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A REVIEW OF ROAD TRAFFIC HAZARD AND RISK ANALYSIS ASSESSMENT

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Abstract:

Few studies have stressed on the interrelating between the categories which will show the level of road risk and hazard more efficiently. The relatively of risk were interrelating with the road hazard. Therefore, the objective of this paper is to identify the direction of study of road traffic hazard and risk analysis throughout the year 1977 to 2020. Review works of literature were identified through multiple sources from transport planning and transport engineering database available in open access journals with a focus on keywords of 'road risk analysis and hazard' and road risk assessment. The review showed that while previous research focused on qualitative and quantitative risk analysis in order to get risk rate accuracy was less accurate. The risk analysis and hazard taken a few changes it has been improvised a few times in order to get more accurate risk rate and data which will help to improve road safety.

Keywords:

Road Traffic Hazard, Road Traffic Risk, Assessment

Introduction

Background of The Review

The death and injury incidence of road accidents is a public health issue in the world. One million people are estimated annually losing their lives in road accidents and about 10 million

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are physically disabled (Murray, C & Lopez, 1997). Estimates that are reported by the World Health Organization (WHO, 1999) road traffic accidents as the 10th leading cause of mortality and implications in all WHO member states. The death and injury from road accidents is estimated that it will raise to third in ranking in the world, after chronic depression and heart disease, and in second, after clinical depression. (Seymour, 1996). Every accident cost lives, material assets and growth of low and medium – income economies.

In transportation planning, a traffic conflict is an event involving two or more moving vehicles approaching each other in a traffic flow in such a way that a traffic collision would ensue unless at least one of the vehicles performs an emergency maneuver. (Mohan, 2002) road traffic accident is the leading cause of death by injury and the tenth-leading cause of all deaths globally which now make up a surprisingly significant portion of the worldwide burden of ill-health. Exposure to potential road traffic injury has increased largely because of rapid motorization, coupled with poor road conditions, rapid population growth, lack of safety features in cars, crowded roads, poor road maintenance, and lack of police enforcement (Population Reference Bureau, 2006).

Predicting and reducing traffic accident have been outlined for a long time as one of the main tasks of freeway safety research. A safe approach is now advocated by many developed countries, a concept of road safety that recognizes that people make mistakes but should not die from crashes. While road enhancement is simply a part of road safety programs, both parties are responsible for reducing road accidents and mitigating injury incidence from road crashes. To fulfil the enormous obligation to keep the road clear, no party should be singled out.

Risk assessment is important for the study of road safety quality. Previously the road safety outcome was directly on identifying such influence at intersections where the infrastructure were more diverse. According to Werneke & Vollrath, 2012, they concluded that poor infrastructure planning near intersections would lead to serious vehicle collisions. Furthermore, cross analysis between the driver's vision pressure and psychological stress confirmed the importance of proper road should width and access management. In addition, the speed adaptation behaviour of the drivers has been shown to vary with the different road infrastructures and the conditions of traffic complexity. Complex data on infrastructure would have a significant effect on regular spend adjustment behaviour.

According to statistic data from WHO, the number of road crashes death rate in the world increased by 1.7% per year. A total of 1,252,811 of road crashes death rate were recorded in 2016. The numbers of increment are 29,339 which resulting a total of 1,282,150 of road crashes death rate recorded in 2019.(Figure 1)

