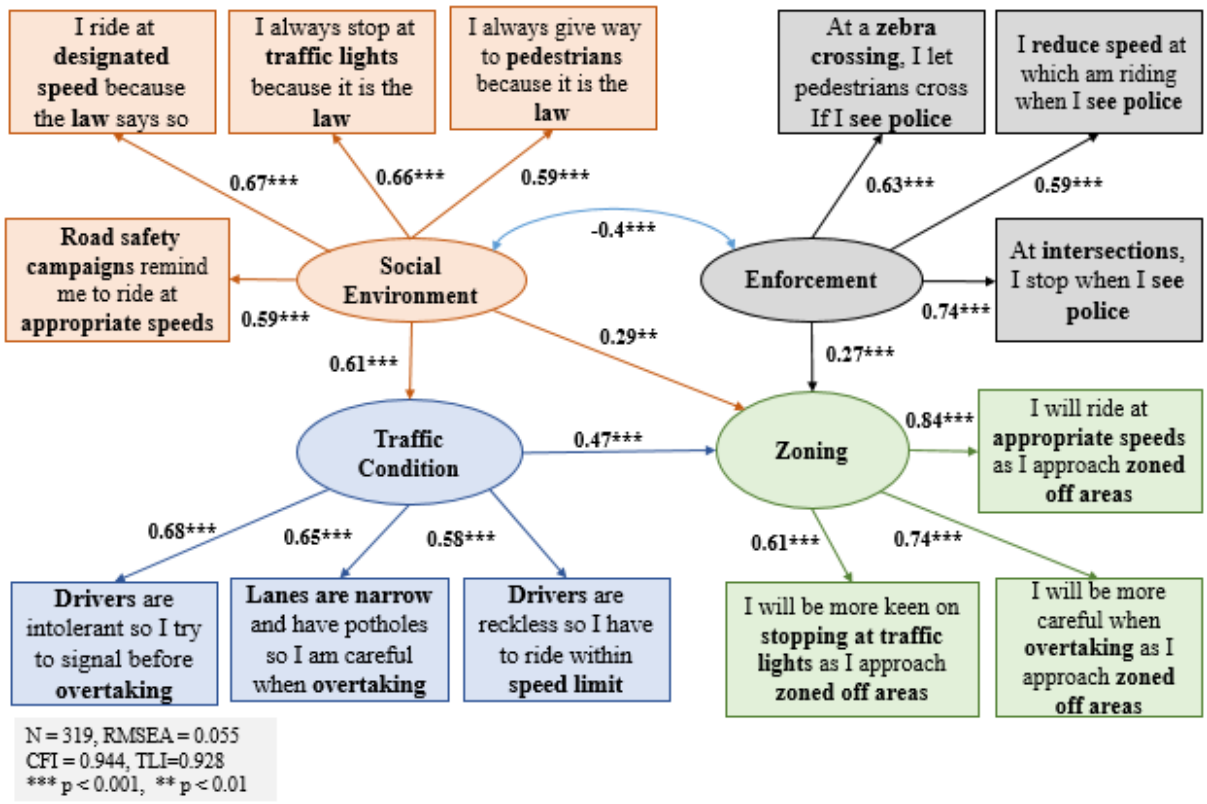

Figure 4-12: SEM Model 4 - Effect of Enforcement

reports showed that the police is involved in bribery, extortion and harassment of the riders. This has therefore created mistrust between the two parties and may explain why the riders are reluctant to follow police directives [99, 109, 110, 111, 112]. The lack of trust between the public and authorities came up as one of the reasons why the effects of an enforcement campaign targeting helmet use, in Karachi, did not last long [84].

Zoning of this magnitude is new to Kampala residents so the police and the public would have to be trained about the regulations related to zoning. This would improve the public image of the traffic police as is suggested by some studies [84].

4.5.3.2 Results related to Exclusive lanes

Model 5 (**Figure 4-13**) also showed a good fit (CFI = 0.973, TLI = 0.960, RMSEA = 0.045). In model 5, police presence would enable the riders to stay in their lanes. However, police presence would have a negative effect on traffic conditions. As mentioned under model 4, the public has low confidence in the police that they do not trust their directions and in most cases prefer to rely on their own knowledge. This many explain the negative regression coefficient between "enforcement" and "traffic conditions".

As elaborated in model 1, riders were able to read the traffic environment and hence stay in their lanes. Overall, both police presence and improved driver behavior (through emphatic driving) and improving the road conditions would enable the riders to follow the regulations related to exclusive lanes. Such a combination of solutions albeit "non-traditional" is a good

way to explore solutions that may boost sustainability in mobility and safety.

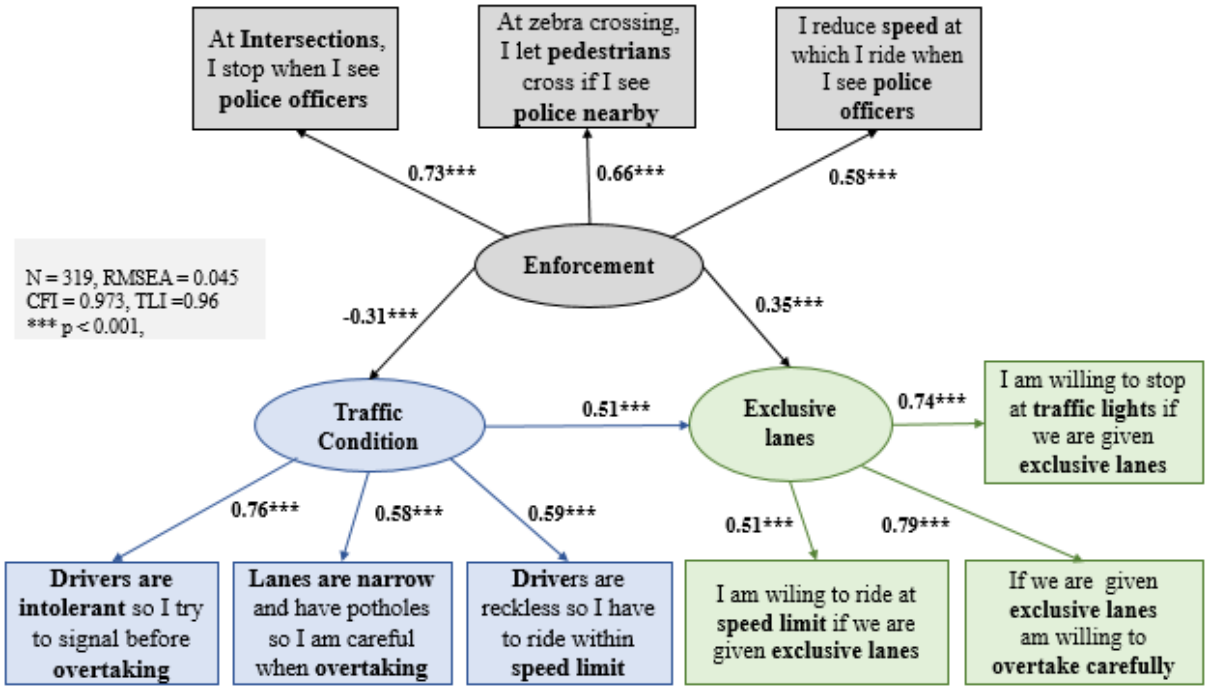

Figure 4-13: SEM Model 5

The structural model 6 (**Figure 4-14**) showed an acceptable fit based on CFI = 0.910, TLI = 0.865 and RMSEA = 0.085. Model 6 was similar to model 5 and model 1 but here the influence of passengers was examined. The influence of other people on drivers or riders has been found [103,106,107,108,109] to be either positive or negative. In Kampala [98,99], riders have reported that customers or passengers pressurize them to take risks because they want to arrive fast or to cut costs. This was further illustrated by the high exploratory power of "I ride at high speeds because customers ask me to". This explained why "human influence" had a negative effect on riders' perception of traffic conditions.

However, the effect of "human influence" had a relatively low significance on exclusive lanes. This maybe because exclusive lanes are a new concept, some passengers may be for it or against it depending on whether they prioritize their safety or get getting to their destinations. Overall, improvement of drivers' attitude to riders and road conditions would have a higher impact on riders adhering to exclusive lanes.

This model brought in the socio-economic aspect that is rarely explored when it comes to moto-taxi riders. Matters concerning the income of the rider have not been widely voiced by other stakeholders, most probably because they do not completely comprehend the dynamics. In this model, another important stakeholder, the passenger or customer, was introduced. The role of the passenger or customer is crucial in influencing the behavior and safety of riders but had not been extensively discussed in previous studies. It is believed that, campaigns targeting the passengers or customers' attitude towards speed would improve the riders' adherence to

exclusive lanes.

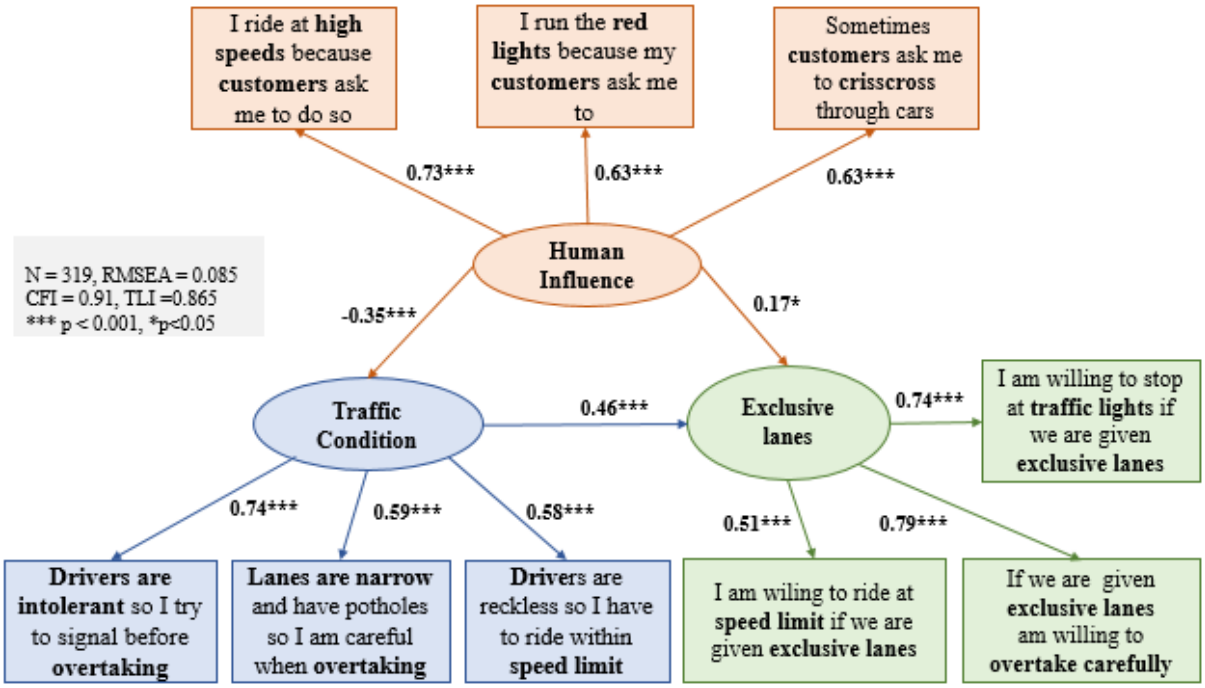

Figure 4-14: SEM model 6

4.6 Summary

This chapter suggested the cross-sector solutions that different stakeholders can plug into to ensure that there is a bridge between spatial planning and traffic management in the form of zoning and exclusive lanes. The proposed solutions created another perspective that developing countries, especially African cities with high numbers of moto-taxi riders, can utilize to boost sustainable mobility and safety.

Imparting knowledge of traffic rules and regulations had a cumulatively higher effect on promoting zoning. To achieve this, targeted trainings and campaigns should be tailored to improve the riding skills of riders but also introduce empathic driving for drivers.

In addition, many studies concluded that drivers "don't see" or "don't acknowledge" riders as rightful users of the road that deserve respect and priority. Huth et al [82] emphasized that driver training should include information about riders to familiarize drivers with other road users; and that campaigns should encourage drivers to "use their mirrors more". Clarke [69] also re-echoed the need to "make drivers aware of the numerous ways they fail to perceive a motorcycle". Therefore, including these aspects in driver training courses would create a safer environment for riders. For this to happen, the designated road safety agencies together with legislators, civil service and driving school instructors should come together and draft guidelines on the content and mode of delivery to ensure effective training in driving schools. By bringing together relevant stakeholders, new sustainable solutions would be created.

