REPORT OF RESEARCH RESULTS

Title: Decision Making Model of Stakeholders at a Traffic Junction to Improve Pedestrian Safety Crossing Road

Primary Researcher:
Lieutenant Dr.Tongkarn Kaewchalermtong, Chulachomklao Royal Military Academy

Co-researcher(s):
Major Dr. Thai Chankol, Chulachomklao Royal Military Academy

Summary:
Approximately 1.24 million people who die in road traffic crashes every year are pedestrians, motorcyclists, and cyclists. The pedestrian' deaths are significantly one fourth on the road traffic crashed results. Most of research and technology progresses have been paid attention towards protecting driver and passengers in the car. Unfortunately, these road users, especially pedestrians, are facing the vulnerability of death, injury and disability at a traffic junction. The need of reduction or elimination of pedestrian from deaths and injuries in a traffic environment is important. There are basically three involving stakeholders: drivers, traffic controller officer and pedestrians for pedestrian safety. This purpose of this research is to study decision behaviours of these stakeholders when people crossing a traffic junction. Understanding the results is able to develop safety environment system.

Multiple criteria decision analysis (MCDA) that considers multiple criteria in decision making road traffic environment is used to develop a model. Stakeholders decision model are integrated. The model analysis and results to understand behaviours of stakeholders to implement an effective road and pedestrian safety, as well as allow the policy maker, performing allocation resources, to protect pedestrians from accidents.

A traffic junction at Bangkok downtown is utilized to demonstrate the technique: Sathorn road and RAMA 4 junction. The results are presented that the marked pedestrian crossings with traffic lights or signal controlled crossing are the safest solutions. The highest weight assigned to the criterion of the driving speed, traffic volume/intensity, length of the pedestrian crossing or road width of vehicle drivers, traffic controller officers and pedestrians respectively.

Aim of Research
This research is aimed to develop an integrated decision making model of pedestrians, drivers and traffic control officers. The model results will present a way to improve the safety of pedestrian crossing junction.

Method of Research & Progression

Traffic environments are complex. The most vulnerable and high-risk aspects points in the traffic network are pedestrian crossings. Enabling pedestrians to safely cross the road are needed. The safety level depends on the age, type, physical ability and perception of personal safety of pedestrian crossing. The differences between individual types of pedestrian crossings can be noted also in relation to other criteria such as the price, energy, environmental impact, accessibility, etc. Besides, various groups of users assess the quality service differently, even when this refers to the same type of pedestrian crossing. Therefore, optimal solution of a pedestrian crossing has to be selected based on a comprehensive and rational analysis and application of adequate software tools.

The selection methodology of a pedestrian crossing safety is defined and developed into a model using a multiple criteria decision analysis (MCDA). The Analytical Hierarchy Process, AHP which synthesizes the aspects of different opinions and studies the unique common result is used in this research. AHP is a priority method applicable to problems that can represented by a hierarchical structure. The top of hierarchy is the goal, one level lower are criteria and there is the possibility of having more levels for sub-criteria. The lowest level is represented by alternatives. The methodology of integrating the stakeholders' decision-making process for pedestrian crossing safety has been proposed in five steps: 1.Problem identification, 2.Defining the alternatives, 3.Defining the alternative evaluation criteria, 4.Evaluation of criteria, and 5.Selection of alternatives.

Stakeholders decision model are integrated. The model analysis and results to understand behaviours of stakeholders to implement an effective road and pedestrian safety, as well as allow the policy maker, performing allocation resources, to protect pedestrians from accidents. According to decision-making is a set of activities that starts with the identification of the problem and ends with the selection of an alternative or a decision.

This study is specified and limited the alternatives of pedestrian crossings to four types.

PC1 – marked pedestrian crossings or zebra crossing without traffic lights,

PC2 – marked pedestrian crossings or signal controlled crossing with traffic lights,

PC3 – unmarked pedestrian crossings,

All the mentioned types of pedestrian crossings/passages generally represent alternatives and are designated by codes PC1 to PC3. The knowledge of advantages and drawbacks of every alternative is necessary for the selection and classification of criteria as well as pondering of the selected criteria.

The pedestrian safety defines and selects of the criteria that will affect the efficiency of the made decisions is a complex and sensitive task, due to the need to consider the problem and all the key parameters integrally. For the selection of the pedestrian crossing i.e. precise ranking of the alternatives, adequate numbers of criteria have been introduced, that were classified into four main groups.

C1-Criterion: Driving speed;

C2-Criterion: Traffic volume/intensity;

C3-Criterion: Length of the pedestrian crossing or road width.

Pedestrian Safety Goal

Pedestrian safety is a condition in which a person can normally perform their functions i.e. normally cross a pedestrian crossing, with the process not being disturbed nor degraded due to various threats and dangers.

The estimate of risk is a procedure of evaluating the probability of events that represent possible danger and threat to persons crossing the road. As possible dangers, the driving speed, traffic volume/intensity and the road width have been analysed.