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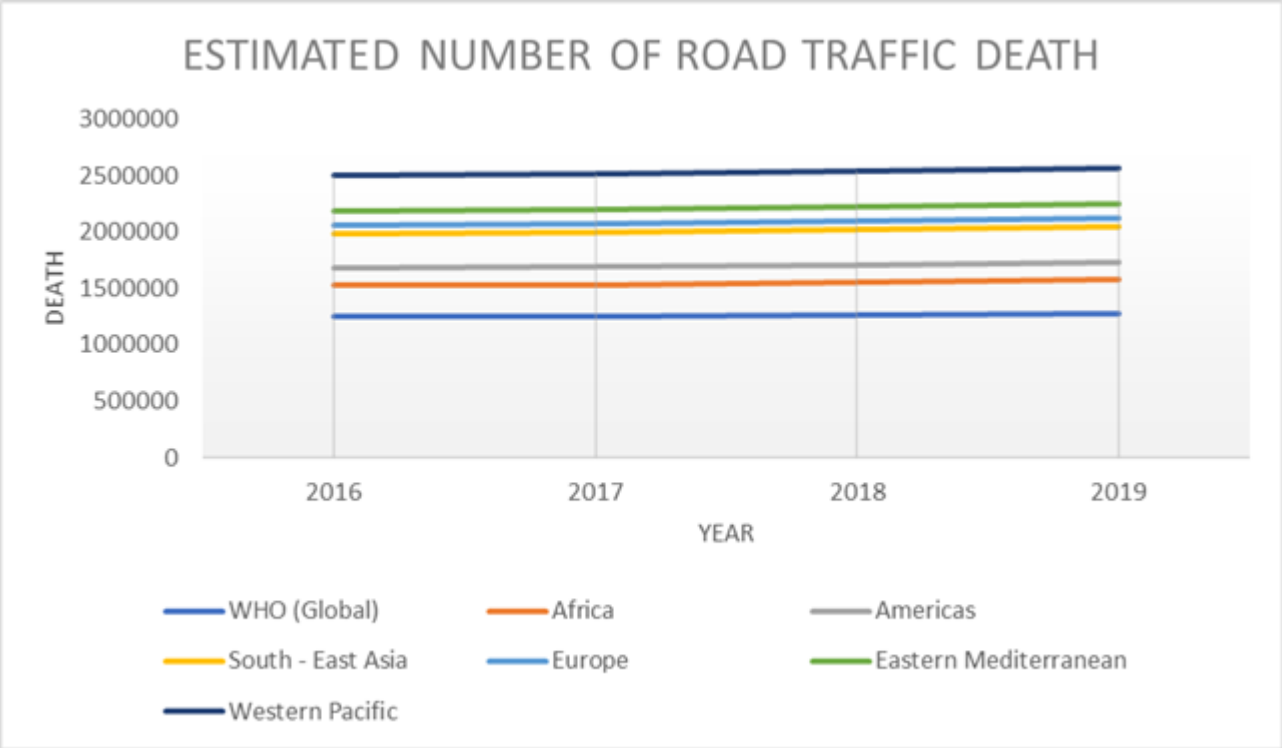

Figure 1: Estimated Number of Road Traffic Death

In order to reduce traffic conflicts, an effective assessment of traffic risks should be carried out in order to ensure that possibility of road risk to be avoided and that the road traffic can be operated effectively at an acceptable level of safety. As far as safety engineering output is concerned, risk is widely known as safety measures. Risk is therefore often used to describe the level of safety in transport systems (Koziol & Gromek, 2017). The basic approach to road risk assessment highlights the relationship between the expected number of accidents and the exposure. Most conventional theories are also based on diverse sets of hazard determinants. The lack of practical strategies for posing traffic risks can be clearly identified across a wide spectrum. Losing our family's lives because of road crashes is an experience that anybody ever would want to live with when we know it can be prevented. The need for reliable road networks and security is very critical and for this reason, effort to improve the convenience and protection of road users are growing rapidly.

Major Causes of Road Traffic Accidents

In the cause of significant road crashes, environmental conditions and stress play an important role. The deaths and the severity of injuries are determined by more relevant factors such as vehicle age, preventive procedures, human error and accident time and location.

In most vehicle collisions, human mistakes appear to be the main cause. The operator or human cause assessment has become a key factor of the analyses of accidents. Investigation of the human factor of the transport system is critical for the issues of road safety. Driver capabilities and the road situation are other accident considerations. Stress because of economic or family troubles is often caused by human negligence. Such a mental state causes injuries on the road.

Journal of Tourism, Hospitality and Environment Management
JTHEM
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In our world, carelessness is one of the leading causes of traffic accidents. Using a cell phone while driving a car, disregarding red traffic signals, and emerging from a side road into the direction of another vehicle are only a few examples. Most of the reasons is that accident incidence increases with crash speed, and the more serious but preventable injuries are caused by a lack of head protection.