Like in many countries, road safety campaigns target drivers but not riders. There has been

reported success of campaigns such as "Fika Salama" [88] and "Twedekko" [59]. However, these were tailor made for drivers and the public but not the riders. Therefore, similar campaigns should be tailored for the public and riders to educate them about zoning and exclusive lane regulation. These campaigns should highlight the benefits of having such interventions in cities with high vehicle reliance and underdeveloped public transport systems.

In addition, holding workshops or having accessible inquiry desks to answer to the public's concerns would create "buy-in" from the public and the riders because they would support a cause they fully understand. This "buy-in" strategy was successful in some cities that created new street design guidelines [113]. Akinlade & Brieger [114] also suggested that extending safety education and campaigns to the community through community leaders (religious and otherwise) would be beneficial in improving the road safety in South Western Nigeria. Zoning and exclusive are new strategies that could benefit from this method.

Passengers or customers are part of the public, so the proposed solutions would most likely change their mindsets towards positively influencing the riders rather than encouraging them to break the law. Such human-centered interactions worked well in the creation of sustainable street design guidelines in some cities in India [113]. Broadcasting messages such as "having more than one passenger increases the risk of sustaining serious injuries", is one of the suggestions Oluwadiya et al [115] made as a way of discouraging passenger overload. Therefore, these would be explored in situations where sustainable mobility and safety is the goal.

Presence of police or enforcement in developing countries had a negative covariance effect on "social environment" and "traffic conditions" in relation to zoning and exclusive lanes respectively. This can be remedied by re-training the traffic police on regulations related to zoning and exclusive lanes. However, this leaves the aspect of low public confidence in the police.

Two avenues can be utilized to build public confidence in the police. Use of surveillance cameras to display good acts of policing. This strategy has been utilized in creating road safety campaigns by displaying how reckless behavior leads to avoidable road crashes [116]. Another avenue is the use of social media which is faster and far reaching. Both the police organization and many high-ranking officials have official social media handles that the public can readily access. This platform could be used to address queries from the riders (or public) or it could be used to highlight good policing acts to improve the image of the city. It could also be used to report police officers that act out of line. It is the 4th Industrial revolution therefore; technology is a big part of our lives today and should therefore be utilized in whatever form available to improve safety of riders and hence foster sustainability in transportation.

Improvement of the road conditions and furniture placement had a positive correlation on zoning especially when it came to prioritizing pedestrians. Visible and functional road furniture is an aspect of engineering that has not received a lot of attention in developing nations including Uganda. Yet, it was a fundamental tool for improving road safety especially of

vulnerable road users. In Cameron, moto-taxi riders identified poor road conditions as the main cause of accidents [117]. While in Australia, riders called for improvement of road surfacing, markings and placement of road furniture, as one of the interventions to enable them ride safely on the road [82]. Many studies have shown that riders are able to scan their environment as they move. Other riders have showed that absence of road furniture would cause them to act in an appropriate way that would put them and other road users in danger.

The initial step of providing and properly placing the road furniture was important even though some stakeholders have pointed out theft and vandalism as the main reason for the absence of road furniture in many developing countries, especially in Africa. This is a rather difficult issue to tackle because it is a symptom of a deeper societal problem. However, campaigns pointing out the importance of road furniture and serious police crackdowns on places where stolen road furniture is sold, maybe some of the temporary solutions to this problem.

The road to sustainable mobility requires various stakeholders coming together to support a hybrid of solutions as opposed to supporting one intervention at a time. Apart from the traditional stakeholders (politicians, police, engineers, driving/riding instructors), other stakeholders should be considered in these hybrid solutions. These include the public (who include customers or passengers and pedestrians), IT professionals (to deal with technological aspects), drivers and the motorcycle riders themselves. Road safety training or campaigns should be tailor made for riders and other road users. In addition, for all new mobility or safety measures, training or awareness campaigns for all parties involved should precede enforcement.

Sustainable mobility can be achieved by using the A-S-I strategy that stands for Avoid, Shift and Improve [118]. Spatial planning strategies like zoning are a good "avoid strategy" which look to moderate speeds through urban design reforms. Therein curbing the excessive freedom of boda boda riders while paving way for walking and cycling. However, this should not be done with the sole aim of "throwing the riders out" of the cities.

In the "shift strategy", moving towards public transport is the overall goal. As earlier explained, boda boda still play a major role as public transport modes while the countries are in planning phases of implementing public transport modes that cover a wider area and carry more passengers. Once, these are implemented, boda boda riders would continue to play an auxiliary role of "first and last mile" to and from public transport hubs. With this in mind, it is important to continue ensuring that the riders' safety needs are met both in short and long term.

Exclusive lanes are a kind of spatial segregation in the road space that can be considered as an "improve strategy" and "avoid strategy". As city authorities look to improve existing infrastructure and create new master plans, exclusive lanes should be considered as a way to monitor riders' behavior.

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5 Chapter 5: Utilizing the cross sector cooperation approach in creating sustainable machizukuri solutions – Case study of Bulandshahr and Patiala cities in India

5.1 Overview

The biggest problems affecting road transport in the world are; road traffic accidents, traffic congestion and air pollution. However, these problems are a result of poor urban land use and transportation systems. These challenges are worse in developing countries where there is rapid motorization and industrialization. India is one of the countries that is hard hit by all of these three problems.

5.1.1 Situation in India

India is one of the fastest growing economies in the world with the world's second largest population [119] standing at approximately 1.36 bn as of 2019. In 2015, the population weighted mean annual ambient [120] PM 2.5 exposure was reported to be 55 $\mu g\ m^{-3}$ in many areas while in others; it was more than 100 $\mu g\ m^{-3}$. Many parts of India, therefore, experience PM 2.5 exposure of 5-10 times higher than the recommended WHO value of 10 $\mu g\ m^{-3}$. In 2019, a total of 1.67m deaths occurred because of air pollution [121]. This is approximately 10 times the fatalities caused by road accidents in the same year. Over the years, the proposed solutions to curb this problem have included [122]; switching to clean energy sources, raising fuel taxes and parking fees and levying congestion charges.

Road traffic accident fatalities [1] are estimated at 22.6 per 100,000 population as compared to the world average of 18.2 per 100,000 population. Over speeding was reported as the biggest cause of road accidents, therefore, the government of India proposed the opening of 1000 driving schools across the country. There have also been numerous road safety campaigns, such as the Indian Road Safety Campaign [123] that was started in 2014 and is spearheaded by students. In addition, there was a 10% reduction in number of fatalities [124] because of the amended Motor Vehicle Act in 2019.

Furthermore, approximately 30% of India's urban population lives in small cities, many of which face the aforementioned problems although in varying degrees. In addition, many sustainability efforts are concentrated in larger cities such as Delhi, Mumbai etc. Nonetheless, two small cities in India managed to create SDG-Oriented street designs guidelines albeit with limited resources. This presents an interesting case study for this chapter by exploring how to replicate this achievement in cities with similar shortcomings.

5.1.2 Brief introduction of Patiala and Bulandshahr cities

Patiala city is the fourth largest city of Punjab and it the administrative headquarters of Patiala district, which is located in the South Eastern part of Punjab state (see **Figure 5-1**). The city is reported to have a population of about 760,000 people. About 80% of the road users are

bicyclists, bike users and pedestrians despite the fact that the roads are designed for the car. Public transport makes up about 11%, although para transit is the most diverse from of transportation. However, the infrastructure is not suited to this kind of transport, which results in low level of service (see **Figure 5-3**).

Bulandshahr city is the administrative headquarter of Bulandshahr district, which is located in the National Capital Region of Dehli (see **Figure 5-1**). About 50% of road users are pedestrians, 37% are bicyclists and bike users, therefore, approximately 70% of trips are made on foot or by bicycle. The population of the district is expected to grow by 44% in coming decades despite it not having developed economically and industrially. This will most likely exacerbate the transportation problems in this area.

The road traffic situation in both cities is quite similar despite slight differences in local conditions (see **Figure 5-2**). Both cities are small as compared to others such as Mumbai, Dehli and Pune. Nonetheless, they still face similar problems as these big cities as will expounded upon in the following sections. Their commitment to use local resources to overcome these transportation challenges makes them exemplary cities that embody the benefits of localizing SDGs.

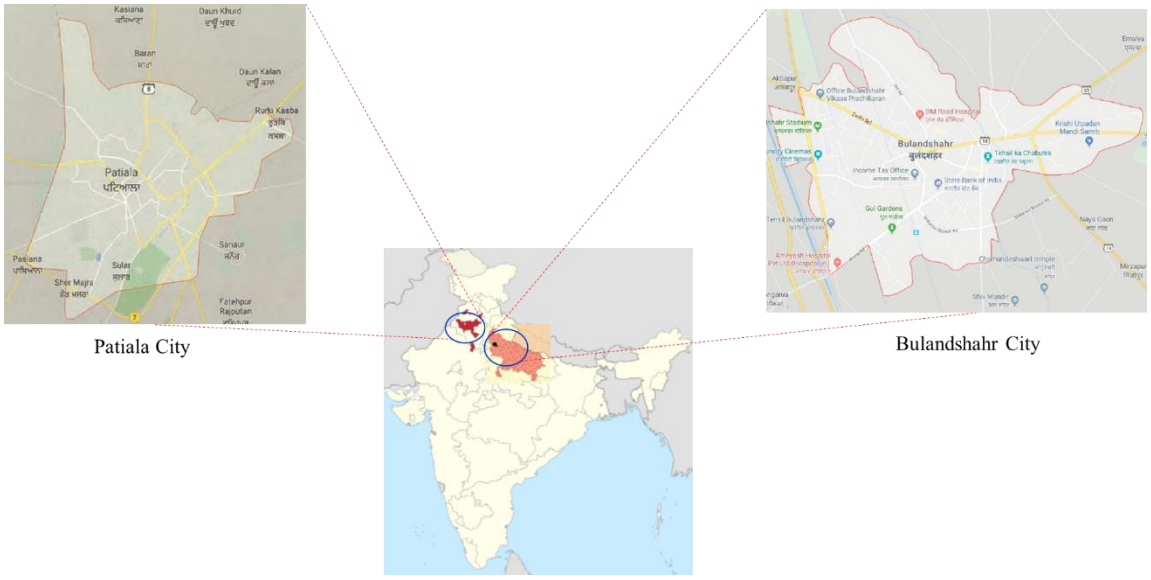

Figure 5-1: Location of Bulandshahr and Patiala Cities
Ref: Google Maps

Figure 5-2: Street condition in Bulandshahr
Ref: SDG Oriented Street Design Guideline for Bulandshahr

Figure 5-3: Street condition in Patiala
Ref: SDG Oriented Street Design Guideline for Patiala

5.1.3 The importance of localizing SDGs

As mentioned in the overview, road transportation is faced by three main problems, each of these have been tackled on a problem-by-problem basis. However, with localizing sustainable development goals (SDGs), it enables localities to tackle various challenges using a single approach. This leads to better planning, effective resource allocation and meaningful implementation.

Traffic congestion has been tackled through systems like road-pricing methods, bicycle-sharing programs, implementing Bus Rapid Transit (BRT) systems. Conversely, road accidents have been remedied by the 3Es. In recent years, social approaches such as the Vision Zero policy [125] have been spearheaded to work alongside the technical ones. Air pollution is tackled on a sector-by-sector basis through methods such as extending renewable energy sources, shifting to walking and cycling. In reality, these problems are inter-connected and it would be beneficial to tackle with single solutions depending on the local situation.

Although, these "individual methods" have worked in the past, it is best to handle them with more collective solutions such as SDG-oriented street designs. These are a form of "smart streets" which reduce the reliance of a city on vehicles while making it more human centered. With this, cities become livable, enjoyable and the residents feel a sense of ownership because the street are centered on their immediate demands.

This kind of city planning is known as Machizukuri [126], a concept coined as far back as the 1950s, from the Japanese works "Machi" and "Zukuri". Machi refers to a small area community as opposed to a large one, while zukuri means to build, make or create. In a study by Evans [127] noted that machizukuri concept is about cross-sectoral collaborative activities between local residents and government entities to create a sustainable city tied to residents' needs.

