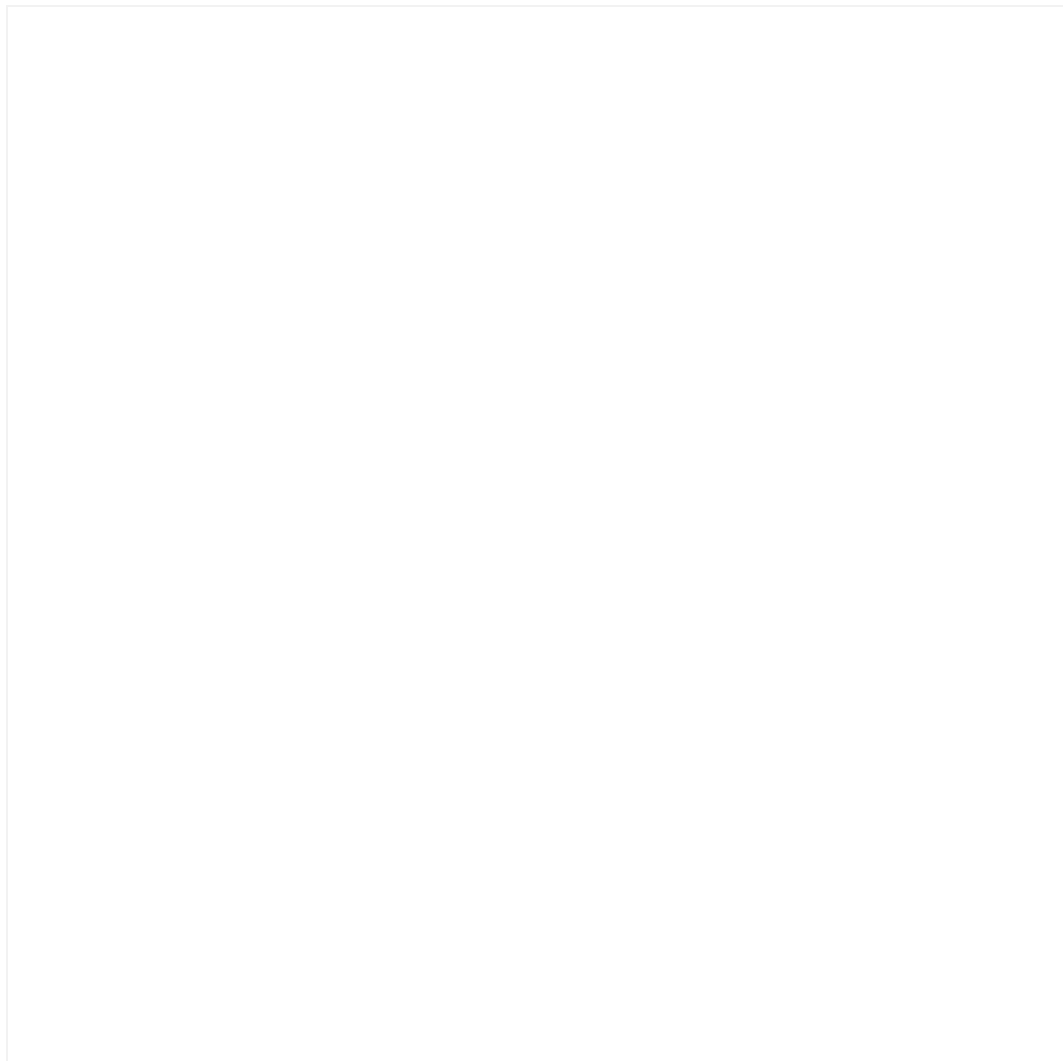


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Please refer to this document as follows: Usami, D.S. (2017), Installation of Median, European Road Safety Decision Support System, developed by the H2020 project SafetyCube. Retrieved from www.roadsafety-dss.eu on DD MM YYYY



Please note: The studies included in this synopsis were selected from those identified by a systematic literature search of specific databases (see supporting document). The main criterion for inclusion of studies in this synopsis and the DSS was that each study provides a quantitative effect estimate, preferably on the number or severity of crashes or otherwise on road user behaviour that is known to be related to the occurrence or severity of a crash. Therefore, key studies providing qualitative information might not be included in this synopsis.

1 Summary

Usami, D.S., April 2017



1.1 COLOUR CODE: LIGHT GREEN

The installation of medians is found to reduce injury accidents, but not property damage only accidents. The effect is greatest for the most severe accidents. The measure seems to be less effective at road intersections than road segments.