Inexperienced drivers, underqualified drivers, and a lack of understanding of traffic signals all contribute to a rise in the rate of road traffic fatalities.

Another significant factor contributing to the unprecedented rise in the number of road fatalities is driving while intoxicated. When drivers are under the influence of alcohol or other intoxicating agents, they lose self-awareness and control of their vehicles, which leads to crashes.

Another of the causes is a lack of sensitivity and accountability on the part of state authorities. State authorities' social mindset and existence feelings lead them to investigate incidents on the highways, such as traffic light malfunctions, which can lead to collisions if not adequately managed.

What is Hazard Analysis?

The hazard is defined as a threat or risk as well as a possible source of danger under the Oxford Dictionary. There are different dangerous situations in our daily life, and a dangerous road situation is one of them. Perception of hazards is an ability to see danger and risk in the situation. The understanding of one's danger varies according to education and experience. To prevent a possible accident, how road users view risks on the road are important. Hazard Perception Test (HPP) is not included in the national driving licensing system. Theoretically, but not technically throughout the lesson, Hazard is taught during driving training session. The new drivers can therefore not have ample exposure dangerous driving condition. In other word a hazard is any source of potential damage, harm or adverse effect on something or someone. The contributing factor or threat to a transportation system is physical factor, environmental factor and driver behaviour factor.

What is Risk Analysis?

Risk analysis consider the probability of an accident and its effects, where an occurrence will occur from a minor road crash to a major road crash that's include a loss of life. For example, a transport risk assessment will determine the lifelines in a given area that could be impacted by a landslide. The failure of a lifeline to a flood, or the reduction of its services, will have differing effects based on the nature of the lifeline, its role in the process, and the consequences of and accident will occur for the area. According to Kaplan & Garrick (1981), risk analysis can be seen as the method of enumerating all value within the spatial and temporal context. The likelihood of a situation varies inversely with its implications; which are expressed in the definition of a hazard curve. In Kaplan and Garrick's framework. One scenario, for example, could be an intoxicated driver speeding up on a wet road at night, while another could be an earthquake that caused a landslide which will be a risk for the drivers.

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In other word, risk is the chance of probability that a person will be harmed or experience an adverse effect if exposed to a hazard. In transportation system risk is the combination of the likelihood of the occurrence of a harm and the severity of that harm.

Method

This review covers literature published between 1977 and 2020 containing studies that are focusing on road risk assessment. There are four methods in choosing the article that is using searching, screening, filtering and organize & reporting.

The earliest method in choosing the right article are using the searching method which finding article/journal in Google Scholars, ResearchGate, Scopus and Science Direct with the keyword of "road risk assessment", and "road hazard". After all the articles were found, the next method is screening which any duplicate title and abstract will be removed and after that the result will be identify if it fulfil the inclusion criteria.

The next step will be filtering and after that it will arranged by related subtopic and year. While the result will be using PRISMA (Preferred Reporting Items for systematic Reviews and Meta – Analyses) Guidelines for this review paper process. Table 1 will show the process of the method for this review paper.

