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Best practice analysis of action for road safety in Iran amongst the leading developing countries using an optimized success indicator

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ABSTRACT

This study evaluates Iran amongst emerging societies which can be considered as development benchmarks specifically in the field of road safety. The five pillars of road safety development were analyzed within three main layers of the road safety management system consisting of institutional management functions, interventions, and results. The main objective of this study is to introduce a ranking criterion that explains the success in each road safety pillar using the concepts of the *managing by result* and also to identify best practices within a set of developing countries, focusing on the archived results for Iran. A virtual performance indicator shown by 'S' was defined as the success score of each pillar in the decade of action for each country to achieve the targets of decreasing road fatalities. This virtual indicator as well as two other indicator classes (intervention outputs and final outcomes) go into an optimization problem using Data Envelopment Analysis (DEA) approach. It is concluded that the S value shows the quality weight of the actions taken in countries and could be a suitable numeric indicator for benchmarking the best practices. The success of Iran in advancing the interventions in two pillars of safer roads and mobility (safer infrastructure) and safer road users (enhanced enforcement) has been higher than the other activities. The actions needed to be taken in Iran include the development of vehicle safety, the structure of road safety management, and post-crash response in order of preference. This country requires to follow best practices in Turkey and Romania which were identified as benchmark countries for Iran. The target value for the fatality rate per 100,000 population in Iran was earned 12.6.

1. Introduction

In 2010 a United Nations' General Assembly resolution proclaimed 2011–2020 the Decade of Action for road safety, with a global goal of stabilizing and then reducing the forecasted level of global road fatalities by increasing activities conducted at national, regional and global levels (United Nations, n.d.). Amongst multiple objectives of this global plan, one can denote developing and implementing sustainable road safety strategies and programs, setting an ambitious yet feasible target for reduction of road fatalities, and monitoring progress and performance on predefined indicators. The importance of achieving the goals is well explicated in the second five-year plan of the decade known as the *Time for Result* (Second Global High-Level Conference on Road Safety, 2015). Performing a successful road safety benchmarking practice is by no means easy. Challenges exist from the definition of benchmarking framework at the very beginning to the final decisions in terms of identification of best practices and establishment of a continuous process of mutual learning (Shen et al., 2015a,b).

Accepting the global objectives, this study tries to outline a rational framework based on a mathematical model to achieve corresponding goals at the national level in Iran amongst a set of leading developing countries. This study evaluates Iran amongst emerging societies which can be considered as development benchmarks specifically in the field of road safety. To this end, we attempted to carry out this study in observance of global recommendations including the Global Plan for the Decade of Action for Road Safety (United Nations, n.d.) and also the concepts of *managing for results* in road safety management system (Bliss and Breen, 2013). Accordingly, the five pillars of road safety development including road safety management, safer roads and mobility, safer vehicles, safer road users, and post-crash response can be analyzed within three main layers of the road safety management system consisting of institutional management functions, interventions, and results (see Table 1). Having introduced the five pillars, road safety performance indicators (RSPIs) were employed to explain results in three layers of intervention outputs, intermediate outcomes, and final outcomes. These indicators are usually defined individually or compositely for specific types of interventions, risk factors and risk indices (e.g. fatality rate) but no composite indicator have ever been employed which could have

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Table 1
Illustrating the five pillars and the other variables in the context of the road safety management system.

three main layers in SMS	Contents of the Safety Management System			Pillars and data adjusted to this study
Results	Social Cost			Not considered
	Final Outcomes			y (WHO estimated road traffic fatality rate per 100,000 population)
	Intermediate Outcomes			S (the success score)
	Intervention Outputs			x (intervention value)
Interventions	Planning, design, operation and use	Entry and exit of vehicles and road users	Recovery and rehabilitation of crash victims	Pillars 2, 3, 4, and 5 (Safer Roads, Safer Users, Safer Vehicles, Post-Crash Response)
Institutional Management Functions	Coordination/legislation/Funding and Resource Allocation/Promotion/Monitoring and Evaluation			Pillar 1 (Road Safety Management)

indicate the status of each pillar quantitatively. Possessing such a composite indicator, as well as determining the success value of countries in implementing the five road safety pillars, the actions contributing to that success can be identified as best practices. This success indicator can be calculated for each country compared to a set of other countries. In this regard, Iran as the main case of this study was compared with a set of developing countries which are adjacently upper than Iran's position in terms of human development indices and road safety condition. Thus, the main objective of this study is to introduce a ranking criterion that explains the success in each road safety pillar using the concepts of the *managing by result* and also to identify best practices within a set of developing countries, focusing on the achieved results for Iran. Following such an analysis, we can also obtain further considerable results such as setting a strategic quantitative target in country specific reduction of road traffic fatalities.

