Golestan University

Geographical planning of space quarterly journal

Journal Hopepage: www.gps.gu.ac.ir

Research Paper

Assessing the Potential Threat of Road Transport Networks with Passive Defense Approach in Khuzestan Province

Rasoul Afsari [a], Jahanbakhsh Balist [b*], Hassan Darabi [b], Mohammad Reza Mirzaei [c]

[a] *Assistant Professor, Department of Urban PlanningPassive Defense,Superme National Defense,University of Tehran, Tehran, Iran*

[b] *Department of Environment, Faculty of Environment, University of Tehran, Tehran, Iran*

[c] *Department of Geography, Faculty of Literature and Humanities, Ferdowsi University of Mashhad, Mashhad, Iran*

A R T I C L E I N F O

Keywords:
Passive defence,
GIS,
Multi-criteria decision making,
Vital arteries,
Road transport network.

Received:
06 April 2022
Received in revised form:
10 June 2022
Accepted:
08 August 2022
pp. 149-167

A B S T R A C T

The growing importance and, at the same time, the emergence of the issue of passive defense and the dispersion and lack of information in this field, on the one hand, and the vital importance of the transportation network, which are highly vulnerable during humanitarian crises such as war and natural disasters such as floods and earthquakes, on the other hand, It has caused the need to provide a model and a comprehensive method to identify the threat potential in this network with a passive defense approach. The purpose of this research is to provide a model using a geographic information system and decision-making techniques with a passive defense approach to identify and evaluate the threat potential in the road transportation network. For this purpose, first, 13 criteria were identified in three categories: natural, human, and transportation, and their cause-and-effect relationships were evaluated with the Dimatel method. Then, they were weighted by the network analysis method and evaluated in the geographic information system using fuzzy logic, weighted linear combination method, kernel density estimation, and hot spots function to produce threat potential maps. The results showed that the most important criteria were the density of the road network at 0.141, bridges at 0.133, the presence of rails at 0.124, and the location concerning cities at 0.104. Also, the results of fuzzy methods and weighted linear combination identified the range of threat potential in the range of 0.21 to 0.87. Sections of the network near cities and bridges had the highest threat potential. Also, the hot spot function showed that urban areas and areas with high network density are hot spots that attract threats. Based on the results of the research, it was suggested that in the new planning for the development of the transportation network, the principles of passive defense should be used in the design of the network, especially bridges.

Citation: Afsari, R., Balist, J., Darabi, H., & Mirzaei, M. R. (2022). Assessing the Potential Threat of Road Transport Networks with Passive Defense Approach in Khuzestan Province. *Geographical planning of space quarterly journal*, *12* (2), 149-167.

http://doi.org/10.30488/GPS.2021.265835.3356

∗. Corresponding author (E-mail: r.afsari@sndu.ac.ir)

Extended Abstract

Introduction

The need to provide a comprehensive model and method to identify the threat potential in road transportation networks with a passive defence approach is quite apparent due to two following reasons; The growing importance and, at the same time, the emergence of passive defence and the dispersion and lack of information in this area on the one hand and the vital importance of the transportation network in times of humanitarian crises such as war and natural disasters such as floods and earthquakes of high vulnerability, on the other hand,

Transport infrastructure is one of the leading centres of gravity that can be easily targeted due to the helplessness and widespread nature in times of crisis. Therefore, it is necessary to prepare a model for assessing the potential threat of infrastructure, including the road network, to be aware of the severity of their vulnerabilities and to prevent their reduction in performance in times of crisis by eliminating shortcomings.