Localizing SDGs enables government entities and residents to focus on how the city can address priority (P) and speed (S) management of the city as well as comprehension (C) of traffic rules and regulations among road users or compactness (C) of a city. Sustainability dictates that cities prioritize the needs of vulnerable people (P) in the community. This includes

regulating the speeds at which vehicles move or even opt for slower modes of transport (S) so that other road users feel safe. In addition, it should become easier for both residents and non-residents to move around (C). Furthermore, cities should be such that social and economic activities are within reach of all residents despite their abilities; this can be achieved by having cities that are more compact (C). These explanations show that the PSC principle plays a vital role in localizing SDGs.

5.2 Literature review

Local and regional governments around the world have started working towards SDGs 4, 8, 18, 13, 16 and 17 through mobilizing and training members. Most of these governments [128] are in Europe, Africa and Latin America. Asia, on the hand, has just started to take part through cooperation forums like ASEAN.

Despite the benefits of localizing SDGs, many local governments complain about shortages in staff and financial resources. Region 4 Sustainable Development and University of Strathclyde [129] noted that approximately 45% of respondent regional governments found it difficult to prioritize SDGs over other agendas, while 32% required additional capacity to train staff and more financial resources to execute different programs.

Based on this, some scholars suggested that the first step towards localizing SDGs is to understand the local problems and then utilizing local resources to resolve them. Obura [130] pointed towards education/awareness through traditional and local institutions and partnerships as some of the ways to achieve this goal in the blue economy.

Almeida [131] re-echoed this by developing a conceptual framework and distinct indicators that Brazilian cities could use to track the progress of SDG 11. He stressed that Brazilian cities had to address governance, transparency and social participation if this goal was to be achieved.

Horn and Grugel [132] proposed that localization should be such that national and local governments focus on SDGs that of immediate domestic importance instead of attempting to achieve multiple goals simultaneously. From their perspective, Ecuador should focus on SDG 10 (target 10.2) and SDG 11.

Despite the fact that there have been various strategies proposed, in 2018, the Asian Development Bank (ADB) noted that there is no single approach to localization [133]. Therefore, each locale was tasked to determine suitable strategies and it encouraged governments to exhibit strong commitment towards supporting these initiatives.

Localization of SDGs is a relatively new aspect therefore; it is important for cities to learn from each other. The International Institute of Sustainable Development (IISD) reported that Hawaii, Kelowna, Baltimore, and Winnipeg cities had similar challenges and were working closely to overcome them. IISD [134] encouraged cities to collaborate so that they can learn from each other.

Therefore, the first purpose of this chapter was to apply logical methodologies, often used

in other sectors such as Education, Health, to explain the process that led to the formation of the SDG-oriented street designs. The second purpose was to propose a framework that other cities, with limited resources, can utilize to tackle local problems in order to achieve localized SDG goals.

5.3 Methodology

Logical methodologies were utilized to propose a framework for localizing SDGs. These were document review, logic framework and Theory of Change (ToC). The documents reviewed included; reports about SDG oriented design and community participation [136, 137] and the SDG oriented street guidelines [149, 150]. From the document review, information was gathered about the processes that led to the SDG-Oriented street design guidelines. The logic framework was used to illustrate how stakeholders and inputs interacted to create the final outputs of the project. The logic framework together with the PDARU (plan, do, assess or analyze, report and utilize) cycle were vital in assessing the social impact of the decisions made towards the localized SDG solution.

5.3.1 The PDARU cycle

This is a process used by project donors and funders to ascertain if a tangible change has occurred because of their contribution towards a project. It was used to visualize the value created from utilizing technology or prior knowledge employed by the private sector to solve social issues. This cycle differs from the traditional PDCA (Plan, Do, Check, Act) cycle because PDCA is a closed internal quality control process while PDARU is open and inclusive cycle, which incorporates the aspect of "Reporting and Utilizing" (see **Figure 5-4**). By opening the

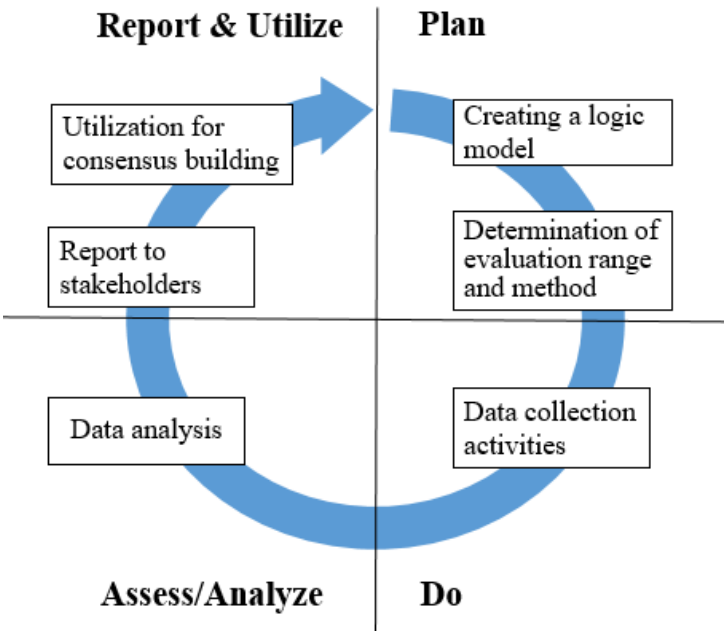

Figure 5-4: PDARU cycle

process to include these two items, trust is built and discussions that are more inclusive are held. This increases the knowledge base to enable communities to create tailor made solutions that other communities can learn from.

The PDARU cycle and logic model has been utilized by Hirano [135] et al to assess the necessity and effectiveness of public transport in Shodoshima, Japan. From their study, it was concluded that the introduction of the olive bus program enabled the residents to go out independently, improved relationships with family and friends, and improved the well-being of individuals and regions. This was a success example of the localization of SDGS, whereby public transport contributed towards improved mobility and access, regional revitalization, improved health and relations among the residents. The PDARU cycle of Patiala and Bulandhshar cities will be described below based on the review of reports reference 136 and 137.

5.3.1.1 Planning

This is an important step for any project, under the PDARU cycle, a logic model is created where short, mid and long-term goals are determined. In addition, the scope of the project including methods to collect and evaluate the data, are determined and agreed upon by all stakeholders.

In order to understand the main challenges of Patiala and Bulandhshar cities, the Transport Research & Injury Prevention Programme (TRIPP) and the Indian Institute of Technology (IIT) identified a team of professionals and researchers. This team carried out preliminary studies that showed the major challenges in both cities are air pollution, traffic congestion and road accidents. A perception study was also conducted to understand the view of the resident regarding the situation in their locality. The results will be discussed in **section 5.4**. Baseline studies to ascertain the extent of aforementioned challenges were carried out. These included; collection of traffic safety data, road network data, air quality data and travel patterns.

5.3.1.2 Do

At the stage, planned activities were executed. Traffic data was collected from police stations and coded onto a GIS base. The road network data was also collected, digitized and imported onto a GIS base. Travel patterns were gathered from the 2011 census and the perception survey was conducted to collect residents' views on traffic and mobility. Air quality data was also collected from the monitoring station in each city.

5.3.1.3 Assess/Analyze

Analysis is an important step because it is from these results that decisions are made. From data analysis, these were the results for Patiala and Bulandhshar cities;

i. Annual fatalities were 62 and 19 for Patiala and Bulandshahr, respectively.

ii. Public transport use in both cities was approximately 11%. In Bulandshahr, about 48% of the population prefer walking to work. In Palatia, 80% of the population either walks, cycles, or uses a motorbike.
iii. Air quality in both cities was extremely poor.
iv. In both cities, the biggest challenges noted were traffic congestion, road safety, air pollution, vehicular parking, and inadequate pedestrian facilities.

5.3.1.4 Report and Utilize

Reporting should be done in the simplest form for all stakeholders to understand the results. This requires innovation and creativity because the results presented are the basis for the stakeholders to make decisions.

In the case of Patiala and Bulandshahr cities, the project was phased into three parts and a report was disseminated to the relevant stakeholders [136, 137]. Other forms of reporting included dashboards to show road accident incidences and air pollution levels. Based on all this information, SDG- oriented street design guidelines were the proposed as a way forward.

5.3.2 Logic framework

A logic framework is defined as an overview of the inputs, outputs and outcomes of a project. Each aspect of a logic framework not only ties into a stage of the PDARU cycle but can be used to explain how localization is done. **Figure 5-5** below is a simple illustration of a logic framework, how it ties into the PDARU cycle and SDGs.

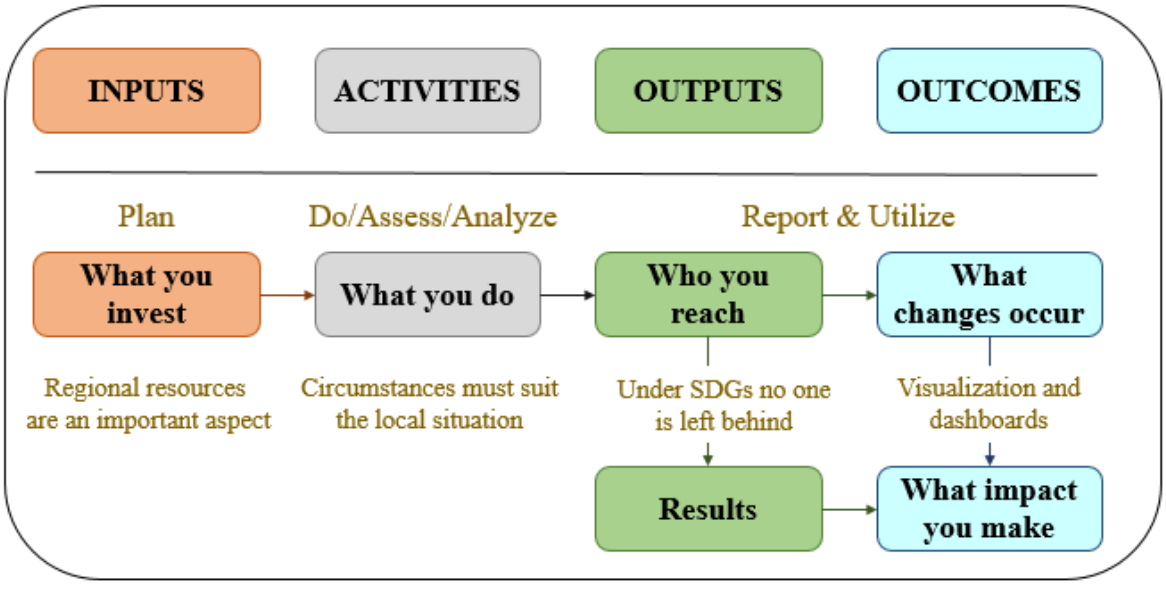

Figure 5-5: Simple Illustration of a localized SDG based logic framework

At the planning stage, the inputs should be resources that are readily available in that locale. When deciding on the methods for data collection and analysis, it is important to do so based on the local situation so that results reflect the reality on ground. The outputs that are reported

should be presented in a way that all stakeholders understand the results. In this way, no one is left behind, as is the motto for SDGs. In order to utilize the information obtained, visualization is an important outcome because this makes it possible to understand the intended impact. This is best illustrated in the detailed logic model, in **Figure 5-6**. This figure shows the process and outcome side [138] of the logic model as well as their respective definitions.

To replicate how SDG-oriented street design guidelines were reached, a Theory of Change (ToC) was used. A ToC outlines a step-by-step pathway to identify events, requirements and assumptions as well as how these interact to generate a desired outcome. This is built from a detailed logic framework by adding "underlining factors" that enable stakeholders to move from one stage to another. These underlying factors are as described by Mayne [139]. ToC [140] can be defined as models of "how change is expected to happen or how change has happened." They may also be defined [141] as "a comprehensive description and illustration of how and why a desired change is expected to happen in a particular context."

