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*The 16th International Symposium on Operational Research
in Slovenia*

September 22 - 24, 2021, Online

Edited by:

S. Drobne, L. Zadnik Stirn, M. Kljajić Borštar, J. Povh and J. Žerovnik



Slovenian Society INFORMATIKA (SDI)
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Preface

This volume, Proceedings of the 16th International Symposium on Operational Research, called SOR'21, contains papers presented at SOR'21 (<https://sor.fov.um.si/>), organised by Slovenian Society INFORMATIKA (SDI), Section for Operational Research (SOR), University of Maribor, Faculty of Organisational Sciences, Kranj, Slovenia (FOV), and University of Ljubljana, Faculty of Mechanical Engineering, Ljubljana, Slovenia (UL FS). The SOR'21 symposium, held 22-24 September 2021, was originally planned to take place in Bled, Slovenia, but was moved online due to the situation of COVID-19 in Slovenia and beyond. The volume contains blind peer-reviewed papers or abstracts of papers presented at the symposium.

The opening address at SOR'21 was given by Prof. Dr. Lidija Zadnik Stirn, President of SOR, Mr. Niko Schlamberger, President of SDI, representatives of FOV and UL FS, Prof. Dr. Mario Jadrić, President of Croatian Operational Research Society (CRORS), Dr Sarah Fores, manager of The Association of European Operational Research Societies (EURO), and presidents/representatives of some others Operational Research Societies from abroad.

SOR'21 is the scientific event in the field of Operational Research, another in the traditional series of biennial international OR conferences organised in Slovenia by SDI-SOR. It is the continuation of fifteen previous symposia. The main objective of SOR'21 is to promote knowledge, interest and education in the field of OR in Slovenia, Europe and worldwide in order to build the intellectual and social capital essential for maintaining the identity of OR, especially at a time when interdisciplinary cooperation is proclaimed as particularly important for solving problems in today's challenging times. By joining IFORS and EURO, the SDI-SOR has also agreed to collaborate with different disciplines, i.e., to balance the depth of theoretical knowledge in OR and the understanding of theory, methods, and problems in other fields within and outside OR. We believe that SOR'21 creates the advantage of these goals, contributes to the quality and reputation of OR by presenting and sharing new developments, opinions and experiences in the theory and practise of OR.

SOR'21 was highlighted by five distinguished keynote speakers. The first part of Proceedings SOR'21 contains invited abstracts, presented by five outstanding scientists: Assist. Prof. Nikolina Ban, University of Innsbruck (UIBK), Department of Atmospheric and Cryospheric Sciences, Innsbruck, Austria, Assist. Prof. Vedran Kojić, University of Zagreb, Faculty of Economics & Business, Zagreb, Croatia, Prof. Panos Patrinos, KU Leuven, Department of Electrical Engineering (ESAT), STADIUS Center for Dynamical Systems, Signal Processing and Data Analytics, Leuven, Belgium, Prof. Suresh P. Sethi, Eugene McDermott Chair Professor of Operations Management, Director, Center of Intelligent Supply Networks, Naveen Jindal School of Management, The University of Texas at Dallas, Dallas, USA, and Prof. Jerneja Žganec Gros, Alpineon Ltd, Ljubljana, Slovenia.

The Proceedings includes 118 papers or abstracts by 240 authors. Most of the authors of the contributed papers came from Slovenia (82), then Croatia (52), Hungary (23), Portugal (23), Serbia (17), Poland (9), Czech Republic (8), Slovak Republic (7), Spain (6), Netherlands (4), Bosnia and Herzegovina (2), Austria (1), Belgium (1), France (1), Germany (1), Romania (1), Ukraine (1), United Kingdom (1), and United States of Amerika (1). The papers published in the Proceedings are divided into Plenary Lectures (5 abstracts), eleven special sessions: Application of Operational Research in Smart Cities (6 papers), Computational Mathematical Optimization (7 papers and 6 abstracts), Data Science – Methodologies and Case Studies (10 papers), Graph Theory and Algorithms (2 papers),

High-Performance Computing and Big Data (3 papers), Industry & Society 5.0: Optimization in Industrial and Human Environments (6 papers), International Projects in Operations Research (2 papers), Lessons Learned from the COVID-19 Pandemic: Applications of Statistical and OR Methods (8 papers), Logistics and Sustainability (9 papers), Operational Research in Ageing Studies and Social Innovations (5 papers), Operations Research in Agricultural Economics and Farm Management (5 papers), and eight sessions: Econometric Models and Statistics (6 papers), Environment and Social Issues (5 papers), Finance and Investments (6 papers), Location and Transport, Graphs and their Applications (5 papers), Mathematical Programming and Optimization (5 papers and 1 abstract), Multi-Criteria Decision-Making (10 papers), Theory of Games (3 papers), and Problems Approaching OR (3 papers).

