

## INFRASTRUCTURAL DETERMINANTS OF HUMANITARIAN LOGISTICS DEVELOPMENT IN ASEAN COMMUNITY

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### Abstract

The world literature experiences the deficit of scientific publications illustrating the problems of humanitarian logistics from the perspective of regional association. Thus, the article refers to infrastructural aspects of humanitarian logistics development that are characterized by regional convergence. The unification of activities requires a wide scope of investments. The précised preparation, efficient reaction as well as effective reconstruction plays a key role in undertaken activities. Infrastructure determinants refers to transportation systems, energy policy, ecological aspects and general logistics ratios. Therefore, the research problem consists of two questions. The first one is: what kind of infrastructural determinants have an impact on humanitarian logistics development? The second question is: what is the role of the regional community during natural disasters? The methodology of the article consists of a multivariate data analysis. The results underline the role of coordinated, integrated and internationalized humanitarian supply chain that is configured at the regional level in ASEAN.

**Keywords:** Humanitarian logistics, infrastructure, determinants, development

### 1. INTRODUCTION

The purpose of this paper is to present infrastructural determinants of humanitarian logistics development. The objects of analysis are ten countries that are members of ASEAN Community. The methodology of the article consists of a multivariate data analysis that has been visualized in a two-dimensional space on the basis of the variation in time (2007-2015). There are two main reasons for choosing the particular region. The first one confirms that a localization in the Pacific Ring of Fire area determines higher number and intensity of natural disasters in the field of material, people and economic losses [1]. The second one is associated with integrated, coordinated and internationalized logistics operations carried out at the community level. ASEAN is the very first region that cover up humanitarian actions across borders.

Considering the above facts, the author formulated the research problem: what kind of infrastructural determinants have an impact on humanitarian logistics development? Furthermore, what is the role of the regional community during natural disasters?

Firstly, the world literature experiences the deficit of scientific publications illustrating the problems of humanitarian logistics from the perspective of regional association. The existing publications and articles discuss primarily the role of the State in the undertaken activities, or characterize the fragmented operations carried out by individual units [2][3]. In case of the government sector the approach taken is limited to one of the factors of humanitarian logistics convergence [4], i.e. crisis management, which takes the form of just forcing the development of activities and processes to be performed in the course of particular humanitarian logistics phases in the situation of disasters.

Hence, both humanitarian organizations and the government sector take a fragmented approach to the overall problem of humanitarian logistics along with the humanitarian supply chain, which results in a significant number of gaps and inconsistencies in the carried out activities [2][3]. The coordination of all undertaken humanitarian actions requires an excellently developed and thus effective supply chain, which should be

defined as the coordinated network of entities involved in providing humanitarian aid, mutually related by certain feedbacks and permanent information flow, which create value in the form of products and services of exclusively humanitarian nature [4].

## 2. FINDINGS

Humanitarian logistics operations depend on the legislation in force in a given area, the regional culture as well as the available infrastructure and the level of economic development. It aims at its unification based on logistics processes and activities. Approaching all entities, engaged in providing aid, as equal participants of a humanitarian supply chain and taking their needs and possibilities into account in crisis oriented planning as well as the undertaken activities remain the crucial and indispensable aspects having direct impact on the effectiveness of carried out activities. Therefore, the involvement of the regional association and public sector in the cooperation with private sector results in the reduction of the occurring disasters' effects [2, 4].

The harmonization of activities performed by particular entities, systems' monitoring, data measurement, risk analysis, preparing plans and potential scenarios altogether result in a more effective cooperation and safety improvement. Coordination, integration and internationalization remain fundamental within the framework of humanitarian supply chain in order to minimize the effects of disasters [4, 5]. The humanitarian logistics development means progress in processes associated with improvement and modernization of institutions, economy, social aspects, IT and infrastructure. All of this groups are defined by particular indicators that compose the comprehensive research.

The uncertainty of time, place and type of disasters occurrence creates the problem of the reserved resources quantity, available to eliminate their effects. Putting each time a human being in the centre of all logistics and humanitarian analyses and defining tasks based on local and regional determinants results from internationalization which influences the efficient elimination of natural disasters' effects in diverse areas. The development of logistics humanitarian processes and assigning adequate owners coming from the respective regional, public and private sectors exerts impact on effective cooperation and coordination of the carried out logistics operations [5].