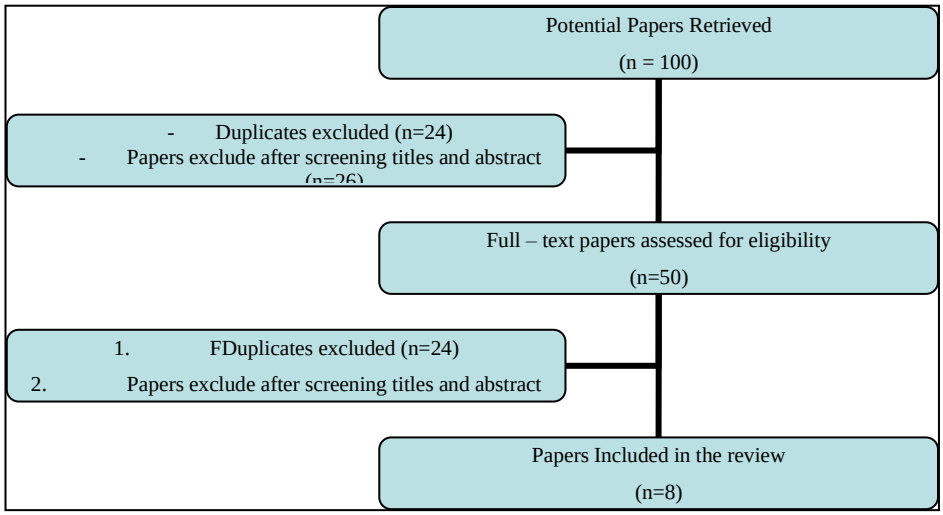

Table 1: Flow Diagram of Literature Screening

Main Result

Studies on Various Road Safety Models

Risk analysis methods are frequently used in studies to determine the danger that may occur in any system in advance and if this danger occurs, to be affected with the least damage from the result. In order to minimise material and moral harm caused by collisions, it is very critical that places of risk of accidents in urban transport networks be identified. There are two basic techniques of risk analysis. There are both qualitative and quantitative approaches. These are qualitative. In order to quantify risk the quantitative risk analysis uses analytical methods. Numerical values such as the likelihood of hazard and impact of the danger are given in

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qualitative risk analysis and these values are processed using statistical and rational techniques and the importance of risks is identified.

The designation of risk maps by means of risk analysis approaches in these regions should be carried out in order to recognise hazardous regions as regards risk in urban transportation networks and to take the appropriate precautions. In the study, one of the risk assessment techniques used was the risk index system for the determination of risky parts of roads. This method was developed by Taylor and Thompson (1977) based on both accident data and non-accident data. The problem areas of injury risk are measured by the establishment of a hazard index with this approach.

Ward et al. (1987) developed an intersection hazard index in order to draw danger maps from traffic data collected from the West Virginia area. It was determined that regression models built for estimating injury rates are not statistically meaningful. The key benefit of the established hazard index is that it can be measured from injury reports. Details on the accident type and site may also be provided with the indices received. Data from traffic accidents were collected in their analysis by Gitelman and Hakert (1997) by artificial techniques. In order to measure accident data, the hazard index was created. Based on such features, the data collection is split into sections and the accuracy of the model was checked. Taking into account local circumstances, the evolved model makes the accurate assessment. The model is then specified to assess areas of injury risk.

Kwok-Suen et al. (2002) also developed a traffic accident forecast and accident probability prediction algorithm. The algorithm developed consists of a mixture of the geographical and mathematical approaches (GIS). Based on the findings, the risk analysis conducted with the built algorithm was found to be more effective than the risk estimate based only on accident data. Aarts and Schagen (2006) studied driving speed and traffic crash chance. In the analysis, mathematical relations between speed and accident rate were discovered, which can be expressed with various functions. Furthermore, the rise in speed on secondary roads in urban transport systems has been more important than the increase in the rate of accidents on main roads, which are more intense in terms of the volumes. Action was undertaken in Lassarre et al. (2007) to identify the danger of pedestrian traffic visibility. Pedestrian behavior were first and foremost modelled and risk exposure was identified using traffic length, density, lane speeds and turning motions information for each crossing point. As a result of the crossing time and the traffic level the risk posed while crossing is determined. In order to calculate the probability of collision in crossing pedestrians, the hazard index value was also calculated.

G A Hindle et al., (2011) stated the rates of personal injury collision (PIC) on the roads of English local authorities have been registered over the past decade. The rate of change differed significantly between the urban and rural dimensions, and it was highly dependent on PIC risk thresholds. The accident scenario of sites under continuos camera monitoring and its effect on injuries were the subject of the research.

Dinesh Mohan (2011) had shown that data on road crashes were unreliable in a few developed countries, but good data structures exist in a few developing countries. This research looked at the state of road safety in 178 countries. The information gathered from national governments in a structured survey form was used to propose road safety strategies and policies. It was also

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shown that there is no connection between a country's income level and individual road user fatality rates.