Proceedings of the previous fifteen International Symposia on Operational Research organised by the Slovenian Section on Operational Research, listed at <https://www.drustvo-informatika.si/sekcije/sor/sor-publikacijepublications/>, are indexed in the following secondary and tertiary publications: Current Mathematical Publications, Mathematical Review, Zentralblatt fuer Mathematik/ Mathematics Abstracts, MATH on STN International and CompactMath, INSPEC. It is expected that Proceedings SOR'21 will be covered by the same bibliographic databases.

The success of the scientific events at SOR'21 and of the present conference proceedings should be seen because of joint efforts. On behalf of the organisers, we would like to express our sincere gratitude to all those who assisted us in the preparation of the event. Without the dedicated and advice of the active members of the Slovenian Operations Research Section, we would not have been able to attract so many top-class speakers from all over the world. Many thanks to them. In addition, we would like to express our deepest gratitude to the prominent keynote speakers, the members of the Programme and Organising Committees, the reviewers who improved the quality of SOR'21 with their useful suggestions, the section chairs and all the numerous people - far too many to list individually here - who helped in organizing of the 16th International Symposium on Operational Research SOR'21 and compiling this proceedings. Finally, we thank the authors for their efforts in preparing and presenting the papers that made the 16th Symposium on Operational Research SOR'21 a success.

We would like to give special thanks to the Partnership for Advanced Computing in Europe (PRACE) for their financial support.

Ljubljana and Kranj, September 22, 2021

*Samo Drobne
Lidija Zadnik Stirn
Mirjana Kljajić Borštnar
Janez Povh
Janez Žerovnik
(Editors)*

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METHODOLOGICAL FRAMEWORK FOR MEASURING REGIONAL LOGISTICS PERFORMANCE

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Abstract: This research aims to contribute to bridging the gap between the connection of logistics and regional development. Firstly, based on the available literature, the contribution of logistics to socioeconomic development was analyzed, and having in mind the importance of Regional Development for economic and social development, this research brings to the light the importance of logistics activities to regional social development, and framework to assess these connections is proposed. Then a framework comprising a set of indicators to evaluate logistics performance was proposed. As a main result, a framework for the assessment of regional logistics performance is proposed together with several logistics performance indicators to assess the impact of logistics on regional development.

Keywords: Logistics, Regional development, Indicators, Framework

1 INTRODUCTION

The emerging debate about the development of policies and initiatives devoted to Regional Development (RD) has been increasing over the years. It can be justified due to available policies did not take effective responses to the current needs of different regions.

In this regard, it is imperative considering the characteristics of each region as well as the goals to be achieved. According to Pike *et al.*, [1] economic development is not an objective in itself, but only a way to achieve well-being. Over the last decades, regional well-being has become a common concern for several countries worldwide. Regional Development allows countries to better balance regional differences by providing communities with the means to prosper [2]. According to OECD [3], RD is a broad term, but it can be seen as a general effort to reduce regional disparities by supporting economic activities (employment and generating wealth) in the regions. This definition is corroborated by Bærenholdt [4], who states that RD is the effort to developing countries in a socioeconomic context.

According to Karayun and Caiming [5], [6] logistics is considered as one of the most important strategic sectors of the 21st century. The authors defends that there is a strong

positive relationship between the logistics development and the economic growth in several countries, such as China and Brazil.

This sector has been contributing to RD, through providing companies competitive advantage in their supply chains. In doing so, logistics can be considered as activities that contributes to promote the development of a region. Economic globalization and the social division of labor have transformed logistics into a sophisticated organization and an increasingly important and strategic management technology in the region's economic development [7]. In the light of these views, namely the importance of logistics activities to RD, this research proposes an integrated framework comprising a set of logistics indicators, based on the relevant literature in this topic. In the current literature works such as Gozacan; Khan et al., and Aislu et al., [8]–[10] have been focusing on developing logistics indicators, yet, they do not focus on regional development, which persist as a gap in the literature. This research is divided as follows. Section 2 presents the methodological approach used in researchy. Section 3 demonstrates the main results focusing on the framework proposed and the indicators for measuring logistics performance . Finally, the last section presents the conclusions and suggestions for future lines of research.

2 METHODOLOGICAL APPROACHES

In this research, the conceptual framework to measure regional logistics performance at organizational level uses the combination of different stages. The design of the proposed framework includes several methodological stages. The work began with a (1) literature review considering two main areas, namely logistics and regional development. In this stage, key aspects related to logistics and RD were analyzed, and were used as the main source of data to design the proposed framework for analyzing regional logistics performance. Then (2) the selection of set of regional logistic indicators which aims to be used as measures for assessing regional logistical performance was conducted. From the scarce literature available, this work aimed to (3) identify the key logistics indicators which can contribute to socio-economic development.

This is the first attempt to (4) develop a methodology that will allow in the future to evaluate the performance of logistics at a regional level. Finally, the main conclusions of the work and suggestions for future research are presented.

3 PROPOSED FRAMEWORK FOR MEASURING REGIONAL LOGISTICS PERFORMANCE

The development of the framework structure contains 3 distinct phases divided into several sequential steps that encompass the following topics:

1. Literature review.
2. Survey of logistics indicators.
3. Definition of criteria for the selection of indicators.
4. Preliminary list of selected indicators.
5. Selection of a set of companies to validate the previously selected indicators.
6. Validation of indicators.