ToC models are common among development organizations whose primary focus is education, health, sanitation and poverty alleviation. Department for International Development (DFID) [142] has utilized ToCs in Ethiopia, India, DRC and other areas to identify a local problem and local resources, map out the desire outcomes and show what factors have to be utilized to

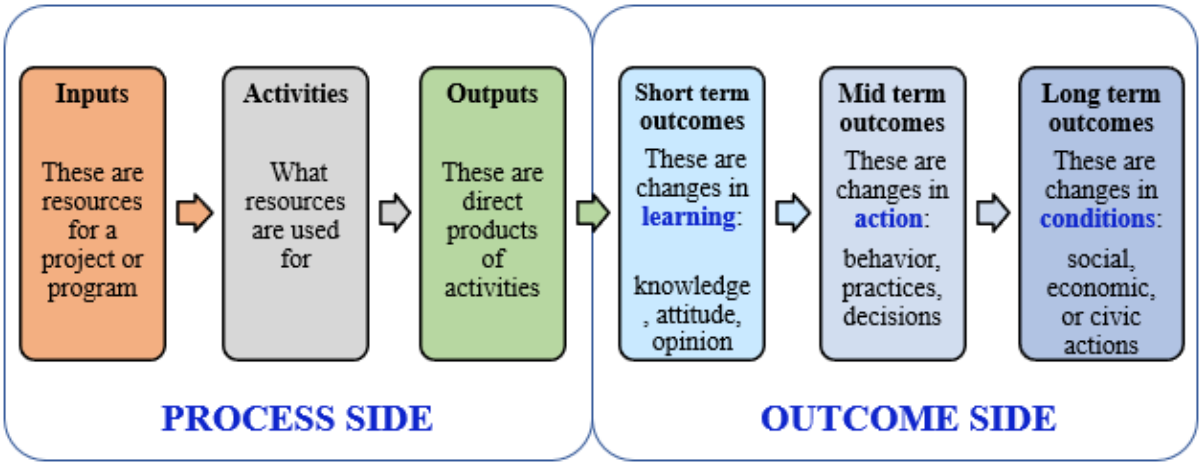

Figure 5-6: Detailed Logic framework

meet the desired goal. HCT group [143], a leading social enterprise that provides bus services to create social impact in their communities, utilized ToC. Their ToC was designed to meet their mission by enabling the company to adjust activities to meet their set outcomes.

5.4 Results

5.4.1 The Perception study

A perception study was carried out in the form of a survey targeting various stakeholders with the aim of them expressing what they thought were the traffic and mobility problems [136, 137]. The results were represented as a percentage of the stakeholders' opinion of the severity of

the problem. In this section, these results (see **Figure 5-7**) were expounded upon and their connection to SDGs further elaborated by connecting the problems in both cities to the three SDG pillars. These pillars are; Social, Environment and Economy (SEE).

As earlier mentioned, the top three global problems facing the transport sector are traffic congestion, road safety and air pollution. Traffic congestion has a direct impact on the economy of any nation. In 2018, it was reported that traffic congestion in Mumbai, Bengaluru, Kolkata and Delhi cost the Indian economy [144] about Rs 1.5 lakh crore (approximately $200 m) annually. Although there is no conclusive information on the cost of traffic congestion in Patiala and Bulandhsahr cities, we can assume that they cause an economic dent in the country's economy. Therefore, reduction of traffic congestion would not only improve the economy of India but it would move the cities closer to attaining SDG 11 (target 11.2) which calls for provision of access to safe, affordable, accessible and sustainable transport systems for all.

Road safety was noted as the second biggest challenge in both cities. The "Road accidents in India report, 2018" ranks India [145] as the country with the highest number of road accident deaths. India accounted for 11% of the world's accident related deaths while the age group 18 -45 accounted for 69% of all road accident victims. These statistics gave an insight on the social grief, loss and disruption that road accidents cause in India. Therefore, improving road safety would ensure that cities attain SDG 3, target 3.6.

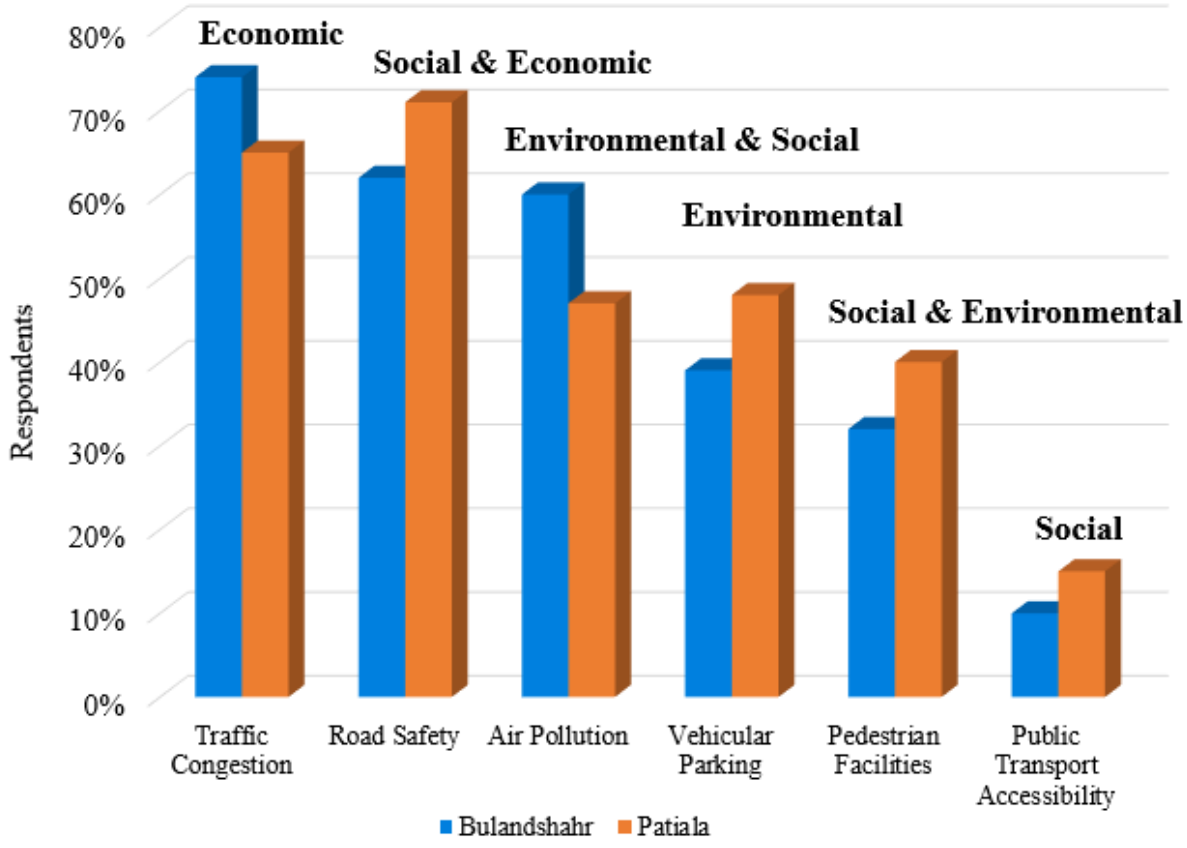

Figure 5-7: Results of the perception study in Patiala and Bulandhshar cities

Of the top 20 world's most polluted cities, 14 are Indian cities. Many of these cities in India have an annual PM 2.5 concentration of more than 83 µg m^{-3}, which is eight times higher than the WHO recommended annual concentration of 10 µg m^{-3}. IQAir [146] ranked Bulandshar and Patiala cities as the 13th and 310th most polluted cities in the world, with annual PM 2.5 concentrations of 89.4 µg m^{-3} and 35.2 µg m^{-3}, respectively. Air pollution is not only an environmental threat but a health one too. In 2016, WHO [147] reported that 4.2 premature deaths occurred due to outdoor air pollution. While in 2019, air pollution contributed to 1.67 m deaths in India [148]. The situation in India is dire, therefore, a reduction of air pollution would reduce the burden of diseases such as stroke, heart disease, lung cancer and other. The attainment of this goal would fulfill SDG 3, target 3.9.

Majority of residents in Bulandhshar and Patiala cities walk, cycle or use motorcycles. However, the roads have no proper sidewalks, there is no traffic segregation on the road and street parking is menace. In addition, there is a diverse range of informal economic activities, such as vending and hawking, taking place on the streets. Therefore, an improvement in the street design to cater for these common modes of transport and economic activities would improve the movement of people and boost the economy. If conducive environments for walking, green spaces and designated vending areas were provided for in the street designs, this would lead to the achievement of SDG 9, target 9.1 and SDG 11, target 11.7. **Table 5-1** is a summary of the major problems in these two cities, the sustainable pillar related to the problem and the SDG targets that would be achieved if these problems were tackled.

Table 5-1: Summary of the perception study results

S/N	Major problems in the cities	Sustainability pillar related to the problem	SDG target(s) to achieve
1	Traffic congestion	Economic	11.2
2	Road Safety	Social and Economic	3.6
3	Air pollution	Environmental and Social	3.9, 11.6
4	Vehicular parking	Environmental	11.7
5	Pedestrian facilities	Social and Environmental	11.7
6	Public transport accessibility	Social	11.2, 9.1

5.4.2 SDG oriented street designs for Patiala and Bulandhshar cities

The perception study and other results outlined the biggest problems in these cities, but also revealed an opportunity of particular SDGS to achieve. Accordingly, SDG Oriented street design guidelines were created. These guidelines conform to four of the six guidelines of the Japanese perspective of localizing SDGs. These guidelines are;

a) Improvement of the quality of life (**QoL**) of all citizens

b) Development of distinct **transport machizukuri** solutions
c) Creation of a synergy where **social, economic** and **environmental** issues are tackled as a unit
d) Promotion of partnerships among domestic stakeholders;
e) Promotion of global partnerships;
f) Realization of autonomy and sustainability of local entities through SDGs.

Table 5-2 and **Table 5-3** represent how localization of SDGs through the design of SDG oriented streets would enable Patiala and Bulandhshar cities to solve their biggest challenges. The tables address items a), b) and d) above while the SDG oriented streets guidelines embody item c). This was graphically represented by **Figure 5-8**, and will be discussed later in this section.

Table 5-2: Merits of localizing SDGs in Patiala city

Items to consider	**Patiala city (current situation)**	**Patiala city (SDGs focus)**
1. Improvement of the QoL of citizens in terms of: a) Material living conditions b) Productivity or main activity	Inadequate industries or manufacturing units to engage many people in informal activities, such as vending items and hawking	Places for hawkers and vendors were integrated in the street designs and provided with adequate lighting. (SDG 9.1)
2. Distinct transport machizukuri	•There is no defined public transport means in Patiala • There are some footpaths but many are not well maintained • Non-Motorized Transport (NMT) is the most commonly used form of public transport but its network is not well detailed	• Public transport share was to be increased from 0% to 45% (SDG 11.2 and 9.1) • Footpath coverage was to be increased from 70% to 100% (SDG 11.7) • NMT was to be increased from 35% to 45% (SDG 11.2 and 9.1) • A a detailed inventory of NMT infrastructure was to be developed (SDG 11.2 and 9.1)
3. Cooperation among various stakeholders	Was not clearly defined	The following consultations were held with (SDG 17.16); • Patiala Urban Planning and Development authority • Police Department • Public works department

Table 5-3: Merits of localizing SDGs in Bulandhsahr City

Items to consider	**Bulandshahr city (Current situation)**	**Bulandshahr city (SDGs focus)**
1. Improvement of the QoL of citizens in terms	According to a survey, 70% of the people admit that climate	• Universal access to safe, inclusive, accessible, green,

Items to consider	Bulandshahr city (Current situation)	Bulandshahr city (SDGs focus)
of: a) Accessibility b) Health c) Natural and living environment	change is affecting the area and 47% believe that motorized vehicles contribute to greenhouse gases	and public spaces was to be provided (SDG 11.7) • Air pollution and particulate matter were to be monitored. (SDG 3.9 and 11.6)
2. Distinct transport machizukuri	Currently vendors and hawkers stand along roads to provide services to bus commuters, cyclists and pedestrians	In the redesign of streets and roads, there was a provision for hawkers and vendors (SDG 9.1)
3. Cooperation among various stakeholders	Was not clearly defined	Consultations were held with (SDG 17.16); • Bulandshar Khurja Development Authority (BKDA) • Police Department • State Transportation Department

