Vol-07 Issue 05, May-2023 ISSN: 2456-9348
Impact Factor: 6.736

iJETRM
International Journal of Engineering Technology Research & Management

BIKERS' RESILIENCY FRAMEWORK ON BIKE LANES IN DAVAO CITY: AN EXPLORATORY FACTOR ANALYSIS

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ABSTRACT

This study aimed to identify the factors contributing to bikers' resiliency in Davao City, as perceived by the bikers on the recently installed bike lanes in the city, and develop a framework based on these factors using the Exploratory Factor Analysis (EFA) statistical technique. With 150 respondents, the study was conducted in three locations in Davao City where bikers are commonly seen. The respondents are not limited to only those who only bike for recreation but even those who use bikes as transport means for errands. A modified questionnaire was used as a research instrument to gather data on this study. Five factors identified through the EFA contribute to the bikers' resiliency when using the bike lanes, including road safety, biker and bike condition, biking policies, emergency response, and safe biking practices.

Keywords: Bikers' Resiliency, Exploratory Factor Analysis, Bike Lanes

INTRODUCTION

The bicycle was the first mode of personal transportation accessible to the general public before the advent of the automobile. It was even regarded as "the great leveler" during the 19th century for improving access for all (Guroff, 2017). Its prominence later declined post World War II turning bicycling more into a recreational hobby than a mode of transportation. Even so, the bicycle has profoundly impacted our transportation system until today. The Netherlands, for instance, has proven successful in incorporating cycling as a significant component of its transportation system, as evidenced by having the highest share of bicycling globally. The Dutch transport system is composed of five underlying principles that make up their traffic system known as Sustainable Safety, and these are; (1) *functionality* which refers to the design of road infrastructures, (2) *predictability* which refers to the road user behavior, (3) *forgiveness* which refers to the design of the road environment that is more forgiving and less likely to cause injury to a road user in the event of a crash, (4) *homogeneity* which refers to the difference in speed, mass, and direction of road users, and lastly (5) *awareness* which refers to the assessment of a road user on his/her ability to drive. These principles are the foundation for creating a safer and healthier road environment (Bopp, Sims & Piatkowski, 2018).

The bicycle has a long history of staying in and out of trends. In the 1990s, bicycling had dramatically grown in the United States 60 years after it fell out of favor. This year served as the renaissance of bicycling, brought by the emergence of community-based advocacies that aimed to reduce reliance on automobiles. It has increased bicycle rates in the United States as well as the tension between bicyclists and other road users, particularly drivers. Currently, bicycling has once again risen to prominence worldwide as one of the alternative modes of transportation during the pandemic. The bicycling promotion also played a huge part in the country's economic activity as the land transport sector contracted tremendously over the past years. With its sudden surge in demand, our legislators and lawmakers must pay time and attention to reinforcing the policies that protect our cyclists.

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BACKGROUND INFORMATION

Similarly, amidst the onset of the Covid-19 Pandemic, the local government unit of Davao City has enacted a resolution known as EO 40 series of 2020, which is titled "An Order Providing for The Suspension of Bicycle Registration, Bicycle Registration Fees, And Allowing The Use of Bicycle Lanes In The City of Davao." The order, as mentioned above, pertains to the provisional cessation of the enforcement of two ordinances that aim to grant the citizens of Davao the privilege of utilizing the bike lanes without incurring any penalties for non-registration, among other violations, until such time that the two ordinances have been reconciled. The Department of Transportation of the Philippine Government recently launched a 54.74-kilometer network of bicycle lanes in Davao City on July 20, 2021. This initiative's primary objective is to ensure cyclists' safety during the ongoing pandemic. The Metro Davao Bike Lane Network, amounting to P145 million, was financed by Republic Act 11494, otherwise referred to as the Bayanihan to Recover as One Act of 2020. The bicycle lane network, which is a collaborative effort between the Department of Transportation (DOTr) and the Department of Public Works and Highways (DPWH), was finalized on June 30 of the previous year (Colina IV, 2021).

Figure 1: Davao City Bike Lanes

PURPOSE OF THE STUDY

The study was conducted to determine the factors contributing to the resiliency of bikers in Davao City and to develop a resiliency framework to represent these factors.

RESEARCH QUESTIONS

1. What are the dimensions of bikers' resiliency?
2. What framework can be developed based on the findings?

LITERATURE REVIEW

This literature review lists and discusses the major factors contributing to bikers' resiliency as road users.