Therefore, infrastructural aspects of humanitarian logistics development are characterized by convergence. The unification of activities requires a wide scope of investments. The précised preparation, efficient reaction as well as effective reconstruction plays a key role in undertaken activities. Hence, a modern technology adaptation and structural regeneration of infrastructure raises the levels of development [4]. Moreover, a fully prepared society for natural disasters' consequences has an adequate framework. Its modernization is a key determinant of humanitarian supply chain configuration. An advanced road, rail, air and maritime transport systems are responsible for the entire infrastructure development [6]. Thus, an effective usage of trucks, planes and boats (both river and sea) should be adapted in natural disasters' prevention, reaction and reconstruction. What is more, container transport that is associated with a high level of investments represents a potential for effective relief distribution. Especially, that it represents involvement in a global economy.

Infrastructural determinants of humanitarian logistics development are also correlated with broadly defined energy. It is absolutely a very critical source of financial and material losses [7]. An energy intensity of the modern economy demonstrates a higher levels of primary energy consumption. Therefore, it results in higher energy costs for the particular country. Besides, sustainable development policy is correlated with exploitation of renewable energy. It should be important factor for humanitarian logistics processes due to involvement of the local communities. All the more so ecological determinants are an external aspect of humanitarian supply chain creation [3].

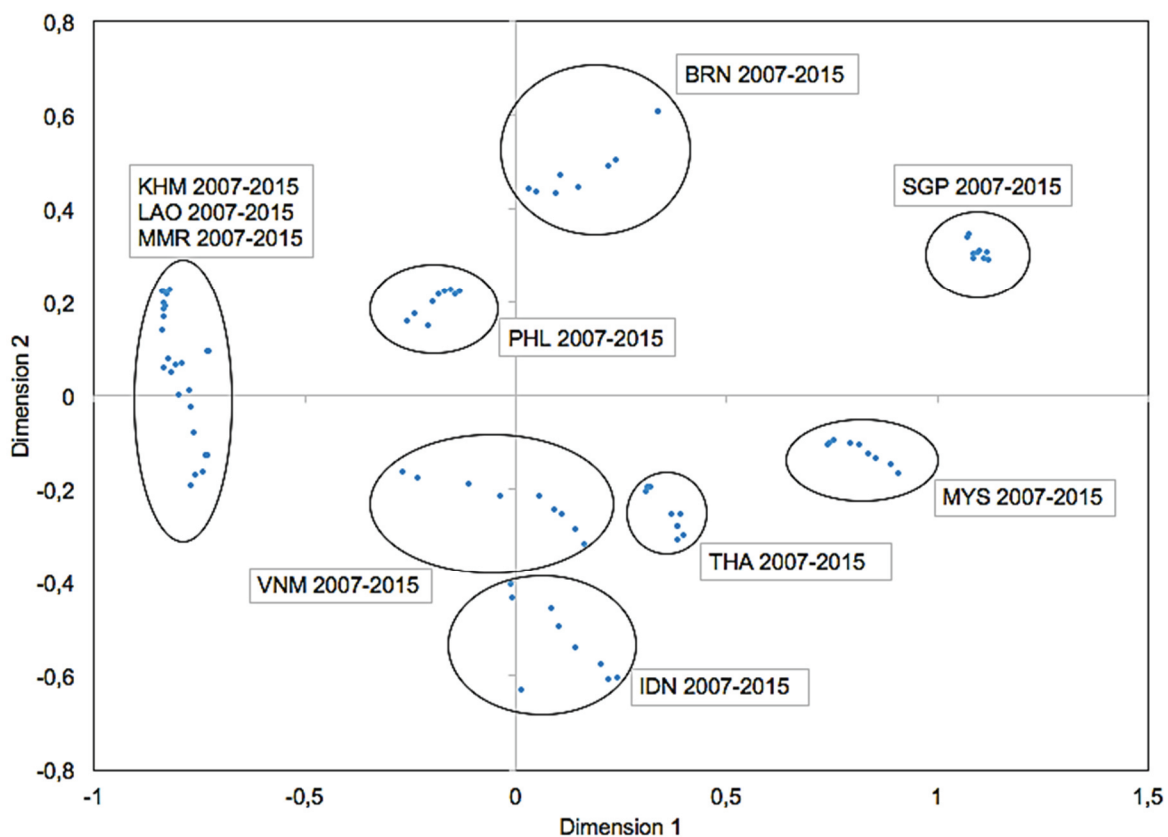
Furthermore, effectiveness of that chain as well as infrastructural efficiency is associated with electricity production. It determines a long term development that cover logistics operations during natural disasters. Early-warning systems and two-way communication in real time require a wide access to electricity. However,

all the IT aspects should be analysed as the informational and social determinants of humanitarian logistics development rather than infrastructural.

