

Implementation of Road Safety Audits Case Study: Sana'a, Yemen

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Road Safety Audit (RSA) is important concepts that has been used around the world, but seemingly unimportant and may be are not implemented in Yemen. The aim of this article is to show How the RSA implementation will has a positive effect provide reduce risk safety road, cost and improve environment situation in Yemen, compared to roads designed and constructed doesn't guarantee safety of traffic. This study using RSA tools techniques in the Seventy Square Road (Sana'a City, Yemen).Data collection research with cooperation Ministry of Transportation and Traffic Department (supported by Yemeni Experts). A result of this study, the accident rate has been reduced approximately to 50% (24) of the total number of accidents for the year 2019, were 48 accidents. Also, reduced cost about 7,742,043 Riyal which equal 12,000USA.

Key words: *Road safety audit (RSA), Report World Health Organization (WHO), Saving Cost, Equation Cronbach's alpha, and Checklist of (RSA).*

Introduction

Daily thousands of people die, hundreds of thousands injure, and enormous amount of resources lose in road crash worldwide. Developing countries account for the overwhelming part of these losses. Yemen lies in the highest share of the road crash burden highest per capita rate of road fatalities according to world health organization global status report on road safety, 2015. Therefore; we have to keep in our consideration to apply the Road Safety Audit (RSA) for the risk of preventing accidents. In that case; constructing the road will be fully completed (World Health Organization, 2015).

Definition of Road Safety Audit (Rsa)

A formal examination of a future road or traffic project or an existing road, in which an independent, qualified team reports on the project's crash potential and safety performance (World Health Organization, 2018).

Safety audit is a procedure for enhancing the safety of existing and new roads which were introduced in the late 1980's, Great Britain. The RSA ideas were at first developed and introduced in the United Kingdom (UK), 1989. The advantages of such systematic checking were soon recognized around the world and many countries have since established their own similar systems. The most active countries have been Australia, Denmark, New Zealand, UK and many other developed countries are moving toward adopting such safety checking procedures. Several developing countries including Fiji Islands, Malaysia, Singapore, Thailand, and Vietnam have introduced the RSA into their road planning and design procedures (AUSTROADS , 1994).

The RSA ideas are increasingly being chosen and they are beginning to have an impact in avoiding the development of dangerous road networks.

The road safety audit is carried out by examining a new road or road improvement project to detect faults or features that may contribute to accidents through data located in the traffic or field landing to find out the reasons. Road safety audit may be applied on all stages of road projects including planning, design, construction, operation, and maintenance phases. They are applied to small and large projects and are used on rural and urban roads. World's Developed Countries use and apply road safety audit to improve road safety and preserve the lives of people. Yemen's road network lacks the proper and necessary safety measure that leads to road accidents and fatalities. Although; The Department of Transport in Yemen has considerable knowledge of road safety measures. That related to increase rate of road accidents. The construction of roads in Yemen usually follows the construction of buildings in an effort from the government to widen road network. Those buildings no plans were found to account for the urban development and increase of population.

Objective

The main objective of this article is to identify main causes of risk accidents and fatalities in roads Sana'a – City roads (Yemen) general. Therefore; Choose roads particular for applying RSA to minimize the number of accidents, injuries and saving cost. The following summarizes main objectives of this studying:

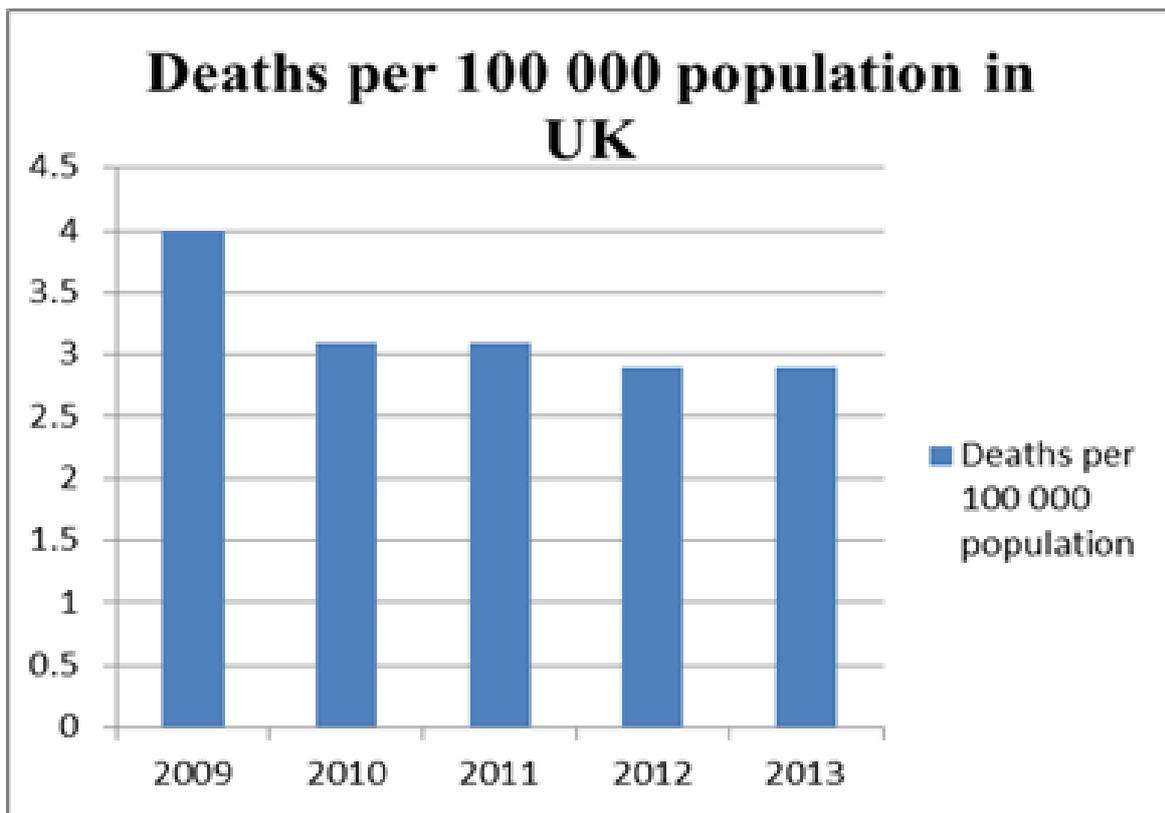
- 1-Study the causes of road traffic accidents in Sana'a City, Yemen.
- 2-Selecting and developing of suitable road safety audit procedures Applying to road network.

- 3- Study the expected cost saving due to safety improvements.
- 4- Implementing international standards for road safety which improve pedestrian safety within urban communities.

Practice & Benefits of Road Safety Audit (Rsa): ExampI

In the Surrey County Council, In the United Kingdom(UK), where they benefited a lot from the implementation of the process of RSA where 19 projects were studied for highways and also were studied 19 projects for highways where the application of RSA there was a big difference found that the implementation of the RSA decreased The number of accidents and fatalities Although the frequency of accidents and deaths in annual audited sites has decreased by 1.25 per year (an average decrease from 2.08 to 0.83 per year) The project, which was not audited, decreased the frequency of annual accidents of deaths and injuries to 0.26 per year (an average decline from 2.6 to 2.34 per year). (Ref; Austroad Book 1994).

Figure 1. Death per 100,000 populations (WHO, 2015).



A table monitored in the following by World Health Organization and by country, 2018 (Asian Development Bank, 2003).

Table-1. Total deaths in some countries (WHO, 2018).

Country	Deaths, total		Deaths/100K
	Estimated by the WHO	Reported by country	Estimated by the WHO
UK	2,019	1,804	3.1
Australia	1,351	1,296	5.6
New Zealand	364	327	7.8
Denmark	227	211	4
USA	39,888	35,092	12.4
Qatar	239	178	9.3
Egypt	9,287	8,211	9.7
Saudi Arabia	9,311	9,031	28.8
Jordan	2,306	750	24.4

Note;

In 2013 Death per 100,000 populations 10.2 in Yemen, according to the (WHO, 2015).
The last five years no reports sourced from WHO. Because; There is a war situation.