Road Safety

Health hazards, motorist behavior, bikeways infrastructure, and vehicular or pedestrian crashes are the four variables that must be considered for road safety (Camba, Dimayuga, & Doroy, 2017). According to the Road Safety and Social Sustainability report published by the Asian Development Bank in 2016, accident rates in developing Asian nations are anticipated to be significantly higher than in developed nations. Consequently, roughly 60% of the 1.18 million fatalities and injuries caused by road accidents worldwide each year occur in Asia, and roughly half of those killed in road traffic accidents are pedestrians, cyclists, or users of motorized two-wheeled vehicles (ADB, 2016). Due to their small stature, pedal cyclists are among the most vulnerable road

users. Cyclists must adhere to all traffic regulations to increase their safety on the road. Many bicycle accidents can be avoided if cyclists wear the appropriate protective gear (Singapore Road Safety Council, 2016).

Adopting the Road Safety Code in Quezon City marks the initial occurrence of such an action in the Philippines. Quezon City, situated in Metro Manila, boasts the largest land area, and accommodates approximately 25% of the region's populace. Consequently, it is a significant contributor to the incidence of road accidents. Between 2010 and 2016, Quezon City exhibited the highest incidence of accidents, fatalities resulting from crashes, and injuries arising from crashes in the Metro Manila area, accounting for 33,717 out of 109,334 incidents. The city swiftly adopted a Road Safety Code in response to the concerning statistics. Various stakeholders, including public transport associations, car owners, biker and motorcyclist groups, and homeowners' associations, were involved in public hearings and consultations, as reported by Caleda, Villena, Paras, Munsayac, and Villatema (2018).

Inadequate data governance on road accidents remains one of the most significant obstacles to addressing road safety in the Philippines. Due to underreporting, the number of road traffic fatalities may be understated. Only 10% of road crashes are documented. For instance, the Philippines Department of Public Works and Highways reported 1,513 road traffic fatalities in 2013, which accounted for only 6.9% of the estimated 10,379 road traffic fatalities reported by WHO in the same year (Caleda et al., 2018).

Bikers' Health and Bike Condition

Good health enables us to live life to the fullest. The adage "Health is Wealth" refers to health as the most excellent form of wealth somebody may possess. When we are in good health, we can accomplish anything. Physical activity like biking can strengthen our bones and muscles and increase our ability to carry out daily tasks. As mountain biking becomes more popular as a recreational activity and a way of transportation, there has been a similar rise in injuries recorded. According to Ansari, Majid, Nourian, Ruhollah, Khodaee & Morteza (2017), bike fit is the process of making the cyclist and bicycle geometry compatible to minimize the risk of injury and improve performance at the same time. It is very important to consider the type of bicycle you will be using and its condition. Using appropriate gears, blinkers, and lights and regular bicycle maintenance checks are a must before biking on the road. Moreover, bike fitting is associated with increased odds of reporting a comfortable bike posture and the absence of pain while cycling (Quesada et al., 2018). Bike positions have an influence on the cyclist's perception of fatigue, pain, and comfort. A study conducted by Quesada et al. (2016) had cyclists undergo cycling tests wherein they biked in different positions, which were defined by the knee flexion angle and the trunk flexion angle. Results show that these two parameters influenced the comfort levels of the cyclists; greater knee flexion angles had a negative effect on trunk comfort and brought on greater levels of fatigue and pain in the thighs and knees, while an upright trunk position accompanied by the recommended knee angle was perceived as the most comfortable position. Thus, the position a cyclist possesses may lead to a greater or lesser onset of pain.

Biking Policies and Regulations

A policy is regarded as one of the most important factors for bicycle promotion, particularly now that bicycle demands have surged since the pandemic erupted, with more people turning to cycling to avoid COVID infection (Peña, 2020). As such, transportation planning efforts have been pushed to consider increasing the levels of walking and bicycling by providing footpaths and bicycle lanes. However, with the limited documentation and data relating to road bicycle accidents, many transport advocates have still called for more stringent policies to ensure cyclists' protection and safety (Bautista, 2022).

Until recently, bicycles were not given much thought (Peña, 2020). Cycling was difficult during the pre-pandemic period, according to Keisha Mayuga, an environmental planner and cycling advocate. Some bikers claim that law enforcement discriminated against them by prohibiting bicycles on certain bridges, flyovers, and national roads across the country (Villarete, 2019). When reviewing the current National Transport Policy, there is not much emphasis on meeting the needs of bicyclists in terms of safety or any other means that could at least promote and increase bicycle use in the country. Although the policy stated otherwise that infrastructure such as bike lanes would be built, this was never fully explored and fulfilled until the pandemic hit, when the continuing bikers' concerns were met with several initiatives from our lawmakers. According to DOTr, the government has already

built over 564 kilometers of bike lanes nationwide and plans to expand to another 234 kilometers across eight regions, constructing speed tables and bike bridges and developing a bike share system.