2. Literature review

Best practice analysis has been a major concern of road safety practitioners so as to find benchmarks which could actually lead actions to gain the highest efficiency achievements. Data Envelopment Analysis (DEA) with thirty years of scholarly literature (Emrouznejad et al., 2008; and Cook and Seiford, 2009) is the main method which could have best played the major role in such analyses. Undesirable effects of road crashes have been an issue of concern in recent years as undesirable output variables in DEA (e.g. Hermans et al., 2009; Ahmadvand et al., 2011; and Behnood et al., 2014). A better understanding of road safety performance at local territorial level was discussed by Eksler (2010) by application of Full Bayes spatiotemporal model on local road risk data. As a means to identify traffic safety best practice, Odeck (2006) used DEA to investigate target achievements of the operational units of the Norwegian Public Roads Administration (NPRA) charged with traffic safety services. Using accident rates as surrogates of safety performance measures, the DEA can be deployed to endogenously construct non-linearly arranged set of best practice countries when the weight of each safety performance measure is endogenously determined based on optimization techniques (Vaziri, 2010). Accordingly, The DEA delineates the best practice frontiers and realistic target values. In 2011, Shen et al. (2011) enhanced the DEA model into a generalized multiple layer analysis to further embody multilayer hierarchical structures of inputs and outputs defined in the road safety management system. A master study in European Union called road safety data collection, transfer, and analysis (DaCoTA) aimed at building a composed Road Safety Index (RSI) in which indicators describing the road safety outcome or output of a country are combined into one figure (Bax et al., 2012). In the context of best practice analysis, the index facilitates easy comparisons between countries to inspire them to increase their efforts and improve road safety in their country. Concurrently, Shen et al. (2012) adopted the categorical DEA road safety model after clustering the countries with inherent similarity in their practices so as to identify best-performing and underperforming countries in each cluster as well as practical yet challenging target for each underperforming country. The research team used the DEA-based Malmquist productivity index (DEA-MI) to measure the extent to which the EU countries have improved their road safety performance over the period 2001–2010 (Shen et al., 2013). In another study (Shen et al., 2015a) they investigated the possibility of including the number of serious injuries in addition to the number of fatalities for road safety benchmarking and to further illuminate its impact on the countries' rankings. They showed that most of the countries achieved a higher risk score when the number of serious injuries was included, which implied that compared to the road fatalities, more policy attention has to be paid to improve the situation of serious injuries in most countries. Some changes in ranking list was also indicated by Sadeghi and Moghaddam (2016) using the DEA with uncertainty assessment. The DEA approach was developed in United States by Egilmez and McAvoy (2013) who used Malmquist index model to assess the relative efficiency and productivity of US states in decreasing the number of road fatalities. Alper et al. (2015) estimated the relative efficiency of 197 local municipalities in traffic safety during 2004–2009, using DEA. They used inputs reflecting the resources allocated to the local municipalities (such as funding), outputs include measures that reflect reductions in accidents (such as accidents per population), and intermediate variables known as safety performance indicators (SPI): measures that are theoretically linked to crash and injury reductions (such as use of safety belts). Behnood et al. (2017) presented a model to evaluate the efficiency related to the measures annually implemented throughout 30 provinces of Iran by introducing an inefficiency index defined as the proportion of weighted sum of road fatality risk indices to the weighted sum of road intervention indicators. They developed a fuzzy decision support system to cross-cut the route to make policies in the context of qualitative decisions. In a recent study, Rosić et al. (2017) used efficiencies (composite indexes) obtained by different models, based on DEA and TOPSIS, to present PROMETHEE-RS model for selection of optimal method for composite index.

3. Materials and methods

This study used the data developed by the Global Status Report on Road Second Global High-Level Conference on Road Safety, 2015 (World Health Organization, 2015) and converted them to the indicators to be applied in road safety performance evaluation and monitoring in a variety of developing countries. In the other words, the data used as road safety performance indicators for intervention outputs and final outcomes were linked to each other. This linkage was defined for all five road safety pillars in the global plan for the decade of action and can find the action share of each pillar by simultaneously analyzing final outcomes (i.e. road fatality rates). In this study, a score was belonged to each road safety pillar in each country which indicates the amount of success for progressing the pillar specific actions. The information adoptable from the Global Status Report on Road Second Global High-Level Conference on Road Safety, 2015 (World Health Organization, 2015) and to be used in this study is briefly shown in Table 2. As discussed by Bliss and Breen (2013), institutional management functions are founded to achieve results by implementing interventions. The results include intervention outputs (e.g. the indicator for regular road safety inspection) in the initial level and final outcomes (e.g. road fatality rate) in the final