Method

After what have been previous studies of the importance application Road Safety Audits. The topic was presented to experts in Yemen and admired it. Because; That importance for Yemen suffers from safety problems in the roads. Similar factors as Joshua Reid Jones were used with some changes of factors based on the opinion of Yemen experts (Ref; Traffic Accidents, By; General. Abdullah Ali Al-Nowirh, 2001 & Building and Construction Engineering, By; Dr. Salah Ali Al-Saheqi, 2011) and what the Yemen environment need. Six factors were used as based on expert's opinion as follow:

1. Sight Distance.
2. Signs and markings.
3. Intersections.
4. Pavement Conditions.
5. Pedestrian.
6. Spot Speed.

After setting those six factors, a questionnaire from was prepared to be evaluated by experts, in order to weigh those factors and know the risk of those factors. Also, it will be confirmed whether the evaluation is correct or is there a problem in the evaluation through an equation Cronbach's alpha. Can be written as a function of the number of test items and the average inter-correlation among the items. Below, for conceptual purposes, show the formula for the Cronbach's alpha: is the most widely used method for estimating internal consistency reliability. It is most commonly used when you have multiple Liker questions in a survey/questionnaire that form a scale and you wish to determine if the scale is reliable (Cronbach's Alpha Formula , The Annual Book , 2018 , The Annual Book , 2019 , Traffic Accidents, 2001 , Building and Construction Engineering, 2011)

Cronbach's Alpha Formula:-

$$\alpha = \frac{N \cdot \bar{c}}{\bar{v} + (N - 1) \cdot \bar{c}}$$

Where:

- N = the number of items.
- \bar{c} = average covariance between item-pairs.
- \bar{v} = average variance.

Seventy Square in Sana'a city, Yemen was selected to apply that method.

Seventy Square contains two directions one of them has 12 lanes, other one 7 lanes and total width 70m.

Figure 2. Seventy Square.



Figure 3. Number of accidents for Study Area (2017-2019, Traffic Department, 2019)[8,9].

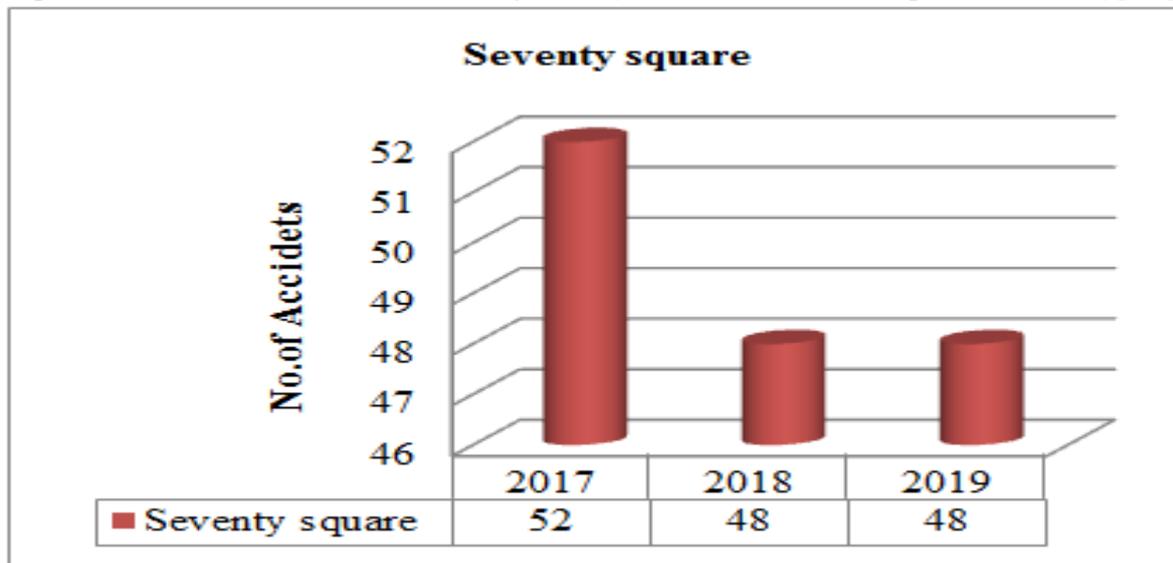


Table 2: Implementing of road safety audit (RSA) for Seventy Square.