Despite these institutional efforts, many motor vehicles continue encroaching on the exclusive lanes designed for the bikers, necessitating the reformation of existing policies and regulations (Juangco, 2023). Salapantan (2022) argued that the rules and guidelines concerning bike lanes are inconsistent and unclear according to motorists, and this has remained a subject of debate among all motorists. On top of that, there are no specifications on the apprehensions for those who violate the use of lanes. The regulations are also not unified, as each LGU imposes different rules and regulations rather than formalizing a national set of rules. With this information, Juangco (2023) contended that the policy was never flawed; it simply required reinforcement and adequate public dissemination of information.

Biking Emergency Response

The World Health Organization reports an estimated annual global mortality rate of approximately 1.3 million individuals due to road traffic accidents, with 20 to 50 million individuals experiencing non-fatal injuries. Vulnerable road users, such as pedestrians, cyclists, motorcyclists, and passengers, comprise over 50% of all road traffic injuries and fatalities.

Despite the country's numerous emergency responses, where its focus is more on natural disasters, crimes, car accidents, terrorism, and among others, but failed to recognize the appalling response to bike incidents, particularly during the COVID-19 pandemic, when people shifted to bicycles as a mode of transportation to rid themselves of the infection or as a form of social distancing (Shinar, 2018). The pandemic opened a "window of opportunity" for hastening the adoption of sustainable transportation regulations (Gaspay, 2022).

Adhikari, (2022) emphasize that it is important to pay greater attention to laws and to improve rules for punishments in the event of infractions to increase bike safety. Bike riding is one of the most dangerous ways of transportation, and it requires extra care. When a bike rider possesses the relevant history and motive for the violation, the kind of road elements and ambient circumstances are irrelevant. To enhance road safety, particularly for bike riders, this implies that persons who have already committed traffic offenses may commit new ones. When they risk losing their license or face a serious hazard, they will commit fewer violations than the previous.

Another emphasis, according to Shinar, (2018), is the necessity of alternate data sources and the need to create new methods of collecting information on bicycle accidents. Crash categories such as "falling off the bike" are now included. Two-vehicle collisions are more often recorded than single-vehicle crashes (falling off a bike or colliding with a fixed object). These might be because there is no one to blame in a single bicycle mishap (other than the cyclist himself/herself), or there are no legal infractions.

Safe Biking Practices

The best responses for cyclists on the road must be understood. Before you ride in traffic, take the time to familiarize yourself with the rules of the road and gain riding experience, according to the Safe Riding - Bicycle Riders - Staying Safe - NSW Centre for Road Safety (2020). Although there is literature on bike safety that cover bike practices and safety, there have been more attempts to increase road safety overall by using a more evidence-based approach. One such initiative is the Highway Safety Manual (HSM), published in 2010 by the American Association of State Highway and Transportation Officials. The HSM outlines typical motor vehicle SPFs for popular road types. To aid future research in developing safe and reliable infrastructures as well as other potential factors that may have an impact on bicycle safety, (Nordback, 2014) underlines the need to incorporate bike safety performance functions (SPFs) in Highway Safety Manuals (HSM) and other manuals of a similar nature. Bicycle signal heads should be established in Marikina City as a substitute for the coordinated signal system that has to be constructed at the city's intersection locations, according to (Camba et al., 2017). Additionally, the Cycling Safety Study Final Report (2015) made several recommendations for improving cycling safety, including the following: 1) A better understanding of cycling safety hotspots and concerns; 2) Engineering treatments like

protected bicycle lanes, buffered bicycle lanes, colored conflict zone markings, and protected bicycle signal phases; and 3) Education and encouragement initiatives that will raise awareness among bicycle users, pedestrians, and motorists about how to avoid collisions with other road users.

METHODOLOGY

The study employed Exploratory Factor Analysis (EFA) with 150 biker respondents from three locations in Davao City: Toril, Talomo, and Coastal Road.

Data Collection Methods

The study used primary data from the respondents using the prepared survey questionnaires, and the respondents were given consent forms before accomplishing the questionnaires.