Methodology

This study aims to provide a model using GIS and decision-making techniques with a passive defence approach to identify and evaluate the potential threat in the road transport network. This study studied and assessed the transportation network of Khuzestan province as one of Iran's strategic regions. For this purpose, 13 criteria in three categories of natural, human, and transportation were first identified, and their causal relationships were evaluated by the DEMATEL method. Then, they were weighted by the network analysis process method and evaluated in GIS using fuzzy logic, weighted linear composition method, kernel density estimation, and hot spots function to generate potential threat maps. In this study, to create different layers, their settings were used based on the purpose of the study, evaluation, normalization, superimposition, and production of other maps. In total, 13 criteria in three sections: natural (fault, slope, landslide, erosion, flood, and lithology), human (international borders, cities, land use, and sensitive land use), and transportation (road density, Rail network, and bridges) were used to achieve a threat assessment model in the transport network. First, these criteria were investigated using the Dimatel method, and their causal relationships were identified. In this stage, the criteria that were effective and those that were effective were identified, and in the next phase, their importance or weight was evaluated based on the opinion of experts by the network analysis process method. The Euclidean distance function was used to create distance functions from the point and linear layers. Then all layers with similar cell dimensions were turned into raster layers and normalized using fuzzy membership functions. Kernel density estimation was used to create the road network density layer. After weighting, the layers were stacked in six ways. Five fuzzy operators and a weighted linear combination method were used to create different results. Each fuzzy operator shows the results based on a separate logic that can be used to create different decision scenarios. Finally, using the hot spot function, cold and hot areas with varying levels of reliability were identified in the transportation network.

Results and Discussion

According to DEMATEL results, location relative to cities, land use, sensitive land use, and road density has the greatest impact on other system elements, respectively, and road density, location relative to cities, erosion, sensitive land uses, and bridges have the most impact. They are affected by other system factors. Based on causal relationships, criteria such as road density are related to all other elements, and criteria such as slope, fault, and lithology are unrelated to other factors. According to the results of the network analysis process, the most important criteria are road network density with 0.141, bridges with 0.133, the presence of rails with 0.124, and location relative to cities with 0.104. Sensitive uses include military, industrial centres (refineries and factories), industrial estates, freight terminals, and other sensitive centres. The closer these centres and the transportation network are,

the greater the potential for threat. The road network as the focus of this research is critical and should be designed and evaluated based on the principles of passive defence. Dispersion is one of the principles of passive defence that should be considered in the design of the network. Railways, as part of the transportation network, significantly impact attracting threats. This means that according to the principles of passive defence, the closer the railway and road networks are to each other, the greater the threat of attack. Bridges, as a vital factor in the intersection of the transportation network with rivers and different transportation routes in urban and suburban areas, have the potential to absorb many threats that must be considered in terms of passive defence. Landslide points are areas that, due to the characteristics of soil and rock mass relative to the bedrock and the slope of the area, due to factors such as rainfall and damage to the transportation network. The land has excellent potential for the threat that, if it occurs, could lead to widespread destruction of the transportation network. Therefore, they should be considered in network design. The land slope can be a threat to the transportation network. Thus, from the design and construction stage, due to the high volume of operations, difficult access, and high cost, and in the operation stage, due to natural vulnerabilities, repairs and access in the event of a problem are prone to threats. Floodwaters are a potential threat to the transportation network. In addition to riverbeds, these channels include their confines and flood zones. Given that there are bridges in these areas, it is an important criterion in designing a transportation network with a passive defence approach.

Threat status in the transportation network is the main output of this research, which has shown the level of threat in area 3 (km) of the network. With this map, it is possible to identify critical centres in terms of threats with a passive defence approach and plan to reduce threats and manage them. The hot spot map is based on the HOT SPOT function, and the linear weight combination method maps are introduced as input. Accordingly, areas identified in hierarchical red indicate parts of the network at high risk, and the blue regions indicate harmless sections.

Conclusions

In general, the transportation network can be used as a strategic weapon for developing political relations, opening the economy's doors and sustainable development, motivating foreign investment, and providing sustainable guarantees in economic relations and national development. In this research and to develop the research cycle of passive defence of the transportation system, an approach was developed that can identify threats in the network according to various natural, human, and transportation factors. For this purpose, the GIS was used according to its potential in multiple studies, along with multi-criteria decision-making methods with a passive defence approach. Based on the overall results of this model, human factors have the most significant effect on creating a threat to the transportation network. Proximity to cities, road density, and the presence of bridges are the most important factors that show the result of the DEMATEL method and the network analysis process. Therefore, considering all factors are important in this model, we should focus more on human factors in planning.

Funding

There is no funding support.

Authors' Contribution

Authors contributed equally to the conceptualization and writing of the article. All of the authors approved thecontent of the manuscript and agreed on all aspects of the work declaration of competing interest none.

Conflict of Interest

Authors declared no conflict of interest.

Acknowledgments

We are grateful to all the scientific consultants of this paper.