C1-Criterion: Driving speed. When motorists drive at high speeds along the roads, the pedestrian cannot properly estimate the moment at which the vehicle will reach the pedestrian crossing i.e. the point of intersection between the paths of the vehicle and the pedestrian, and the motorist is not able to stop the vehicle on time. The greater the difference in the speed between the pedestrian and the vehicle, the greater is the danger for the pedestrian. The percentages of fatalities among the pedestrians is exponentially proportion to driving speeds

C2-Criterion: Traffic volume/intensity. If the traffic intensity often results in situations in which the time gap between the approaches of two succeeding vehicles is shorter than the time required crossing the road, the method of stopping the vehicle has to be applied in order to perform the crossing. At these places the pedestrian crossing – zebra is usually constructed. If traffic is of higher intensity resulting in even scarcer occurrences of suitable intervals to cross the road, the pedestrians lose patience and recklessly step onto the roadway. The consequences of such actions may be catastrophic and in such situations zebra crossings do not usually match the needs and signalized crossing needs to be constructed. Should traffic lights cause very long queues of vehicles and pedestrian waiting time exceed the limit of patient waiting (30 seconds) then the pedestrian crossings are grade-separated, i.e. the problem is solved by constructing overpasses or underpasses, i.e. separating the pedestrians and vehicles into different levels.

C3-Criterion: Length of the pedestrian crossing or road width. The length of the pedestrian crossing is in multiple correlations with traffic safety. The crossing time using a longer pedestrian crossing means longer stay of the pedestrian on the roadway and higher risk of getting injured. On a multi-lane road the vehicles moving along the right kerb often obscure the view of vehicles that move along the farther lane. This phenomenon is especially noted in cases when small children want to cross the street and the motorists fail to notice them on time. This leads to accidents even when the pedestrians cross the street in a regular manner, and the motorists drive carefully. This problem is especially emphasized in the vicinity of schools.

Multi-criteria decision-making allows optimization according to several criteria thus improving the quality of the decision-making process. The process represents the optimization of the function of objective on a set of possible solutions, and these solutions are evaluated, compared and ranked by the decision-maker.

AHP is a multi-criteria technique of breaking down a complex problem into a hierarchy, with the objectives being at the top, and the criteria and alternatives at lower levels. The hierarchy created in such a way represents the initial decision-making model, followed by the top-down evaluation of the hierarchy elements. The usage of AHP allows the decision-makers to set the priorities and make decisions in case when it is necessary to take into consideration also the quantitative and qualitative characteristics (non-comparable units of measures).

The process of criteria evaluation has been developed by comparing the criteria pairs according to three scenarios. Scenario 1 represents the proposal of a group of twenty vehicle drivers; scenario 2 is the proposal of ten traffic controller officers, scenario 3 has been proposed by twenty pedestrians with respondent ages of 25-35 and working in Sathorn road and RAMA 4 area.

All the criteria are not equally important, and relative importance of the criteria results from the preferences of the decision-maker which is related to their system of values. Based on the aggregate grades of a group, pairwise comparison matrices are obtained. The matrices of aggregate grades of pairwise comparisons are input into the software tools.

Results of Research

The process of alternatives evaluation has been performed by comparing the pairs of criteria which are assigned a combined grade of the stakeholder group, according to all four scenarios. The higher the grade assigned to a criterion, the higher its influence on the final grade. The method of assigning values to single criteria results in a general model for the selection of the optimal pedestrian crossing. Depending on the studied group of stakeholders such as drivers, traffic controller officer and pedestrians, it is possible to adapt the model so that some criteria are highlighted, that are essential to individual type of the user, and to leave out those that are not of importance in selecting the pedestrian crossing. The results of scenario 1 obtained according to the evaluation of a group of drivers and the performance sensitivity according to the simulation model using the software tools “Oracle Crystal Ball”. This group gives priority, with very small advantage, to the marked pedestrian crossings with traffic lights or signal controlled crossing and the highest pondered value is given to the driving speed. Regarding pedestrian safety, the marked pedestrian crossings with traffic lights or signal controlled crossing are the safest solutions. The results of scenario 2 selected the pedestrian crossing from the traffic controller officers’ aspect and the performance sensitivity. The traffic controller officers find the marked pedestrian crossings with traffic lights or signal controlled crossing the best solution and unmarked pedestrian crossings the worst solution. The criterion of traffic volume/intensity is assigned the highest weight. The finally results of scenario 3 selected the pedestrian crossing from the pedestrians’ aspect and the performance sensitivity. The pedestrians find the marked pedestrian crossings with traffic lights or signal controlled crossing the best solution and unmarked pedestrian crossings the worst solution. The criterion of Length of the pedestrian crossing or road width is assigned the highest weight.

Moreover, the results showed that pedestrians tend to make a decision not to cross a road at zebra crossing at traffic light and non-traffic light, when motor vehicles moving at high speed and distance between vehicles. But pedestrians have potentially cross a road, when vehicles moving at medium to low speed. However, it depends up on each person to take a risk, and/or in the situation that there are gather of group of people at sidewalk. The results of this research problem recommend for implementation to decision-makers and leaders in Thailand leading government and nongovernmental agencies and policies to guide the national road traffic safety effort, who providing overall policy support on road safety, transport and land-use planning. The allocation of financial and human resources to the problem, and implement specific actions to prevent road traffic crashes, minimize injuries and their consequences, and evaluate the impact of these actions.

Future Areas to Take Note of, and Going Forward

For the future research suggestion, different pedestrian types such as disable and aging people, and children can be adopted into a model. Future technology applications, for example Intelligent Transport Systems (ITS), might be implementing in a traffic network system.

Means of Official Announcement of Research Results

The research results are preceded to the 10th International and National Conference on Engineering Education (INCEE-12) on May 2014, and Chulachomklao Royal Military Academy Conference on November 2013.