Another justified aspect are greenhouse emissions. They may increase an intensiveness and number of cataclysms [8], therefore should be included in the further analysis. The last feature informs about operations efficiency and performance. The level of infrastructure connectivity among countries of the association affects the global network connection. Though, a flexible and efficient activities involve natural disasters' prevention, reaction and reconstruction.

Considering the above facts, eleven ratios have been chosen for the infrastructural determinants analysis. These are: share of concrete roads in % (CONC\_ROAD), number of trucks per 1,000 people (TRUCKS), freight air transport in t / km (AIR\_TRANS), container transport in TEU (CONT\_TRANS), electricity production in kWh (ELECT\_PROD), level of primary energy consumption in % (PRIM\_ENCONS), renewable energy consumption in % (RENEW\_EN), greenhouse gas emissions in kt (GGAS\_EM), Logistics Performance Index (LPI), Linear Shipping Connectivity Index (LSCI) and total infrastructure quality (INFRA\_QUAL).

Author of this article used R language in RStudio software with package 'smacof'. It provides a multidimensional scaling based on stress minimization by means of majorization [9]. The procedure consists of data collection, variable normalization, distance estimate for objects as well as two-dimensional (2D) and three-dimensional (3D) scaling if necessary. Due to the length restrictions of the article two first steps will not be presented. Respectively, it is necessary to display a scatter plot in the 2D space (**Figure 1**).



**Figure 1** Scatter plot in the 2D space

Groups of similar objects (States in a particular years of analysis) may be distinguished. Ipso facto, Cambodia, Lao PDR and Myanmar are in a one group of humanitarian logistics development in the infrastructural aspect. These are the countries that are characterized by undeveloped economy, high level of central planning, low

intensity of innovations as well as low quality of transportation systems. Moreover, the natural disasters' negative consequences are higher than in other part of the ASEAN Community.

The rest of the States represents their own individual level of development. Singapore, Brunei Darussalam, Malaysia, Philippines, Thailand, Vietnam and Indonesia are in the separate groups. The three first countries are highly developed States on the basis of economy (Malaysia is located between highly developed and developing level). The high intensity of innovations, connection to the global transportation network (Singapore, Kuala Lumpur) and extensive investments determine infrastructure quality in the means of humanitarian logistics.

Nevertheless, geographical determinants of ASEAN Community as well as natural disasters' impacts make the logistics operations difficult. Philippines, Thailand and Indonesia represents developing countries that have to cover infrastructural investments problems. Such situation has enormous repercussions on the humanitarian supply chain activities. Another country whose economy becomes more open recently is Vietnam. Thus, the modernization of transportation systems as well as critical infrastructure investments are being gradually conducted. It results in logistics operations effectiveness.

However, grouping States into the similar classes is not a sufficient activity in that method. There is a necessity to interpret a correlation ratio for both dimensions (**Table 1**). Such interpretation indicates significance and importance of the particular variables.

**Table 1** Two-dimensional correlation ratio

Variable name \ Dimension	Dimension 1	Dimension 2
CONC_ROAD	0.88893213	0.193700515
TRUCKS	0.83533265	0.170721856
AIR_TRANS	0.79312367	0.153804072
CONT_TRANS	0.85916413	-0.004655502
ELECT_PROD	0.48491621	-0.757668077
PRIM_ENCONS	-0.13783915	0.454272715
RENEW_EN	-0.90994954	-0.179007538
GGAS_EM	0.01690002	0.801098940
LPI	0.94211692	0.042110339
LSCI	0.88186202	-0.060594107
INFRA_QUAL	0.76395514	0.332855600

Therefore, the first dimension is associated with variables: CONC\_ROAD, TRUCKS, AIR\_TRANS, CONT\_TRANS, RENEW\_EN, LPI, LSCI and INFRA\_QUAL. It represents transport, energy independence and general logistics aspects. The higher value of this dimension means higher level of humanitarian logistics development in the field of transportation system as well as level of autarky. Singapore and Malaysia are absolute leaders in ASEAN Community. Next in order are Thailand, Brunei Darussalam, Indonesia since 2009 and Vietnam since 2011. Philippines and Vietnam (between 2007 - 2010) have an average level of development in that field while Cambodia, Lao PDR and Myanmar are decisively underdeveloped.