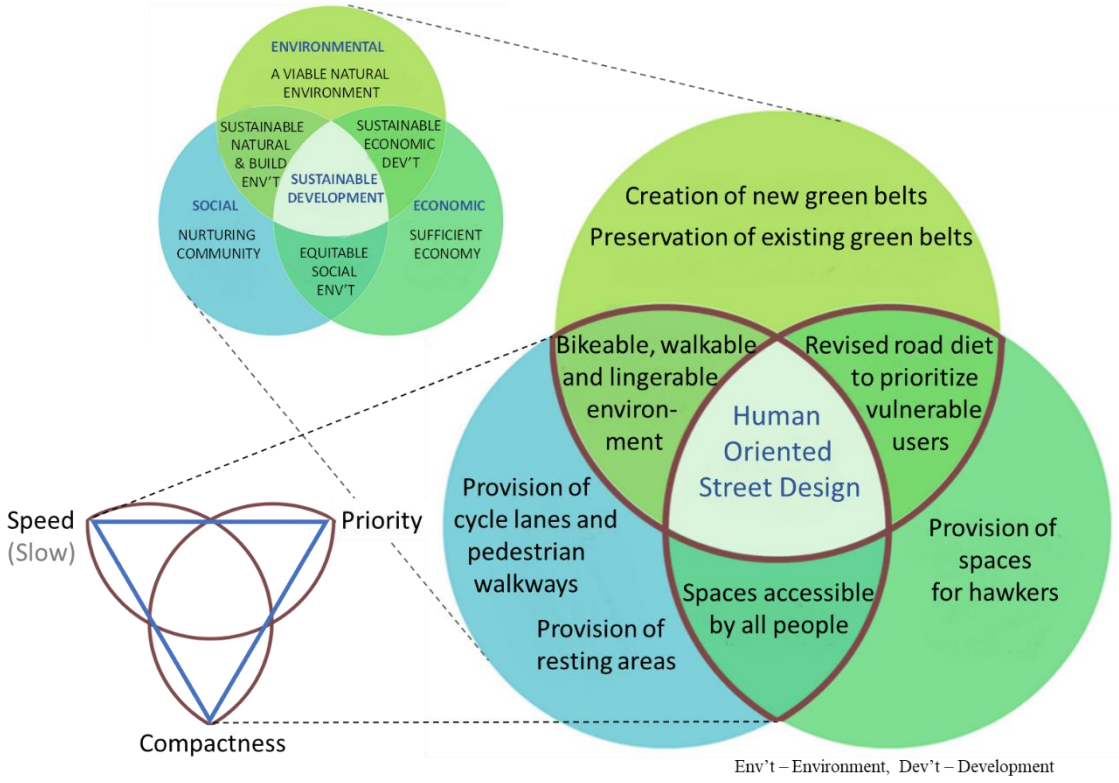

Figure 5-8: The Inclusive locus- relationship between PSC and SDG pillars

The relationship among the different stakeholders before this project is not known. However, the perception study and the SDG oriented street guidelines are good examples of how cross-sectoral interaction of various stakeholders and residents impacted the problem solving process.

Distinct transport machizukuri manifested itself in the proposed solutions shown in the figure above. To elaborate this further, we must first understand the relationship between the PSC principle and the SDG pillars. Solutions such as bike-able and walkable areas cater for the

majority of residents who walk or cycle in the city. In order to have a sustainable natural and built environment, the mode of transport used should be of low speed (S) such cycling and walking.

For sustainable economic development, prioritization (P) of vulnerable road users is vital, because the accidents involving vrus have resulted in huge economic and social losses as elaborated in previous chapters. In order to have equitable social environment, spaces should cater to the different abilities of individuals. This is best achieved by having compact (C) spaces.

The PSC criteria also details solutions that arise from cross-sectoral cooperation efforts. For example, cycle lanes and pedestrian walkways not only provide a safe means of transport but also attract residents to explore the city at a more relaxed pace (slower speeds). The revision of the road diet to prioritize vulnerable road users enables them to move freely in the city and to access service providers such as hawkers. In addition, provision of rest-areas and spaces for hawkers provides an opportunity for residents to organically socialize and access service providers. These three examples explain the tangible and intangible benefits of cross sector cooperation solutions that revolve around the PSC criteria.

5.5 Logic model for Patiala and Bulandhshar cities

The sections above represent the PDAR steps of the PDARU cycle, this section focused on utilizing the information gained from these two case studies. The logic expounded on the activities that led to the SDG oriented designs for both cities. The Theory of Change (ToC) was utilized to outline steps that other similar sized cities could use to create similar solutions.

5.5.1 Process side of the logic model

At the input stage, local resources such as local authorities, researchers and residents played an important role in building consensus and laying the foundation of the project would process. The activity stage involved collection of numerous data to enable the team to understand the root causes of the problems faces in the localities. At this point, the local agenda began to form. The data collection activities in both cities included air pollution base line data, road accident data, travel patterns and the overall proposed master plan. The collection was eased by the consensus that was created by all stakeholders. The perception study was a vital activity because it enabled the authorities to further understand the problems from the “end – users” who usually know what is broken and may have suggestions on how to fix to.

Each of these activities were planned to ensure that the output was meaningful for the advancement of the project. Accident incident maps and dashboards were created to visualize and monitor road crashes. Air pollution and particle matter data was also reviewed to form a baseline for future action. Another important output was the visualization of the citizen’s biggest concerns summarized in **section 5.4.1**.

5.5.2 Outcome side of the logic model

The outcome side has three main outcomes, short term (learning), midterm (action) and long term (conditions). In the short term, many lessons were learnt from the activities carried out. One of the most outstanding was that residents understood what SDGs are and how they related to their situation and their role in realizing them. This gave them a sense of ownership of the proposed projects and it is believed that there will be less resistance from them during implementation. Conversely, the authorities understood the residents' biggest challenges and this prompted them to re-think modal priorities for equitable space allocation.

These and more prompted action in the practices and decisions taken during the design of the SDG-oriented street designs. One major practice change was the incorporation of road audits from project inception to completion. Another change was improvement and promotion of walkability, connectivity and social cohesion of the citizens. This was done by introducing separate lanes for different road users, lights for nighttime and trees to shade pedestrians and hawkers. Cohesion of lanes was considered because it decreased travel time and increase directness for cyclist and pedestrians. Hawking and vending is common roadside activity in both cities therefore, spaces were specially designed for these activities to co-exist with bus shelter, green spaces and resting spaces. With such considerations, the cities were bound to be more attractive and accessible to all citizens. **Figure 5-9** illustrates the logic model representation of the aforementioned aspects, which culminated into;

- Economic vibrancy of the city – SDG target 3.6 and 9.1
- Improved road safety and mobility – SDG targets 3.6, 3.9, 9.1, 11.2 and 11.7
- Better health and well-being – SDG 3.6 and 11.6

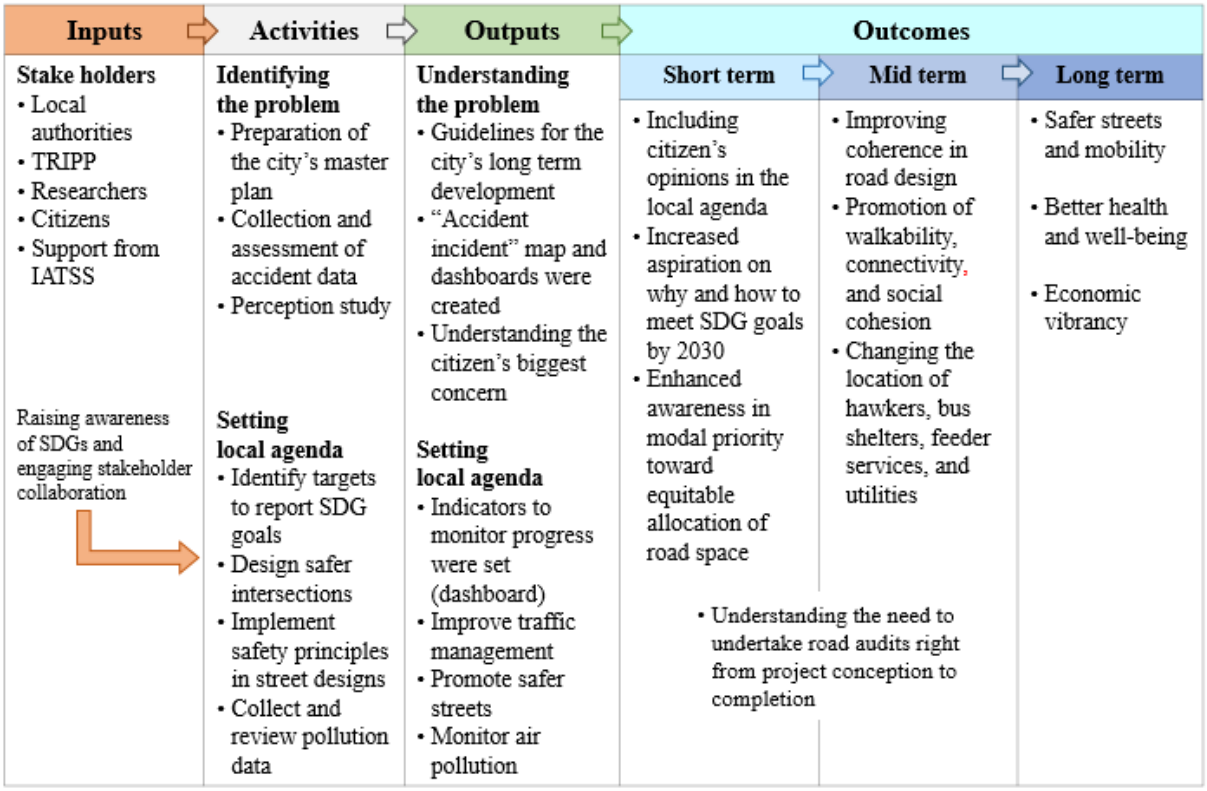

Figure 5-9: Logic Model for Patiala and Bulandhshar cities

5.6 Lessons learnt from Patiala and Bulandshahr cities

The problems in many parts of the world are the same although the intensities are different. Traffic congestion is as daunting in Kampala, as it is in Los Angeles, Lagos, New Delhi, and Paris. Road safety is as challenging in Nairobi as it is in Colombo, Manila, Brasilia, Abidjan, and Moscow. Air pollution is as taxing in Pune as it is in Beijing, Cairo, and Bakersfield.

When one locality develops a solution, it is beneficial for other places to learn from it and implement what works and modify or discard what does not work. Patiala and Bulandhshar cities are an exemplary pilot project for smaller cities that face similar problems yet possess limited resources.

A back-casting ToC was utilized to outline a systematic process that other cities can follow to create similar localized SDG solutions. **Figure 5-10** and **Figure 5-12** showed the process and outcome sides respectively while the items in the bottom boxes represented the underlying conditions required to move the project from one point to the next.

Figure 5-11 is a representation of the Avoid-Shift-Improve strategy in both cities. PSC criteria was used to elaborate this strategy in achieving sustainability. Improvements such as intersections were one way of making the road infrastructure more compact. This was one of the suggestions that were made in the guidelines. Avoid strategies seek to prevent problems such as traffic congestion, urban sprawl and environmental degradation. This is done by ensuring that land reforms, urban designs and build environments encourage moderate or

slower speed travel in cities. These werenot well detailed for both cities but be considered for other cities.

The shift strategy is a mind shift change to ensure that no one is left behind especially the vulnerable people in our communities. This was achieved by incorporating cycle and bicycle lanes to make the cities more human centered as opposed to car-oriented. Improve strategies feedback into Avoid strategies therefore these two must be handled simultaneously to ensure optimal utilization of resources.