1.2 KEYWORDS

raised median; median strip; central reservation; two-way left turn lane, head-on accidents

1.3 ABSTRACT

A median is a physical separation between opposing traffic streams. Results of the studies on the effects of the installation of medians on road safety indicate that the installation of medians significantly reduces injury crash occurrence by 8% on two-way roads. The effect is greatest on urban roads and on control-access roads like motorways (roads with no level intersections). However, installation of medians at intersections is found to increase accidents by 50%. Unfavourable effects of median installation have also been found in curves and when medians imply narrower lanes. Most research was carried out in the United States, Australia, Denmark, Norway, Germany and Malaysia.

1.4 BACKGROUND

1.4.1 What is a median?

A median is a physical separation between opposing traffic streams. In this context, the installation of a median is intended as the implementation of a continuous raised median on an undivided roadway or as the replacement of a two-way left turn lane with a raised median.

1.4.2 How does the installation of a median affect road safety?

Medians are intended to increase the distance between the driving directions and to reduce the risk of drivers accidentally getting on the opposite lane. In addition, medians limit the opportunities to turn or cross the road outside of their openings. Installation of medians has been shown to reduce the number of road accidents on road segments, with the greatest effect on the most serious accidents. The effect is greatest on control-access roads like motorways (roads without level intersections). By introducing a median, the distance between opposing traffic flows increases, which may result in a lower number of head-on collisions. Moreover, the possibility of left turns is removed from through travel lanes and they can also serve as a pedestrian refuge. Installation of medians without a barrier may however also increase the number of pedestrian crossings and thereby increase the total number of pedestrian accidents (Zegeer, Stewart, Huang and Lagerwey 2002). Medians seem to change the distribution of accidents by type. Gabler, Gabauer and Bowen (2005) (in Elvik et al., (2009)) found reduced numbers of head-on collisions, but increased number of less severe accidents. Another study found reduced numbers of side impacts and increased numbers of rear-end collisions (Saito, Cox and Jin 2005). They also reduce passing opportunities.

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1.4.3 Which safety outcomes are affected by the installation of a median?

In the international literature, the effect of the implementation of medians on road safety has been measured using as outcome accident frequency (number of accidents occurred).

1.4.4 How is the effect of the installation of a median studied?

International literature indicates that the effect of the installation of a median is usually examined by comparing the frequency of accidents (crash count) on roads with and without medians through before-after studies. The effects have been studied on two-way road segments and at road intersections, in urban and rural areas. Moreover, the conversion from a previous transversable median to a raised median has been investigated.

1.4.5 Which factors influence the effect of the installation of a median on road safety?

Different road classes are usually designed with different standards (number of lanes, road width, curve radius, etc.) and equipped with different median types (e.g. grass medians, jersey barriers, and guard rails are more common on faster roads). This means that road classification may also influence the effect of installation of medians on the number and type of crashes. On roads with access control, where entrances and exits to the road are provided by ramps and at interchanges, a higher accident reduction is observed than at other roads, since there are no level intersections on this type of road. Medians without a barrier may however also increase the number of pedestrian crossings and thereby increase the total number of pedestrian accidents (Zegeer, Stewart, Huang and Lagerwey 2002 in Elvik et al. 2009). Unfavourable effects of medians have been found in curves and when medians imply narrower lanes. In both cases, significant increases of accident numbers have been found (Elvik et al., 2009).

1.5 OVERVIEW RESULTS

1.5.1 Main results

According to results in the meta-analysis found, the implementation of a median generally improves road safety. Comparing medians to two-way left-turn lanes, medians are associated with crash reduction. However, medians at intersections are found to increase accidents. More specifically, the implementation of medians appears to significantly reduce crash occurrence by 43% on two-way roads (intersections not included) and 24% on two-way roads with intersections. Moreover, implementation of medians on two-way roads of both rural and urban road segments is significantly associated to 8% reduction of injury accidents. However, implementation of medians were significantly negatively effective at intersections (Høye, 2014).

1.5.2 Transferability

Overall, since a meta-analysis including 29 studies was found, the topic has been studied to a sufficient extent. Most research was carried out in the United States, Australia, Denmark, Norway, Germany and Malaysia.

1.6 NOTES ON ANALYSIS METHODS

This synopsis is mainly based on a meta-analysis study. The studies included in the meta-analysis are from the the United States, Australia, Denmark, Norway, Germany and Malaysia. Most of the included studies have compared crash count on roads with and without medians. Most included studies do not specify whether accidents at intersections are included or not. The results are based on different types of studies from a range of years. Neither age of study nor study design were found to affect the results and those do not appear to be affected by publication bias.