From the study on various safety models, coefficients of employed variables like traffic flow, lane width, etc and various maintenance strategies for preventing accidents can be estimated. The model studies are useful in determining factors causing accidents and traffic accident distributions as preventive measures can be devised suitably. Model studies on evaluation of driver's situation and performance can help in identifying preventive measures to avoid rider based accidents. Studies on use of camera surveillance to monitor predicted accident spots showed the efficiency of its usage in preventing accidents.

As shown in the Table 2, many studies were focus only one of the category either on the risk from the environment, the statistic of accident or on the behaviour of driver. Moreover, many studies were conducted in developed countris. Thus, studies on the road risk and hazard assessment in developing countries should be conducted because the real issues are not known yet. According to (Cai, Wang, Chen, & Lu, 2016), several research have shown that risk perceptions could be influenced by driver age, gender, driving experience and accident history. However, the procedure of risk assessment in the study did not analyze effect of these factors on driving risk on rainy days. Instead, these factors were considered to be non – observable variables and assumed to fit the logistic distribution in the ordered legit model

No	Author	Literature Topic	Country	Concern and finding	Lack on/Limitation	Indicator/ Parameter being Measure
1	(Zheng, et al., 2018)	A Novel Framework for Road Traffic Risk Assessment with HMM-Based Prediction Model	Beijing, China (Developed Cities)	Road traffic risk formulation on kinetic energy of moving car using Hidden Markov Model.	- Focus on the motion of vehicle -Ignore the traffic environment (Pedestrian, cyclist, lane line and barrier) -Ignore the effect from weather -Ignore the peak hour of traffic	- Vehicle Velocity - Type of vehicle - Predictive trajectory
2	(Cova & Conger, 2004)	Transportation Hazard	North America	Transportation hazard analysis, vulnerable analysis and risk	-Ignore other road user such as cyclist, other vehicle and pedestrian.	- Avalanches - Earthquake - Floods and Dam Breaks

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			(Developed Cities)	analysis using quantitative risk assessment.	- Ignore the peak hour of traffic - Ignore the behavior of driver	- Fog, Dust, smoke, sunlight and darkness
3	(Ismail, et al., 2018)	A Study Of Road Hazards faced By Malaysian School Children Using Hirarc	Malaysia (Developing Country)	- Data were collected according to the HIRARC (Hazard Identification, Risk Assessment and Risk Control) - Risk and safety of student and school	- Ignore the probability of weather effect - Ignore the probability of risk on highway lane	- Zebra Crossing - Main Road - Pedestrian Bridges - Peak Hour - Waiting area or bus stop - Road Sign
4	(Osafune, et al., 2015)	Analysis of Accidents Risk from Driving Behaviors	Japan (Developed Country)	Assessment of Driving Behavior which are divided by safe driver and risky driver that are using smartphones	- Ignore the effect of weather - Ignore the road conditions	- Type of driver • Safe Driver • Risky Driver
5	(Zhang C. , Yan, Ma, & An, 2014)	Crash Prediction and Risk Evaluation Based on Traffic Analysis Zones	North America (Developed Country)	Using Traffic Analysis Zones to estimate significant factors for the unsafe zones.	- Ignore the effect of weather - Ignore the behavior of driver - Ignore other road user (Pedestrian, other vehicle and cyclist) - Ignore the traffic environment (road Safety)	- Total Number of crashes - Total Number of Fatal and injury Crashes - Total Crash Exposure Rate - Injury/Fatality Crash Exposure rate

Journal of Tourism, Hospitality and Environment Management
JTHEM
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6	(Conca, Ridella, & Sapori, 2016)	A risk assessment for road transportation of dangerous goods: a routing solution	Europe (Developed Country)	Using road accident frequency assessment which is a combination of LoS and Risk.	- Ignore the behavior of driver - Ignore the Traffic Peak Hour - Ignore the risk cause by other road user (Cyclist, Pedestrian and other vehicle)	- Weather Condition - Number of Road Accident - Number of Death Injured - Number of Death Injured
7	(Hamid, et al., 2017)	Autonomous emergency braking system with potential field risk assessment for frontal collision mitigation	Malaysia (Developing Country)	Evaluate the risk using combination of AEB (Autonomous Emergency Braking System) and PF (Potential Field Assessment	- Evaluation are within controlled variable which may differ from real life situation.	- Distance of Vehicles - Time - Vehicle speed
8	(Ozan, Baskan, Haldenbilen, & Erhan, 2010)	Analysis of Traffic Accidents Using Hazard Index Method: Case of Denizli	Turkey (Developed Country)	Assessing the traffic risk using Hazard Index Method	- Ignore other road user - Ignore the behavior of driver	- Number of accident per Year - Accident Rate - Accident Severity - Trend in Accident Number - Wet – Dry Ratio - Night – Day Ratio