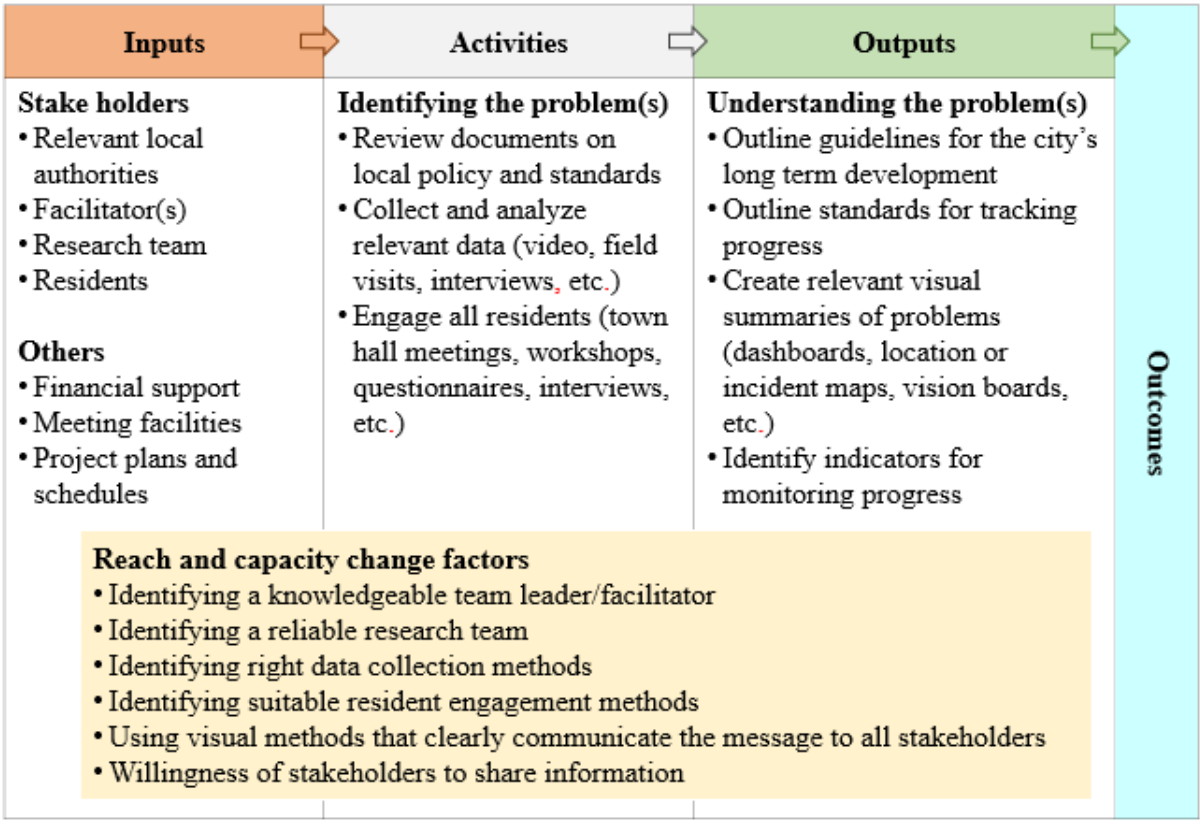

Figure 5-10: Proposed Theory of Change (Process Side)

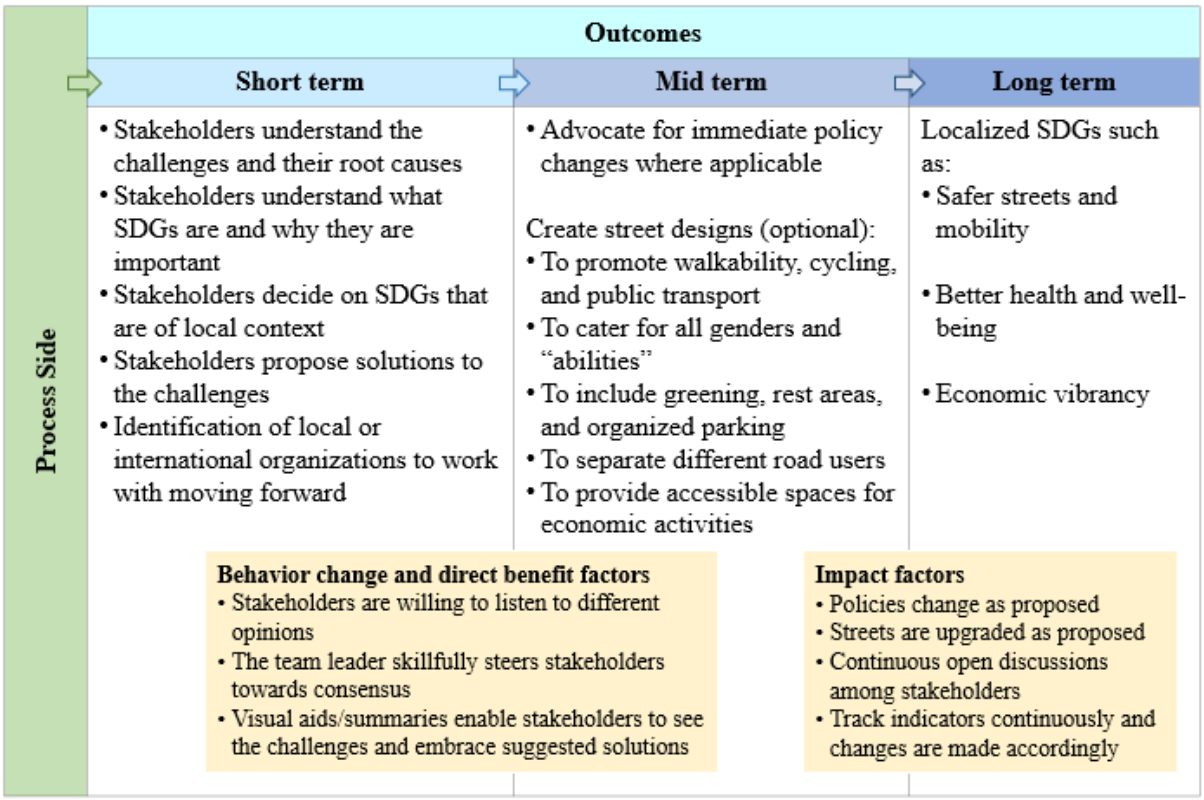

Figure 5-12: Proposed Theory of Change (Outcome Side)

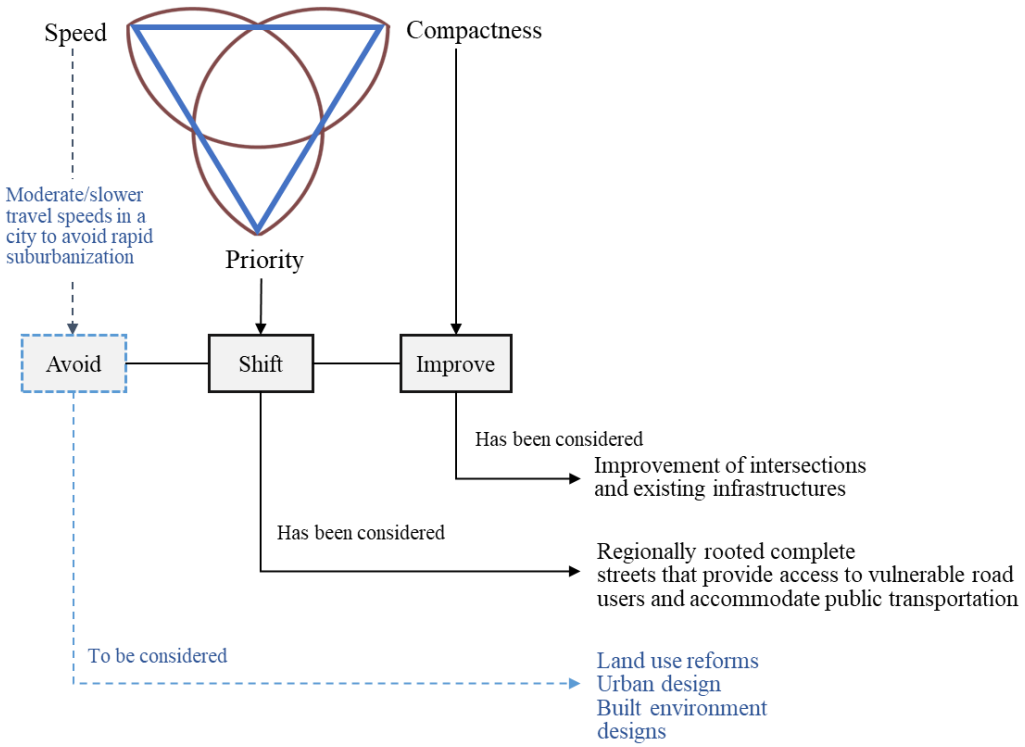

Figure 5-11: The relationship between Avoid-Shift-Improve strategy and the PSC principle

5.7 Discussion

Currently, many sustainability efforts are concentrated in big cities while the smaller cities seem to "have been forgotten". In addition, many cities in India are adamant to adopt SDG goals because they feel that these goals might take precedence over local priorities. However, in creating a local sustainability context, many local challenges can be addressed at once. Patiala and Bulandshahr cities set a good example of how cities can utilize local resources, local institutions and a limited budget to create an SDG-oriented solution to tackle the biggest local challenges. When the SDG oriented street designs are implemented, the cities will be able to achieve SDGs 3, 9 and 11. Other cities can recreate similar localized SDG solutions by applying the following steps.

At the planning stage, it is important to select a reliable team of researchers and a capable team leader to give the project direction. Both Patiala and Bulandhshar cities had an experienced and dedicated team from TRIPP that was able to build consensus with relevant stakeholders. Consensus building at the very beginning creates a firm foundation for the smooth running of the project from start to completion.

In any project, the residents are the end users; therefore, it is important to devise engagement methods that will appeal to them. It is possible that many residents are not familiar with SDGs and maybe unwilling to participate in any project. Therefore, public engagements such as workshops and town hall meetings are good strategies to get residents on board.

The engagement of residents works in favor of both residents and decision makers. The residents will understand what SDGs are, how these can improve their lives and what they can do to participate. On the other hand, decision makers, will understand what type of solutions will benefit the residents. For example, social and environmental problems are much more critical at this point in human history, but the perception study ranked congestion as the number one challenge. This is because traffic congestion directly translates into economic loss for the people in the short term, while social and environmental challenges manifest in the long term. In India, many residents were not aware of the extent of air pollution despite government efforts. Many understood the peril they were in only after New Dehli was covered in a thick fog for many days.

Similarly, social issues such as road safety are crucial but residents understand the impact only when it affects them directly. Another short fall is that women did not actively participate in the perception study yet they make up about 47% of the population in both cities. This may be due to social norms but in spirit of leaving no one behind, women and girls should be given a platform to express their views as well.

When all these issues are taken into consideration, data collection and analysis phase starts. In order to have a smooth process, an effective method of communicating outputs to different stakeholders must be decided upon. In the case of Patiala and Bulandshahr, dashboards and incident maps were simple methods that showed both the decision makers and the residents the

extent of the problems in their cities. This visualization not only enabled all stakeholders to grasp the situation, but also visualized the proposed solutions.

The next phase is determining the sustainable solution that can tackle the top three problems of the locality. This solution is based on the baseline data and propelled by specific goals. Patiala and Bulandshahr cities' aim was to have safer streets accessible to all people, improve the health of residents and boost economic vibrancy, therefore, they zeroed on SDG-oriented street designs. Such specific goals create the blue print for the most viable solutions.

SDG-oriented street designs are a relatively new idea and in order to realize them, a mindset shift is needed. Stakeholders must be willing to listen to all ideas and opinions, and must be flexible enough to abandon some practices and adopt others. For a car-dominated environment, one of the goals set was to have the footpath coverage increased from 75% to 100%. This is an example of an audacious goal and a significant mindset shift. More of such goals are needed if we are to meet the set SDGs by 2030.

In addition, it was important to set up an efficient system to track and report different indicators. It is these indicators that are monitored to continuously improve the lives of residents. One of such tracking system in Patiala and Bulandhsahr cities was the dashboards and accident incident maps.

This process was a representation of the machizukuri concept, a concept whereby local problems are solved by residents and government officials working together. Machizukuri is one way to achieve sustainability because of the cross-sectoral synergies that generate tailor-made solutions.

From this chapter, it was illustrated that sustainability could be expounded upon by the PSC principle. **Figure 5-8** illustrated how cross-sector cooperation solutions prioritized movement of vulnerable road users, reduced travel speeds so that residents could explore their city and how compactness could provide organic socialization and access to service providers. The PSC criteria expanded the Avoid, Shift and Improve strategies of sustainability. To improve traffic flow and access, road infrastructures should be more compact. Shift strategies aims to change mindsets, therefore efforts should now prioritize vulnerable road users so that no one is left behind. In avoiding; traffic congestion, urban sprawl and environmental degradation should be prevented. This can be achieved by ensuring that either motorized vehicles reduce their speeds or slower means of travel are encouraged. In the case of Bulandhsahr and Patiala cities, avoid strategies were merely implied. In the future, cities should critically look at how to incorporate these strategies from the beginning.

As earlier stated, it is important to have clear goals that are followed by clear indicators and actions. Despite the fact that air pollution is a major challenge in Patiala and Bulandshar cities, specific measures and target reductions were not mentioned in the reports. Targets 3.9 and 11.7 were mentioned, but local indictors to track them were not clearly stated. In addition, implementation of any project is possible if there is government regulation and commitment.

However, this aspect was not highlighted in any of the reports. Moving forward, other cities should ensure that goals and indicators are specified, for example, "to reduce air pollution by 5% in 2 years". In addition, government regulation and commitment should also be sought before implementation.