2 Scientific Overview

2.1 LITERATURE REVIEW

2.1.1 Analysis of study designs and methods.

Results are mostly based on a meta-analysis carried out in 2014. According to the literature search results it seems that there is a lack of research on medians from 2014. 29 studies were considered in the meta-analysis by Høye, 2014. Research has been carried out in the United States, Australia, Denmark, Norway, Germany and Malaysia.

Most of the studies compared the frequency of accidents on roads equipped with a raised median with the frequency of accidents on undivided roads. Most included studies do not specify whether accidents at intersections are included or not. The results are based on several types of studies from many different years. Neither type of study nor how old they have been seem to affect the results. Further, the latter do not seem to be affected by publication bias.

Table 1 illustrates an overview of the main aspects of the coded study (sample, method and outcome).

Table 1 Description of coded studies

Author(s), Year , Country	Sample and study design	Method of analysis	Outcome indicator
Høye, A., 2014, Norway	29 studies based on a before-after or case-control design.	Meta-analysis. Random effects	Number of accident

2.1.2 Study results

The studies included in the meta-analysis show that the installation of medians has a significant positive effect on road segments, but it seems they have a negative effect on road intersections. Results can be differentiated according to the accident severity and the specific context examined.

Raised Median on road segments: Installation of median on road segments appears to reduce the number of injury accidents but not the number of property damage accidents. The effect seems to be bigger for the most serious accidents, even if not significant. Many studies have not indicated whether accidents at intersections are included in the data or not.

Raised Median on road intersections: Implementing raised medians at road intersections in which at least one of the roads has a median seems to be less effective than on road segments. At road intersections, the results show that in some cases the installation of medians increases the number of accidents, mostly in rural areas. The results are not statistically significant, but show the same effect as the results for the conversion of a two-way left turn lane to a median. This could be explained by the fact that intersections with medians are generally larger and more confusing than intersections without medians.

Area and type of road: On roads without access control (i.e. road with level intersections) accident reductions were only found in urban areas, but not in rural areas. On roads with access control (i.e.

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roadways where entrances and exits to the road are provided at interchanges by ramps without level intersections or junctions) a higher accident reduction than on other roads was found, which possibly can be explained by the fact that there are no level intersections on this type of roads (e.g. motorways).

From Two-way left-turn lane to raised median: The conversion of two-way left-turn lanes to raised medians is associated with a 43% reduction in the number of accidents. However, installation of medians at intersections are found to increase accidents by 50%. Generally speaking, implementation of medians is associated to 24% reduction of crash counts for all accidents.

2.1.3. Description of analysis carried out

Review-type analysis

Considering the number of studies with the relevant estimates it was decided that neither a meta-analysis nor a vote-count analysis could be conducted. Hence, a review-type analysis was chosen.

The results above present a positive effect of implementation of medians. It can be summarised that the implementation of medians leads mainly to significant positive effects. At the same time and under certain conditions the implementation of medians showed significant negative effects, however, in a small proportion.

Hence, on the basis of both study and effect numbers, it can be argued that the implementation of medians has a positive effect on road safety. There were clearly more significant positive than negative effects listed. As mentioned before, the chosen studies are of sufficient quality and mainly consistent in their results. For the most part, results show that the implementation of medians decreases road safety risk. Hence, a light green colour code was assigned.

2.2. CONCLUSION

Studies on the effect of installation of medians on road safety identified in the international literature mainly focus on accident frequency.

The studies identified indicate that the installation of medians is associated with a statistically significant reduction in crash occurrence.

In the final analysis, the installation of medians seems to reduce crash occurrence as emphasised by the findings of the meta- analysis.

3 Supporting document



3.1 METHODOLOGY

3.1.1 Literature search strategy

The literature search was conducted in January-March 2017. The search strategy aimed at identifying the best quality and recent studies to estimate the effectiveness of median related treatments, thus considering not only median implementation but also the type of median, median barrier and increasing median width. During the screening phase the search focused on installation of median treatments.

A meta-analysis carried out in 2014 is available in The Handbook of Road Safety Measures (online version). As this meta-analysis is available, only recent journal studies (after 2014) in the field of Engineering and Social science were considered from "Scopus" and "TRID" database. No "grey" literature was examined.

Search terms used to identify relevant papers included, but were not limited to: "median", "central reservation", "median strip". Detailed search terms, as well as their linkage with logical operators and combined queries are shown in Tables 2 and 3. A total of 56 pieces of potentially eligible studies were identified (Table 4). After a preliminary abstract screening text, no studies were found to be eligible to the topic (Table 5).