The detailed items for road safety audit on the existing roads ✓ -Acceptable X -Unacceptable (leave a comment) O -Not pasture	Seventy Square		(Comment)
	Daytime	Night day	
	✓	day	
	X	✓	
	O	X	
		O	
Intersection			Seventy Square
Is the presence of all intersection clear to all road users?	✓	✓	
Is the sight distance suitable for all movements and all road users?	✓	✓	
Was it provided the suitable sight distance for the vehicle to enter and exit from it?	✓	✓	
Is there an enough deviation at the rounds?	X	X	U-Turn is dangerous
Is the deviation of the tracks is clear for drivers?	✓	✓	
Are the temporary obstacles still be impeding the basic vision (parked vehicle...etc.)	✓	✓	
Are the street lights enough?	—	O	
Is there an enough warning for the intersections?	X	X	They aren't enough
Are the marking road clear and enough?	O	O	
Does the sewerage disposal active?	✓	✓	

Signs and Marking			
Have the signs been installed. According to the appropriate instructions?	X	X	They aren't
Are every signs clear and organized?	O	O	
Are there an enough numbers of the head signs on the intersections?	X	X	They aren't
Are the head signs clear from the other items trees, and obstacles?	✓	✓	
Are the signs Invisible for other entries?	X	X	Invisible
Can the pedestrians pass safely?	X	X	They are no signs
Are the pedestrians clearly visible from items, and trees and other obstacles?	✓	✓	
Is it easy to see signs at night?	—	X	No lights
Are the warning boards clearly visible, and the dimension of it is enough from the dinger zoon, to get arrived on time?	X	X	No lights and they aren't enough
Are the sings clearly visible?	X	X	They aren't
Can the signs be quickly to understand, if seen?	✓	✓	
Pedestrians			
Is there enough separation distance between the movement of vehicles and the sidewalk on the line?	✓	✓	
Are there an enough numbers of the sidewalks, along the way?	X	X	They are no bridge for pedestrians
Are the shows of the sidewalk is enough?			
Is the sidewalk clear from the items road, and signs?	✓	✓	
Is the crossing point clear from the service inspection hood rooms?	✓	✓	
Are the street lights enough for the movements of the pedestrians?	O	O	
General			
Dose the road surface have a suitable and competitive specifications, and it's free from the cracks and potholes?	X	X	Pavement condition not good
Are the lanes industrial bumps visible and clear at night?	—	X	No lights
Can maintenance be done safely?	✓	✓	

Are the sight distances or sidewalks free from trees, and other obstacles?	✓	✓	
Is the road free from the lighting- breaking features, such as (trees and bridges)?	✓	✓	
Is the speed suitable for roads?	○	○	

Comments of the study Seventy Square

- 1- Design of the U-Turn is not conform to international specifications in the traffic and no warning signs.
- 2- Signs and Marking are not enough on seventy square and not clear.
- 3- No bridge for pedestrians on seventy square.
- 4- There are lights night, But not provided.
- 5- Pavement condition not good. Reasons; There are many potholes, cracking, patching and rutting.
- 6- There isn't any traffic calming procedures used.

Table-3. Report of Road Safety Audit (RSA) for Seventy Square.

Factors	Safety Problems	Percentage	Suggestions
Sight Distance	Noun	0%	Noun
Signs and Marking	<ul style="list-style-type: none"> - There are no riding and warning signs. - The lanes are not being so clear. - Lights are not provided. 	18%	<ul style="list-style-type: none"> - They should do riding and warning signs. - The lanes should be painted for being so clear. - The lights should be provided, so the vision can be clear.
Intersections	<ul style="list-style-type: none"> - The presence of the U-Turn in the middle of the road Is unsafe and not comprehensible for the standards 	10%	<ul style="list-style-type: none"> - The U-Turn in the middle of the road, must be editing for being safe and comprehensible for the standards. - They most have to put clear signs and markings, for the driver to see.
Pavement Condition	<ul style="list-style-type: none"> - There are many potholes, cracking, patching and rutting. - There are unsafe 	24%	<ul style="list-style-type: none"> - They have to treat the pavement condition. - putting obstacles in the middle of the street, safe and comprehensible for the standards.

	obstacles in the middle of the street.		
Pedestrian	<ul style="list-style-type: none"> - There are no tunnels no bridges. - The sidewalk is not painted. - There are no warnings signs & markings for the pedestrian. 	15%	<ul style="list-style-type: none"> - They have to put tunnels and bridges. - The sidewalk should be painted. - They have to put warnings signs & markings for the pedestrian.
Spot Speed	<ul style="list-style-type: none"> - There aren't an industrial bumps or any guideline. - There are no warning signs & markings for speed. 	33%	<ul style="list-style-type: none"> - They have to put an industrial bumps or guideline, for slowing down the driver's speed. - It will be much better if they divided the seventy's square.