5.8 Summary

In this section, the PDARU cycle and logic model were used to explain the process of creating the SDG oriented street designs. The relationship between PSC and SDGs was expounded upon to show that SDGs can be used as a basis to tackle local challenges and also track progress of the proposed solutions. Based on this, the Theory of Change was utilized to create a framework for implementing similar strategies in cities with limited resources albeit differing challenges. It is important to note that the safety hexagon still applies here because for every PSC aspect that a city decides to tackle, appropriate action is taken in the form of 3Es with the cooperation of relevant stakeholders.

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6 Chapter 6: Conclusion

6.1 Overview of study

Road traffic accident trends are rapidly changing in different parts of the world. This may be due to change in demographics and/or economic situation. Therefore, defining a single solution for these challenges is not very easy. However, there are some similarities between developing countries and the road traffic trends that happened in developing countries in the 1970s and early 1990s. This is an opportunity to explore what the developed nations have done different to ensure lower traffic accident rates as compared to developing nations.

To curb the traffic accident crisis of the 1970s and 1990s, one or two of the 3Es were implemented. In addition, a diverse spectrum of stakeholders has been incorporated at all decision-making levels over the years. With organizations such as UN and the world bank calling for reduction of road accidents rates by 50%, new "non-conventional" ideas have to take root. Therefore, a new approach to cross sector cooperation approach was been proposed in this study.

In **chapter 2**, a new cross sector cooperation approach towards road safety was introduced. This was visually represented as the safety hexagon that stems from a combination of the 3Es and PSC principle. This approach stands on two pillars; one is that PSC principle represents the risks or causes of accidents while 3Es represents the solutions to these risks or causes of accidents. The second pillar is the diversity of stakeholders that are necessary for decision-making. Apart from the engineers, lawmakers and enforcers, educators, others such as the community, target group and spatial (information or device) designers should be involved in decision-making. This approach was expounded upon by comparing the national road safety policies of three countries; Germany, Japan and the Netherlands. It was found that Germany and the Netherlands had a form of cross sector cooperation while Japan seemed to have just started on this approach. It was also noted that Germany and the Netherlands have been involving diverse stakeholders in decision-making at different levels, and this could partly attribute to their low road traffic accidents as compared to other countries.

Chapter 3 expounded upon the practicality of the cross sector cooperation approach by showing casing how two highly motorized cities utilized different cross sector strategies to create hybrid solutions to reduce fatalities involving bicyclists and school going children. Although, Japan has well defined 3Es approaches, its systems are fragmented as was shown in **Figure 2-23**. However, some local governments understood the shortcomings of the current system and devised means to engage all relevant stakeholders (school going children, PTA and universities included). Various benefits were accrued from this approach including; the concept of "osuaruku" (pushing one's bicycle in areas where there are many pedestrians), creating a school zone and disseminating information on best routes to use. To adopt similar strategies, a Theory of Change (ToC) for each city was proposed to map out the process on how other cities can utilize different resources to achieve similar goals

The basis of cross sector cooperation approach is universal and should therefore be beneficial to developing nations whose 3Es systems are often fragmented. This can be achieved by customizing the cross sector cooperation approach to fit the needs of that area. To achieve this, cross sector frameworks were proposed to curb particular road safety problems in two developing countries.

In **chapter 4**, a cross sector framework was proposed as a way to improve the safety of boda boda riders in Kampala city, Uganda. Kampala, like many African cities has underdeveloped public infrastructure and a high number of boda boda riders that fill the gap of public transportation. However, the boda boda riders account for a big percentage of fatalities on the road. In addition, the 3Es systems are not well streamlined. This presented an opportunity whereby the cross sector cooperation approach was used to propose hybrid solutions that different road safety stakeholders could plug into. In so doing, the 3Es systems would form a focused synergy to create these hybrid solutions. This was achieved by carrying out a questionnaire survey targeting boda boda riders. The data was analyzed using SEM and the resulting six models represented a framework of hybrid solutions to curb the aforementioned problem. The proposed solutions are expected to serve as a basis for other African cities to create similar solutions to improve safety of boda boda riders and the public transportation system as a whole.

It should be noted that some countries are faced with a triple threat of road traffic accidents, air pollution fatalities and traffic congestion. India is such a country, with its smaller cities hit hardest because they do not have enough funding and human resource. To remedy this situation, SDG oriented street designs were proposed in Patiala and Bulandshahr cities. A lot can be learned from the process that led to the SDG oriented street designs. Therefore, **chapter 5** focused on illustrating how cross sector cooperation can be utilized to achieve similar results cities with limited resources. The PDARU cycle and logic model were used to break down the processes, an inclusive-locus showed the relationship between PSC and SDG pillars, and the Theory of Change (Toc) was utilized to propose a systematic process to achieve similar results.

This entire study has shown that it is important to tackle road safety problems first at a local level. Identification of the root cause of problems should include various stakeholders especially the “non-conventional” ones such as the community, health providers, information designers and many others. In so doing, bottom up solutions will be created. These solutions should be the basis of national and/or regional policies. The change in strategy from strict “top-down” policies to “bottom-up” policies has been successful in countries such as Germany and the Netherlands. As developing nations, grapple with increased number in fatalities, this is a strategy they should consider to create home grown solutions that address the local problem and uses easily available resources. Patiala and Bulandhshar cities have shown that this is possible.

In addition, sustainability of the transportation system should be at the back of every stakeholders' mind. "Localization of SDGs" is very crucial in addressing the demographic, climate and economic situation of the world that we are currently living in. This study has shown that the proposed Cross-sector cooperation approach is not only an inclusive and sustainable approach but a vital one in tackling area-specific problems. It is therefore hoped that it can be embraced in policy analysis, research and advocacy.

6.2 Recommendations for further research

This entire study has shown how cross sector cooperation approach or its elements can bring about new perspectives in the sustainability of transportation and mobility. The next step would be to quantify the impact of these activities after implementation. This would be helpful in knowing how to improve the proposed cross sector cooperation approach. To achieve such a goal, I propose a study on the before and after conditions of a given case study.

7 Appendices

Appendix A: List of Publications

Journal Papers

1. Murungi Elizabeth Mwebesa, Chun-Chen Chou, Kento Yoh, Kenji Doi, "A Cross-Sector framework to boost the sustainable integrated transport and spatial strategies to improve and mobility of moto-taxi riders". *Frontiers Sustainable Cities – Urban Transportation Systems and Mobility*, Nov 2021
2. Murungi Elizabeth Mwebesa, Kento Yoh, Kenji Doi, "Developing the logical cross-sectoral framework of local SDGs project targeting safety and sustainability". *IATSS Research*, Vol 45, Issue 1, Apr 2021, pages 49-59
3. Murungi Elizabeth Mwebesa, Kento Yoh, Hiroto Inoi Kenji Doi, "A new approach to cross-sector cooperation in road safety through a comparison of policies in selected countries." *IATSS Research*, Vol 42, Issue 4, Dec 2018, pages 197-206

Conference Papers

4. Murungi Elizabeth Mwebesa, Kento Yoh, Hiroto Inoi Kenji Doi, "Study on the feasibility of cross sector cooperation approach towards road traffic safety." Proceedings of the Eastern Asia Society Transportation Studies, Vol 12, Colombo, Sri Dec 2019 (Colombo-Sri Lanka)

Appendix B: Detailed Survey Questionnaire

This questionnaire is prepared for academic purposes with the aim of identifying various factors that may affect the behavior of *boda boda* riders on the road

Section A: General Information

a) Location:_____ c) Date:_____

b) Stage name/stage ID:_____ d) Research Assistant:_____

A-1 Which **boda boda organization** do you belong to? □ Safeboda □ Freelance

A-2 Have you attended a workshop on **road safety training**? □Yes □ No

A-3 How old are you?

☐ 18-30years □ 31-40 years □ 41-50years □ Over 51years

A-4 What is your marital status? □ Single □ Married

A-5 What is your **level of education**?

☐ Primary □ O'level □ A'level □ Tertiary Institute □ University

A-6 How many years have you been in the **boda business**?

☐ Less than 1 year □ 1-5 yrs □ 6-10 yrs □ 11-15yrs □ Over 16 years

A-7 For **safeboda**, how many years have you been a safeboda rider?

☐ Less than 1year □ 1-3 yrs □ Over 4yrs

A-8 Does the **rider have a helmet**? □Yes □ No

A-9 If **yes,** how many**?** _____

A-10 How often do you **wear a helmet** when working?

☐ Always □ Sometimes □ Rarely □ Never

A-11 Who taught you how to **ride a boda boda**? (tick all relevant answers)

☐ Myself □ Friend □ Family □ Others _____

A-12 Do you have a **driving permit**? □ Yes □ No

A-13 If yes, did you **take a test** before getting a permit? □ Yes □ No

A-14 If yes, **what was it** (tick all relevant answers)

☐ Oral □ Written □ Practical □ All

Section B: Undesirable Factors

This sections seeks to understand the negative factors that may affect the behavior of *boda boda* riders on the road. Write a score on a scale from 1 to 5 based on the table below.

5	4	3	2	1
Strongly agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**

Item	**Score**
B-1 I always wear my helmet when I know there is police around.	_____
B-3 The roads have many potholes it is difficult for me to maneuver the road.	_____
B-4 Pedestrians cross the roads anyhow, this is a source of constant frustration for me when riding.	_____
B-5 At a zebra crossing, I let pedestrians cross if I see police officers nearby.	_____
B-6 I let pedestrians cross the road if the zebra crossing is visible to me.	_____
B-7 I let pedestrians cross the road if the traffic lights are functional	_____
B-8 At the intersection, I stop when I see police officers.	_____
B-9 At intersections, I stop when the traffic lights are functional, if not I just join the road	_____
B-10 I stop at intersections for fear of being knocked down by oncoming traffic	_____
B-11 At unsignalized intersections, if there are no cars in sight, I will join the road.	_____
B-14 Drivers are intolerant and impatient so I try to signal before I overtake	_____
B-15 I am careful when overtaking because the lanes are narrow and have potholes	_____
B-16 Over speeding can lead to fatal accidents so I try to ride within the speed limit.	_____
B-17 I reduce the speed at which am riding when I see police officers.	_____
B-18 Car drivers are reckless so I have to ride within the speed limit of that area	_____

Section D: Inertia Factors

This section seeks to understand social factors that may influence *boda boda* riders' behavior on the road. Write a score on a scale from 1 to 5 based on the table below.

5	4	3	2	1
Strongly agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**

Item	**Score**
D-1 I always stop at traffic lights because it is the law.	_____
D-2 I run the red lights because customers want to reach their destinations quickly.	_____
D-3 I usually stop at the red lights because my friends do so.	_____
D-4 If there are no traffic lights, I see no use in stopping before I join the road.	_____
D-5 At unsignalized intersections, I usually just join because my friends do the same.	_____
D-6 Campaigns such as "Tweddeko" remind me of the importance of always stopping at traffic lights.	_____
D-7 I always give way to pedestrians because it is the law.	_____
D-8 I ride at high speeds like my friends.	_____
D-9 I ride at designated speed limits because the law says so.	_____
D-10 Road safety campaigns are a good reminder for me to ride at appropriate speeds.	_____
D-11 I usually ride at high speeds because many customers ask me to do so.	_____
D-12 Riding at high speeds excites me	_____
D-13 From TV, I see clips of riders involved in fatal accidents so am more careful when I overtake	_____
D-14 Sometimes my customers ask me to crisscross through cars so I do so	_____
D-15 I overtake on the right side vehicles because it is the law	_____
D-16 It is fun swerving and dodging cars on the road.	_____
D-17 Because of campaigns like "Yambala Elementi", I am more keen to wear my helmet	_____
D-18 The helmet is meant to protect my head in case of a crash so I always wear it.	_____
D-19 I wear my helmet because many of friends do so.	_____
D-20 Helmets are too small and too hot so I don't usually wear them.	_____

Section E: The R Factors

This sections seeks to understand how new factors both on and off the road may influence *boda boda* riders' behavior on the road. Write a score on a scale from 1 to 5 based on the table below.