Table 2 Literature search strategy (Scopus database) - Date: 3rd January 2017

search no.	search terms / operators / combined queries	hits
#1	("road median*" OR "median*" OR "central reservation*" OR "median strip*" OR "neutral ground" OR "central nature strip*" OR "raised center median") W/1 (" " OR "barrier" OR "guardrail") AND ("effect*" OR "evaluation" OR "impact*") AND ("safety") AND DOCTYPE (ar OR re) AND PUBYEAR > 2014 AND SRCTYPE (j) AND LANGUAGE (english) AND SUBJAREA (engi OR soci)	45
#2	("casualt*" OR "fatalit*" OR "accident*" OR "crash*" OR "collision*" OR "injur*") AND DOCTYPE (ar OR re) AND PUBYEAR > 2014 AND SRCTYPE (j) AND LANGUAGE (english) AND SUBJAREA (engi OR soci)	44,314
#3	#1 AND #2	43

Table 3 Literature search strategy (TRID database)- Date: 3rd January 2017

search no.	search terms / operators / combined queries	hits
#1	("road median*" OR "median*" OR "central reservation*" OR "median strip*" OR "neutral ground" OR "central nature strip*" OR "raised center median") AND effect AND evaluation	13*

*Results limited to studies published from 2014

Table 4 Results Literature Search

Database	Hits
Scopus (remaining papers after several limitations/exclusions)	43
TRID	13
Grey literature	-
Total number of studies to screen title/ abstract	56

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Table 5 Screening results

Total number of studies to screen title/ abstract	56
-De-duplication	0
-exclusion criteria A (part of a meta-analysis)	2
-exclusion criteria B (no risk / no measure)	48
-exclusion criteria C (no median installation evaluation)	6
Remaining studies	0
Not clear (full-text is needed)	-
Eligible papers	0

3.1.2 Analysis of study designs and methods

The large amount of studies included in the meta-analysis indicates that the topic has been thoroughly investigated. The results are based on several types of studies from a range of years. Most of the included studies have compared risk of accident on roads with and without medians. Most included studies do not specify whether accidents at intersections are included or not.

Table 6 presents information on the main outcomes of coded studies on installation of medians.

Table 6 Main outcomes of coded studies on installation of medians.

Author, Year, Country	Exposure variable	Type	Outcome variable / Outcome type	Effects for road safety*	Main outcome - description
Høye., 2014 Interanational	Raised median	Meta-Analysis	Severe injury accidents – two-way roads	- -22% (-46;15)	Non-significant effect on road safety
			Injury accidents – two-way roads	↘ -8% (-15;-1)	Significant positive effect on road safety
			Damage only accidents – two-way roads	- -2% (-25;27)	Non-significant effect on road safety
			All severities accidents – two-way roads	- -8% (-15;1)	Non-significant effect on road safety
			All severities accidents – intersections in rural area	- 8% (-53;148)	Non-significant effect on road safety
			All severities accidents – intersections in urban area	- 74% (-7;226)	Non-significant effect on road safety
			Injury accidents – two-way rural roads	- 1% (-24;36)	Non-significant effect on road safety
			All severity accidents – two-way rural roads	- 4% (-19;34)	Non-significant effect on road safety
			Injury accidents – two-way urban roads	↘ -19% (-34;0)	Significant positive effect on road safety
All severity accidents – two-way urban roads	- -7% (-18,6)	Non-significant effect on road safety			

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Author, Year, Country	Exposure variable	Type	Outcome variable / Outcome type	Effects for road safety*	Main outcome - description
			All severity accidents – two-way roads with access control	↘ -14% (-25;-1)	Significant positive effect on road safety
	From two-way left-turn lane to raised median	Meta-analysis	All severity accidents – two-way roads	↘ -43% (-51;-34)	Significant positive effect on road safety
			All severity accidents – intersections	↗ 50% (11;103)	Significant negative effect on road safety
			All severity accidents – two-way roads and intersections	↘ -24% (-31;-17)	Significant positive effect on road safety

*Significant effects on road safety are coded as: positive (↘), negative (↗) or non-significant (-)

3.2 LIST OF STUDIES

3.2.1 Meta-analyses

Høye, A., (2014): Median Strips The Handbook of Road Safety Measures, Norwegian (online) version. Chapter 1.21. <http://tsh.toi.no/index.html?146863>

The following studies were included in the meta-analysis:

Alluri, P., Gan, A., Haleem, K., Miranda, S., Echezabal, E., Diaz, A., & Ding, S. Before-and-after safety study of roadways where new medians have been added. Final Report. 2012 Lehman Center for Transportation Research, Florida International University, Miami, FL and Research Center, State of Florida Department of Transportation, Tallahassee, FL.

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