The second dimension refers to the variables: PRIM\_ENCONS, ELECT\_PROD and GGAS\_EM. It indicates energy policy and environment attitudes. A better position in this dimension is associated with efficient policy and sustainable exploitation of resources. Thus, Brunei Darussalam leads the ASEAN Community with Singapore, Philippines and Lao PDR on the next places. These countries' policies enter the sustainable development paths according to the second dimension of infrastructural determinants of humanitarian logistics.

An extensive energy and environment policy is domain of Myanmar, Cambodia, Malaysia, Vietnam and Thailand. The lowest quality levels of that dimension belongs to Indonesia. Therefore, the characterized States are more likely to increase an intensiveness of natural disasters' consequences.

The three-dimensional scaling may also be prepared in order to group ASEAN countries. However, it does not change the interpretation presented above. Groups are quite similar as in the two-dimension scatter plot. Furthermore, the meaning of variables (**Table 2**) is almost identical due to the mirror reflection of the first dimension. So it refers to transport, energy independence and general logistics aspects. The second one indicates only PRIM\_ENCONS variable, while the third one ELECT\_PROD and GGAS\_EM. Thus, the efficient policy and sustainable development has been split. If we take it to consider in a wider context it does not explain infrastructural determinants of humanitarian logistics more. Therefore, the three- and more-dimensional scaling processes are unnecessary.

**Table 2** Three-dimensional correlation ratio

Variable name \ Dimension	Dimension 1	Dimension 2	Dimension 3
CONC_ROAD	0.890326569	0.07850642	-0.14586623
TRUCKS	0.834601798	0.03895035	-0.19756748
AIR_TRANS	0.784349400	0.38271502	0.07849175
CONT_TRANS	0.856423696	0.29132572	0.21919784
ELECT_PROD	0.501699826	-0.52536305	0.66389067
PRIM_ENCONS	-0.138622070	0.91081275	0.21544773
RENEW_EN	-0.909138193	0.02440886	0.26549866
GGAS_EM	0.001838753	0.47039519	-0.81074530
LPI	0.940110946	0.15095573	0.04267814
LSCI	0.881991253	0.13614678	0.16430737
INFRA_QUAL	0.756608826	0.28301549	-0.28300857

### 3. CONCLUSION

The standardization of procedures and logistics operations at the regional level in ASEAN is an evidence of coordinated, integrated and internationalized humanitarian supply chain. Its external determinants have an enormous impact on the humanitarian logistics development both at the country and regional level. The multi-dimensional compounds of infrastructural determinants indicate the stage of that development in the fields of transportation systems, sustainable development and energy policy as well as general logistics aspects.

Mutual cooperation of all entities involved in disaster relief distribution within highly developed, developing and underdeveloped countries on the basis of economy is possible through the regional humanitarian supply chain. A noticeable progression of the presented determinants in the particular States advocates a convergence processes. Therefore, a further analysis should be prepared. Logistics convergence in humanitarian supply chain [4] is a theory that may explain ASEANs effectiveness in disaster relief operations.

The set of the presented variables define the role and the potential of infrastructural determinants. Obviously, they should be independent and flexible within countries and global economy. However, some special geographic and / or cultural determinants should also be included. That is why, author has excluded indicators defining the level and quality of rail transportation system due to the lack of the data in several States. However, omitting the missing data did not produce an unbiased estimate.

To conclude, higher levels of infrastructural determinants remains the vital component to eliminate the gap in mutual cooperation, transportation systems quality and connectivity as well as to the defragmented logistics operations during natural disasters. Humanitarian logistics is not a chance only, it is also the requirement which should be fundamental for the developed activities, scenarios, plans and policies.

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