5	4	3	2	1
Definitely Yes	**Yes**	**Neutral**	**No**	**Definitely No**

Item	**Score**
E-1 I am willing to ride at the speed limit if we are given exclusive lanes	_____
E-3 As I approach the zoned off areas, I will ride within appropriate speeds	_____
E-4 If model riders get vouchers for free fuel or free bike maintenance, this would make me ride within appropriate speeds.	_____
E-5 If impromptu inspection of boda bodas is strongly implemented, it will encourage me ride within appropriate speeds.	_____
E-6 I am willing to stop at the traffic lights if we are given exclusive lanes	_____
E-7 As I approach zoned off areas, I will be more keen on stopping at traffic lights	_____
E-8 If items such as free fuel, free bike maintenance or shopping vouchers are given to model riders, this would encourage me to stop at the traffic lights	_____
E-12 If we are given exclusive lanes, am willing to overtake more carefully	_____
E-13 Practical riding tests on the road, would prepare me to be careful when overtaking	_____
E-14 I will be more careful when overtaking as I approach the zoned off areas	_____
E-15 If model riders are awarded with as shopping vouchers or free bike, this would make me more careful when overtaking	_____
E-20 I will endeavor to always wear a helmet if I know I might be rewarded with free fuel, free bike maintenance or shopping vouchers	_____

Appendix C: Sample questionnaire responses

The results shown are those of the cleaned data therefore, some respondents are not included.

ID	A-1	A-2	A-3	A-4	A-5	A-6	A-7	A-8	A-9	A-10
1	Safeboda	Yes	31 - 40 years	Married	Tertiary Ins	1-5 years	1-3 years	Yes	2	Always
2	Safeboda	Yes	18-30 years	Single	University	1-5 years	1-3 years	Yes	2	Always
3	Safeboda	Yes	18-30 years	Single	A'level	1-5 years	Less than 1 ye	Yes	2	Always
4	Safeboda	Yes	41-50 years	Married	O'level	11-15 years	Over 4 years	Yes	2	Always
6	Safeboda	Yes	18-30 years	Married	Primary	6-10 years	Less than 1 ye	Yes	1	Always
7	Safeboda	Yes	31 - 40 years	Married	O'level	1-5 years	1-3 years	Yes	1	Always
8	Safeboda	Yes	31 - 40 years	Married	Primary	6-10 years	Less than 1 ye	Yes	2	Always
9	Safeboda	Yes	18-30 years	Single	A'level	1-5 years	Less than 1 ye	Yes	1	Always
10	Safeboda	Yes	41-50 years	Married	Primary	6-10 years	Over 4 years	Yes	2	Always
11	Safeboda	Yes	31 - 40 years	Married	Primary	1-5 years	Less than 1 ye	Yes	2	Always
13	Safeboda	Yes	18-30 years	Married	O'level	6-10 years	1-3 years	Yes	1	Always
14	Freelance	Yes	18-30 years	Married	No school	1-5 years		Yes	1	Always
15	Safeboda	No	18-30 years	Single	Primary	1-5 years	1-3 years	Yes	2	Always
16	Freelance	No	41-50 years	Married	Primary	1-5 years		Yes	1	Always
17	Safeboda	Yes	41-50 years	Married	O'level	6-10 years	1-3 years	Yes	2	Always
18	Freelance	Yes	18-30 years	Single	O'level	1-5 years		Yes	1	Always
19	Freelance	Yes	18-30 years	Married	A'level	1-5 years		Yes	1	Always
20	Freelance	No	41-50 years	Married	O'level	1-5 years		Yes	1	Always
21	Freelance	No	41-50 years	Married	University	1-5 years		Yes	1	Always
22	Freelance	Yes	41-50 years	Married	Primary	6-10 years		Yes	1	Always
23	Freelance	Yes	31 - 40 years	Married	Primary	11-15 years		Yes	1	Always
24	Freelance	Yes	18-30 years	Married	O'level	1-5 years		Yes	1	Always
25	Freelance	No	31 - 40 years	Married	Primary	6-10 years		Yes	1	Always
26	Safeboda	Yes	31 - 40 years	Single	Primary	Less than 1	Less than 1 ye	Yes	1	Sometim
27	Freelance	Yes	41-50 years	Married	Primary	Over 16 years		Yes	1	Always
28	Freelance	No	18-30 years	Married	O'level	1-5 years		Yes	1	Always
29	Freelance	Yes	31 - 40 years	Married	A'level	1-5 years		No	0	Never
30	Freelance	Yes	31 - 40 years	Married	O'level	11-15 years		Yes	1	Always

ID	A-11	A-12	A-13	A-14-1	A-14-2	B-1	B-3	B-4	B-5	B-6
1	Friend	Yes	Yes	All		1	5	3	1	4
2	Friend	Yes	Yes	All		2	4	4	1	4
3	Family	Yes	Yes	All		2	4	4	2	5
4	Friend	Yes	Yes	All		2	4	3	2	5
6	Family	No				1	4	2	3	4
7	Family	Yes	Yes	Oral	Practical	2	4	4	2	4
8	Myself	Yes	Yes	Oral	Practical	2	4	4	4	4
9	Friend	Yes	Yes	Oral	Practical	2	5	4	4	4
10	Myself	Yes	No			1	5	5	5	4
11	Friend	Yes	Yes	All		2	4	5	5	4
13	Friend	No				2	4	4	2	2
14	Family	Yes	Yes	All		1	4	2	4	4
15	Friend	No				2	5	3	2	4
16	Family	Yes	Yes	Oral	Practical	4	4	2	4	4
17	Friend	Yes	Yes	Oral	Practical	2	4	3	4	4
18	Myself	No				1	4	4	1	4
19	Friend	Yes	Yes	All		1	4	3	2	4
20	Myself	No				2	4	4	4	4
21	Myself	Yes	Yes	Oral	Practical	2	4	1	2	4
22	Myself	Yes	Yes	All		2	4	5	2	4
23	Myself	Yes	Yes	All		2	4	4	2	4
24	Family	Yes	Yes	Oral	Practical	4	4	3	4	4
25	Myself	No				4	4	4	4	4
26	Friend	Yes	Yes	Practical		4	5	4	2	4
27	Myself	Yes	Yes	All		2	4	4	3	4
28	Myself	Yes	Yes	Oral	Practical	4	3	4	4	4
29	Myself	Yes	Yes	All		1	5	5	2	5
30	Friend	No				2	4	4	4	4

ID	B-7	B-8	B-9	B-10	B-11	B-14	B-15	B-16	B-17	B-18
1	2	2	2	4	5	5	5	5	1	5
2	2	2	2	4	4	4	5	5	2	5
3	3	2	3	5	4	5	5	5	2	5
4	5	2	2	5	4	5	5	5	2	4
6	4	3	2	4	3	4	4	4	2	4
7	4	2	2	4	4	4	4	4	4	4
8	5	4	2	1	2	3	4	4	4	5
9	4	5	1	5	1	3	4	4	3	5
10	4	4	2	4	1	3	5	5	4	4
11	4	4	4	5	4	5	5	4	5	4
13	4	2	2	4	2	4	4	4	2	2
14	4	1	4	4	1	4	4	4	1	4
15	4	2	2	4	2	4	4	5	2	4
16	4	3	3	4	4	4	4	4	4	4
17	4	2	2	4	2	4	4	4	2	4
18	4	1	2	4	4	4	4	4	2	4
19	4	1	3	4	2	4	4	4	1	4
20	4	3	3	4	2	4	4	4	1	4
21	4	2	4	4	4	4	4	4	4	4
22	4	2	2	4	2	4	4	4	3	4
23	4	2	2	4	2	4	4	4	2	4
24	4	4	3	4	4	4	4	4	3	4
25	4	2	2	4	4	4	4	4	2	4
26	2	5	5	4	1	2	4	5	5	2
27	5	3	2	4	4	4	4	5	3	5
28	4	4	3	4	4	4	4	4	3	4
29	4	2	2	4	5	5	5	4	4	5
30	4	4	2	4	2	4	4	4	4	4

ID	D-1	D-2	D-3	D-4	D-5	D-6	D-7	D-8	D-9	D-10
1	5	1	1	1	1	4	4	1	4	5
2	5	1	1	1	1	5	5	2	4	5
3	5	1	1	1	2	5	5	1	5	5
4	5	1	1	1	1	5	5	1	5	5
6	5	1	1	1	1	5	5	1	5	5
7	4	2	2	2	2	4	4	2	4	4
8	4	4	1	4	1	2	4	1	3	5
9	4	1	4	1	1	4	4	1	3	5
10	5	1	4	2	2	5	4	2	4	4
11	5	1	4	5	2	4	4	1	4	2
13	4	1	1	1	1	4	4	2	4	4
14	5	1	1	1	2	4	4	1	4	5
15	5	1	1	2	1	5	5	1	5	5
16	4	2	2	2	2	4	4	2	4	4
17	5	1	1	2	1	4	5	1	5	4
18	4	1	1	1	1	4	4	1	5	4
19	5	1	1	2	1	4	5	1	5	4
20	4	1	1	1	1	4	4	2	5	5
21	4	1	1	1	1	4	4	1	4	4
22	5	1	1	1	1	4	4	1	4	4
23	4	1	1	1	2	4	4	1	4	4
24	3	3	2	3	2	3	4	2	3	4
25	4	2	2	4	2	4	4	2	4	4
26	4	1	4	1	1	4	4	2	4	5
27	5	1	1	2	1	4	4	1	5	4
28	4	2	2	2	2	4	4	2	4	4
29	4	1	1	1	2	4	5	1	5	4
30	4	2	2	2	2	4	4	2	4	4

ID	D-11	D-12	D-13	D-14	D-15	D-16	D-17	D-18	D-19	D-20
1	1	1	4	1	4	1	5	5	2	1
2	1	1	5	1	5	1	4	4	1	1
3	1	1	5	1	5	1	5	5	4	1
4	1	1	4	1	5	1	5	5	3	1
6	1	1	5	1	5	1	5	5	1	1
7	2	2	4	2	4	2	4	4	2	2
8	1	1	5	1	4	1	5	4	1	1
9	2	1	4	2	4	1	5	4	2	2
10	2	1	5	1	4	2	5	4	1	2
11	1	1	5	2	4	1	5	4	4	1
13	2	2	4	2	4	2	4	4	2	2
14	1	1	5	1	4	1	5	5	2	1
15	1	1	5	1	5	1	5	5	1	1
16	3	2	4	3	4	3	4	4	4	2
17	1	1	5	1	5	1	4	5	1	1
18	1	1	4	1	4	1	4	4	1	1
19	1	1	5	1	5	1	4	4	1	1
20	1	1	5	3	5	1	5	5	1	1
21	1	1	4	1	4	1	4	4	1	1
22	1	1	4	1	4	1	4	4	1	1
23	1	1	4	1	4	1	4	4	1	1
24	3	3	3	3	3	3	4	4	4	1
25	2	2	4	2	4	2	4	4	2	2
26	4	2	4	2	4	4	4	4	5	2
27	1	1	5	1	5	1	5	5	2	1
28	3	2	4	3	4	3	4	4	2	1
29	1	1	5	1	5	1	5	1	1	1
30	2	2	4	2	4	2	4	4	2	2

ID	E-1	E-3	E-4	E-5	E-6	E-7	E-8	E-12	E-13	E-14	E-15	E-20
1	5	5	4	4	4	4	5	5	5	5	5	4
2	5	5	4	4	4	4	4	4	5	5	4	2
3	5	4	4	5	4	4	4	5	5	5	5	5
4	5	4	4	4	4	4	4	5	5	5	4	3
6	3	4	5	4	5	5	4	4	5	4	4	4
7	4	4	2	2	4	4	2	4	4	4	2	2
8	1	4	3	1	4	4	1	5	5	4	2	4
9	2	4	3	2	4	4	2	5	4	4	2	3
10	1	4	2	1	4	5	1	5	5	4	1	2
11	5	1	4	5	1	4	4	2	4	2	4	5
13	2	2	4	4	2	2	4	2	4	2	4	4
14	3	4	4	2	2	4	4	2	4	4	2	1
15	5	4	3	2	4	4	3	4	5	4	3	3
16	4	4	5	4	4	4	5	4	4	4	5	5
17	3	4	2	2	3	4	2	3	4	4	3	3
18	4	4	4	1	4	4	4	4	4	4	4	4
19	4	4	4	1	4	4	4	4	4	4	4	4
20	5	5	1	2	4	4	1	4	5	4	1	1
21	2	4	1	1	2	4	1	2	4	3	1	1
22	2	4	1	1	2	4	1	2	4	4	1	1
23	2	4	2	1	4	4	2	3	4	4	1	1
24	4	4	4	4	4	4	4	4	4	4	4	4
25	4	4	2	2	2	4	2	4	4	4	2	2
26	4	4	4	2	2	5	3	4	4	4	2	2
27	3	5	2	2	3	4	3	3	4	4	3	3
28	4	4	2	3	4	4	2	4	4	4	2	2
29	5	5	2	3	5	5	2	5	5	5	2	2
30	4	4	2	2	4	4	2	4	4	4	2	2