Data Analysis

Keiser Meyer-Olkin's measure of sampling adequacy was used to test the magnitude of partial correlations among the variables. The scree test was also used to determine the number of factors to be retained in a factor analysis.

RESULTS AND DISCUSSION

This section shows the analysis and interpretation of the gathered data.

KMO Test. The table below shows the Kaiser-Meyer-Olkin measure of sampling adequacy and Bertlett's Test of Sphericity. The KMO result of 0.750 implies an average correlation between variables in the study. As shown below, Bartlett's test of Sphericity of 1629 and a significant value of .000 allows it to proceed in factoring in the contributing factors to resiliency among bikers.

KMO and Bartlett's Test*		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.750
Bartlett's Test of Sphericity	Approx. Chi-Square	1629.334
	Df	435
	Sig.	.000

Scree Plot. Figure 2 shows the graphical explanation of the total variance and the Eigenvalues graph against all the factors. The Scree Plot shows the gradual trailing of the Eigenvalues and identifies the relatively fit of each component based on its relative importance. This illustration is very useful for determining which factors will be retained. The point of interest is where the curve flattens. The curve gets flatter as it reaches component number 5. Therefore, there are only five dimensions considered as structures retained.

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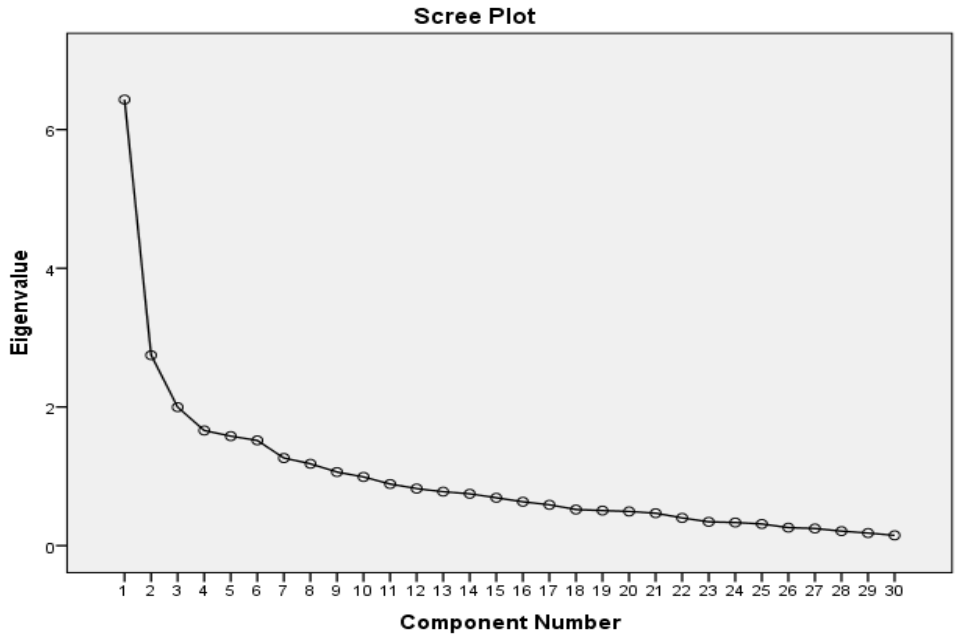

Figure 2: Graphical Explanation of Total Variance

ROTATED COMPONENT MATRIX

Table 1 shows the rotated component matrix with group attributes of road safety. There are five behavioral attributes of bikers under this factor. Bikers are often safety-conscious and self-cautious while driving, and they are more likely to: *avoid biking too close to other vehicles on the road* with loading of 0.832; *do tailgating but not too close to other bikes and vehicles* with loading of 0.796; *use moderate braking to avoid skidding* with the loading of 0.681; *avoid calling or texting when biking* with the loading of 0.658; and *refrain from eating and drinking when biking* with the loading of 0.635. To guarantee the safety of bikers using the bike lanes, section 5 of Davao City's EO 40 series of 2022 incorporated five essential safety standards. Furthermore, (Camba et al., 2017) argued that motorist behavior, bikeways infrastructure, and health hazard are essential factors and must always be present to ensure safety. The absence of one factor can make the roads unsafe for cyclists. The lack of efficient bikeways infrastructure causing accidents and other offenses to cyclists by motorists and other vehicle users is also critical in ensuring bikeways safety. Similarly, the presence of an efficient bikeways infrastructure that may cause more disciplined behavior among motorists and other vehicle users toward the proper use of lanes alone cannot ensure bikeways safety.