Table 2: Previous Studies On Hazard and Road Risk Assessment

Journal of Tourism, Hospitality and Environment Management
JTHEM
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No	Author	Countries		Categories / Focus of Studies			
		Developed	Developing	Environment	Crash Rate	Infrastructure	Behavior
1	(Zheng, et al., 2018)	✓				✓	
2	(Cova & Conger, 2004)	✓		✓			
3	(Ismail, et al., 2018)		✓			✓	
4	(Osafune, et al., 2015)	✓					✓
5	(Zhang C. , Yan, Ma, & An, 2014)	✓			✓		
6	(Conca, Ridella, & Sapori, 2016)	✓		✓			
7	(Hamid, et al., 2017)		✓				✓
8	(Ozan, Baskan, Haldenbilen, & Erhan, 2010)	✓			✓		

Table 3: Focus of Previous Studies

As table 3 shown the previous study focus on their categories of studies on traffic hazard and risk analysis. The previous study shown that most of the studies conducted at a developed country and less on developing country which the type and level of infrastructure provided are different from each other. Besides that, most of the studies were conducted on only one variable of categories which effect the traffic hazard and risk analysis. However, there have been less study on the interrelating between the categories which will show the level of road risk and hazard more efficiently.

Road Traffic Accident Studies in Various Countries

Thuso Mphela (2005) has compiled and written a report on the effect of traffic law enforcement on road crash deaths in Botswana. Multiple regression analysis was used in this report to determine the effect of traffic law enforcement on deaths in Botswana, using secondary data and interview data gathered from law enforcement officers. According to the findings, registered drivers between the ages of 30 and 45 had the lowest fatality rate.

Hossain et al., (2005) reported on the situation of road traffic accidents in Khulna, Bangladesh. Data on traffic injuries was collected over a two-year period from various police stations in the region. 157 traffic collisions occurred during the reporting period, with 25% of the fatalities were between the ages of 30 with 39, and 33% of pedestrians losing their lives and 34% being injured. According to Omar and Ashawesh (2008), traffic crashes will rise to third position in the table of major causes of death and injury by 2020.

Atubi (2010) conducted a monthly study of road traffic accidents using secondary source data. This research proposed prevention and corrective safety steps to reduce road traffic fatalities.

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Over the last three decades, Nigeria has seen a troubling increase in road traffic accidents. A person's chances of dying are slim to none. When compared to the United Kingdom, the risk of being killed in Nigeria is 47 times higher.

Seth Daniel Oduro (2012) discussed brake failure and its effect on road traffic accidents in Ghana's Kumasi Metropolis. This thesis used a survey research design that focused on questionnaires to collect data for interpretation and debate. Brake loss is caused by low or insufficient brake fluid, according to 40% of car owners, and brake overheating is caused by 33% of respondents. The motor vehicle that plys the highways, gross indiscipline on our roads, overloading, and tired driving are all major contributors to road injuries.

Conclusion

This paper summarises the findings of a number of field studies on road traffic accidents conducted in different countries. This literature review aids researchers in gaining a high-level understanding of the impact of road traffic collisions and the safety precautions that can be taken to prevent them. The scientific data and other relevant statistics relating to the road accident occurrence and the steps to avoid road traffic injuries addressed in various studies were presented. Accidents are the result of numerous human, automobile, and environmental factors interacting in a complex manner to produce the initiation of the crash, according to a multifaceted analysis of different literatures. Human error and driver negligence are not the only factors that contribute to traffic accidents. Road traffic accidents must be seen as a problem that requires immediate action in order to reduce the health, social, and economic consequences.

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