Results of Road Safety Audit (Rsa)

The applied of the RSA in the study areas which illustrate safety problems and percentage of the risk. Through that; Put many suggestions and notes for reduce risk were implemented. However; Total accidents in 2019 were 48 accidents, so it reduced into 50%. The suggestions and notes are mentioned previously on the commons of the table (3).

Figure 4. Result of RSA for Seventy Square.

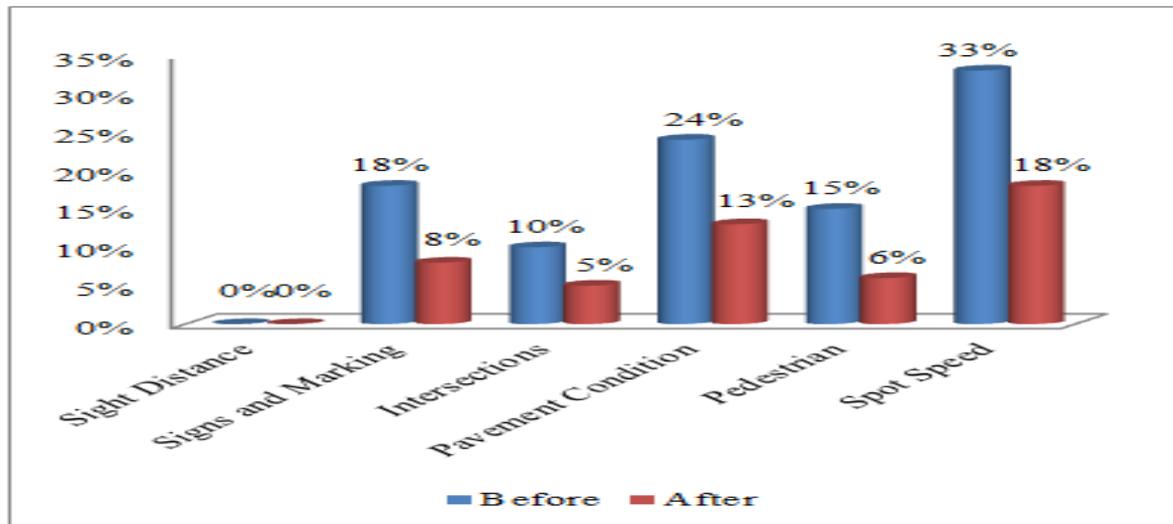


Table-4. Saving Cost for Seventy Square.

Factors	Average Reduction	Weight	Damages Cost (Riyal)	Saving Cost (Riyal)
Sight Distance	0%	21%	26,151,750	0
Signs and Marking	50.04%	12%		1,570,360
Intersections	45.46%	20%		2,377,717
Pavement Condition	53.92%	17%		2,397,174
Pedestrian	51.90%	13%		1,764,459
Spot Speed	46.65%	17%		2,029,507
Total Saving Cost				7,742,043

The table above shows damages cost on Seventy Square using RSA. Also showing saving cost about 30% from total damage. Approximately 12,000USA.

Conclusion

The research are study some effects factors on Yemen's roads. These factors are (sight distance, signs & marking, intersection, pavement condition, pedestrian and spot speed). These factors were studied on the most common areas of accidents inside Sana'a-City, Yemen. According to the collected information from (Traffic Department- 2019). The checklist of RSA was performed for these areas, to knowing the safety problems and the risk percentage for every factor during to the experienced of Yemen. Some suggestions and solution was performed for knowing the average reduction. The results show all of the factors use potential risk reductions after the safety suggestions were made. The factors with the most reduction should be improved and maintenance, (sight distance, pavement condition, pedestrian and sign & marking). There are some cost damages and high cost due to these accidents on Sana'a – City roads. The RSA was implementing for these research saving costs, protect the environment and reduce the air pollution.



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