Table 1. Rotated Component Matrix with Group Attributes of Road Safety

Factor	Attributes	Loadings
Road Safety	Avoid biking too close to other vehicles on the road	0.832
	Tailgating not too close to other bikes and vehicles	0.796
	Using moderate braking to avoid skidding	0.681
	Avoiding calling or texting when biking	0.658
	Refraining from eating and drinking when biking	0.635

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Table 2 shows the rotated component matrix with group attributes of the biker's health and bike condition. These factors cover the bikers and the bicycle condition and preparation before bicycling. There are five behavioral attributes of bikers under this factor, and these are: *the biker is physically and mentally fit to ride* with loading of 0.694; *the biker is familiar with the terrain and topography of his/her biking destination* with a loading of 0.668; *the biker makes sure that the bike is in good condition* with the loading of 0.631; *the biker conducts regular maintenance with his/her bike* with the loading of 0.582; and *the biker is equipped with appropriate gears, blinkers and headlights* with the loading of 0.518. The wellness of the biker, having a good attitude, being fully equipped with appropriate safety gear, and being well-acquainted with the road and its surroundings would likely reduce bicycle-related accidents.

Table 2. Rotated Component Matrix with Group Attributes of Bikers' Health and Bike Condition

Factor	Attributes	Loadings
Bikers' Health and Bike Condition	Physically and mentally fit to ride	0.694
	Familiarized with the terrain or route when going biking	0.668
	Making sure that the bike is in good condition	0.631
	Bringing the bike to the repair shop to undergo regular maintenance	0.582
	Riding with appropriate gears, blinkers, and headlights	0.518

Table 3 shows the rotated component matrix with group attributes of biking policies and regulations. This factor covers the bikers' active participation in crafting policies promoting bicycle safety. There are three behavioral attributes of bikers under this factor, and these are: *the biker is willing to participate in the evaluation of the reliability of bike lanes* with a loading of 0.866; *the biker is willing to participate in the review of policy and regulations on bike lanes* with a loading of 0.815; and *the biker is willing to participate in safety training and seminars on biking* with a loading of 0.691. The provision and maintenance of biking infrastructures such as bike lanes is critical not only for bikers' resilience but also for its promotion, as evidenced by its loading, which received the highest score of any attribute. The bike lanes were the first thing that transport advocates have asked for support from the government during the early stage to alleviate the bicyclists' safety concerns about the country's deadly roads, which they frequently referred to as "death traps" (Bautista, 2022). On the other hand, while the installation of bike lanes has provided our bicyclists' their own safe space, several bicyclists and transportation groups believe that inconsistencies in the implementation of its policy and guidelines have harmed the entire process (Salapantan, 2022). The conduct of biking safety trainings is also thought to be an attribute that can add resiliency among bikers. These trainings should not only focus on existing traffic rules and safety but should also emphasize new policies and guidelines for using bicycle lanes. This is consistent with the argument of Juangco (2023) that the government is underinvesting in information and education in relation to the implementation of new policies in biking safety.

Table 3 Rotated Component Matrix with Group Attributes of Biking Policy and Regulations

Factor	Attributes	Loadings
Biking Policy and Regulations	Willing to participate in the conduct of an evaluation of the reliability of bike lanes	0.866
	Willing to participate in the review of policy and regulations on bike lanes by the authorities	0.815

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	Willing to participate in safety training and seminars on biking	0.691

Table 4 shows the rotated component matrix with group attributes of biking emergency response. It can be observed that biking emergency response is a huge factor in bikers' resiliency. This is because *imposing higher penalties for bike lane violators* with a loading score of 0.641 negates the behavioral attitude of bikers to commit any bike offense. These behaviors, including route choice, speed (Langford et al., 2015), and distracted biking practices ((Mwakalonge, 2014), are some glaring attitudes that have a significant impact on bike safety. While *reporting bike-related incidents to the proper authority* with a loading of 0.652 and *keeping an emergency contact number/hotline* with a loading of 0.624 are quick response measures intended for reporting purposes and for the medical aid responder's immediate care for the victim. The safety of the rider is the sole priority of these attributes. To have a positive control of incidence happening in the metro, it is imperative to create an emergency response team that will look at bicycle incidents just like a normal emergency response intended for crimes, terrorism, and unnecessary happenings. Davao City has its City Transportation and Traffic Management Office (CTTMO) and City Disaster and Risk Reduction Management Office (CDRRMO) in addition to its Davao City 911 emergency response few of the possible agencies to cater to such issues.

