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The Aggregation of Road Star Ratings for Urban Areas

Road Safety has been considered a serious issue and research have been conducted to search for a sustainable solution and control this problem. Road design element is a major contributing factor especially in low-medium income countries. Road authorities have demonstrated that the crash severity and probability depends mainly on roadway designs (Ossenbruggen et al 2001; NRSS, 2010; Mcinerney and Smith, 2010). For example, wide lanes or poor quality roadsides can significantly increase the crash severity and likelihood (Mcinerney and Smith, 2010). Therefore, improving the geometric design elements of highways and establishing modern safety control devices have been considered in the new models of road and traffic safety (Zaloshnja and Miller, 2009). Road and highway experts have designed and present new road designs and modern traffic control system in terms of forgiving roads. This road system considers the interaction of road users' factor with road design factor and helps road users to be familiar with road infrastructure use (Zaloshnja and Miller, 2009). It also considers the needs of road users by providing new infrastructures or new controlling system (NRSS, 2010). For example, if footpaths are provided in locations where a high pedestrian number using the alongside of a road or raising platform at junctions where the cross a road, the severity of pedestrian accident will be less by about third (International Road Federation, 2008). Some road safety models have been developed to assess the level of road safety for the existing and new roads, and to improve the safety level. Some of these models have based on forgiving roads concept. These models have contribute in not only controlling traffic risk problem, but also solving the data availability problem which is the reason behind lacking of road safety studies in low-medium income countries (Mcinerney and Smith, 2010). The international Road Assessment Programme (iRAP) is one of these agencies that have developing a programme of safety assessment which can be used in low-medium countries basing on the road attributes to avoid the lacking of traffic causalities data (iRAP, 2015).

iRAP is supported financially by some government and private organisations and activated in about 70 countries including developed and developing countries. Its main aim is providing safer transport system in all the worlds. The objectives of this programme are quantifying the

level of risk in terms of star rating and developing a safer roads investment plan by suggesting infrastructure improvement based on diagnosing high risk locations (Mcinerney and Smith, 2010; iRAP, 2015b) and conduct economically studies which low- and middle-income countries have lacked. In addition, iRAP provides training courses and technology support for national and international road safety agencies (iRAP,2015a; Rogers and Bin Hashim, 2011; Rogers et al, 2012 and Turner et al, 2009).

iRAP star rating is an “*objective measure*” of road safety level which is classified into five levels. Five to four stars represent the safest conditions produced from well-designed roads that represent the elements of forgiving roads, such as “*grade separated intersections, good quality safety barrier, paved shoulders*”, while one to two stars are the worst safe conditions generated from poor roads elements, such as: undivided pavement, high operational and design speed, poor and inadequate delineation, and frequent curves and intersections (Rogers and Bin Hashim, 2011; iRAP, 2015b). Each level of safety is identified with different colour which is shown in Table (1) (Rogers et al, 2012; iRAP, 2015b)..

Table 1 iRAP Star Rating Levels and Colours (iRAP, 2015a & b)

Star Rating bands and colours

Star Rating	Star Rating Score		
	Vehicle occupants and motorcyclists	Pedestrians	Bicyclists
5	0 to < 2.5	0 to < 5	0 to < 5
4	2.5 to < 5	5 to < 15	5 to < 10
3	5 to < 12.5	15 to < 40	10 to < 30
2	12.5 to < 22.5	40 to < 100	30 to < 60
1	22.5 +	100 +	60+

The star ratings are identified basing on road protected score (RPS), as it is shown in Table 1, which is a term used to aggregate the factors of accident severity with their likelihood. These factors represent the road attributes which are its geometric design elements affecting the severity and likelihood of traffic accidents (EuroRAP, 2011; iRAP, 2015b), as well as traffic flow, speed, and pavement surface condition (Rogers and Bin Hashim, 2011; iRAP, 2015b). Depending on these scores, an investment plan can be developed for safer road and study the effect of countermeasures (EuroRAP, 2011). More information about RPS and Star Ratings is available in iRAP (2015a).

Appendices A shows the data required to compute RPS according to crash type, road user type, and the likelihood and severity of crashes.

The iRAP safer roads investment plan can be designed considering three points which are: the existing roads design elements; the estimated severe accidents and application of countermeasures correction that contributes to reducing the number of fatalities then cost saving resulted from it. Countermeasures correction can be generated using iRAP countermeasure generation module which is developed by combination of iRAP star rating with the existing road characteristics and traffic flow. This model can produce a series of treatments for each countermeasure and highlight the sections where these treatments can be applied (McInerney and Smith, 2010).

However, the outputs of iRAP are four star ratings each one considered an individual road user type. These types are the main users of transport system; they are vehicle-occupant, motorcyclists, pedestrians, and bicyclists (iRAP, 2015b). This point leads to suggesting the topic of this research and developing the main aim which is the aggregating the iRAP star ratings for urban roads.

The Main Aim of the Research

This research aims to develop an aggregated star rating to quantify the overall level of roads' risk. The reason behind this topic is that more than one type of road users are likely involved in urban road's accidents, therefore it is required to consider the interaction of all road users in the subsequent investment plan. In addition, it is required to simplify the design of investment plan and generating the most effective countermeasures which depends on the star ratings producing from running iRAP. This should significantly increase the applicability of the iRAP models for strategic decision making and planning.