Table 4. Rotated Component Matrix with Group Attributes of Biking Emergency Response

Factor	Attributes	Loadings
Biking Emergency Response	Reporting bike-related incidents to the proper authority	0.652
	In favor of the imposition of higher penalties for violators of bike lane regulations in the City	0.641
	Keeping an emergency contact number/hotline	0.624

Table 5 shows the rotated component matrix with group attributes of safe biking practices. This factor covers some of the best practices of bikers in promoting bicycle safety. There are three behavioral attributes of bikers under this factor, and these are: *administering first aid when the incident happened, particularly with co-bikers* with a loading of 0.779; *using hand signals when biking* with a loading of 0.707; and *cautioning fellow bikers who do not follow safe biking practices* with a loading score of 0.514. Bikers must comprehend and implement safe biking protocols to guarantee their safety while biking on urban highways, such as Davao City, as highlighted by Camba et al. (2017). It is essential for individuals who engage in biking activities to recognize the importance of being prepared for any unforeseen circumstances that may arise while on the road. Attaining a comprehensive understanding of road safety protocols, including using manual signals and alerting fellow cyclists who may contravene traffic laws or other measures about bicycle safety as highlighted by the NSW Centre for Road Safety (2020).

Table 5. Rotated Component Matrix with Group Attributes of Safe Biking Practices

Factor	Attributes	Loadings
Safe Biking Practices	Administering first aid when the incident happened, particularly with co-bikers	0.779
	Using hand signals when biking	0.707
	Caution, fellow bikers who do not follow safe biking practices	0.514

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STUDY FRAMEWORK

Figure 3 shows the developed framework based on the findings of the study. The researchers identified that the contributing factors to bikers' resiliency based on the bikers' perception are road safety, bikers' health and bike condition, biking policy and regulations, biking emergency response, and safe biking practices.

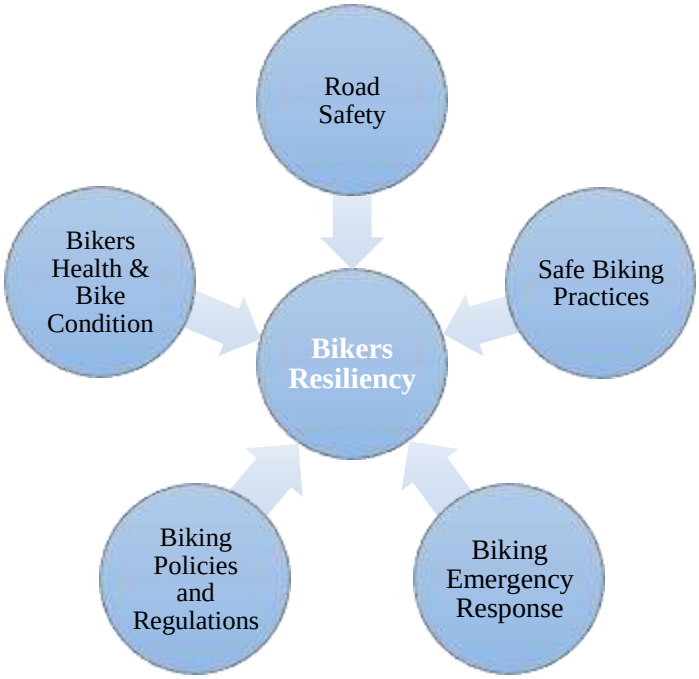

Figure 3: Bikers' Resiliency Framework

CONCLUSION AND RECOMMENDATION

The study identified five factors contributing to bikers' resiliency in Davao City, as perceived by the bikers. The factors include road safety, the health of bikers and the conditions of their bikes, policies and regulations on biking, emergency response for bikers, and the implementation of safe biking practices. The researchers recommend that the local government of Davao should implement a system for monitoring and reporting emergencies related to biking. It is also recommended that the City Transportation and Traffic Management Office (CTTMO) be officially designated as the primary entity responsible for monitoring, recording, and assessing all bicycle-related occurrences in Davao City in collaboration with the Davao City Police Office and the City Disaster and Risk Reduction Management Office (CDRRMO). Furthermore, it is recommended that bikers utilizing the bike lanes within urban areas must be apprised of safety protocols and associated consequences through social media. Encouragement shall be given for training and lectures on bike safety standards and policies. Finally, it is imperative to assess the execution of Davao City's EO 40 series of 2020. This evaluation is necessary to determine the policy's efficacy and propose appropriate guidelines based on the evaluation's findings.

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