As shown in Figure 1, the first phase, literature review, is based on research of scientific works and publications, it serves as basis for phase 2, which focus on LPI indicators. In this second phase, through the information obtained in the previous phase, interviews, questionnaires, focus group can be designed as tools to allow the identification of the logistics performance indicators that will be part of the framework. After identifying and classifying the indicators, the third and last phase, the logistics performance analysis, begins, focusing on the indicators

previously identified in the development phase. Finally, based on the Framework, the intention is to identify the main gaps found at the level of regional logistics. Then, the evaluation tool that can be used to validate the performance of the indicators.

The dimensions of the logistical indicators were constructed based on the LPI (Logistic Performance Index) questionnaire adapted to the regional dimension.

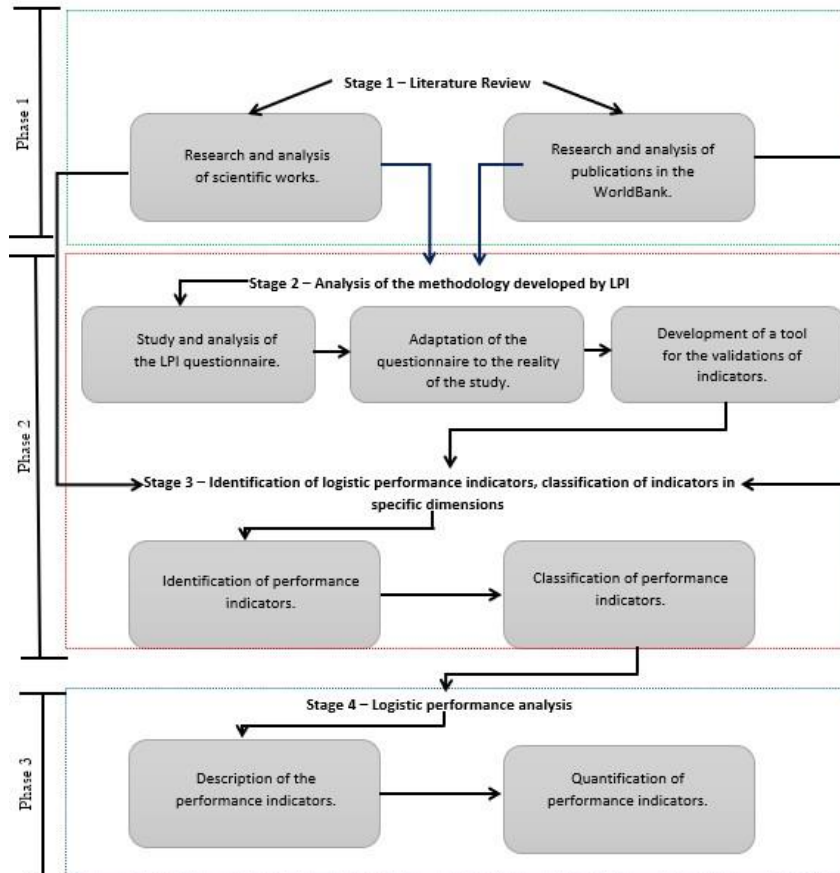


Figure 1: Framework for logistics performance.

Finally, the third and last phase of the Framework, presents the analysis of logistics performance. In this last stage, after obtaining the answers of the questionnaires, the value of each logistic indicator for each dimension will be calculated, which will allow the analysis of the logistical performance of the region. As previously mentioned, the framework was divided into 3 phases as summarized in Figure 5:

Phase 1: Literature review

- Analysis of scientific literature on performance indicators and regional development.

Phase 2: Identification of indicators for logistics performance

- Analysis of the methodology of the LPI
- Selection of a set of performance indicators that can be used and adapted to the reality of the work context (based on previous phase).
- Classification of performance indicators by dimension.
- Development of the questionnaire adapted to regional context, considering the indicators selected in the previous phase.

Phase 3: Logistic performance analysis

- Description of performance indicators by dimension and its way to measure.
- Analysis of regional logistics performance, transforming the answers obtained in questionnaires on a Likert scale from 1 to 5 and making their average.

After the development of the framework, the next topic addresses the assessment tool used in the development of performance indicators. Based on the phases presented in the previous section, a set of indicators were selected and grouped into 6 dimensions. The indicators presented in this section serve as an initial proposal to assess regional logistics performance. The table presented below are based on the methodology proposed by the LPI. It was used due to the methodology has already been validated and used in an international context. The selection of indicators has considered the context in which the companies are inserted, namely, the advantages of applying this type of methodology in the regions, and the potential that a set of indicators can do in favor of the development of the companies and regions where they are located. Table 1 presents the different dimensions for each set of indicators, namely infrastructures, tracking and tracing of goods, customs aspects, punctuality and logistics competence, regional and international shipping, and quality of logistics services. For the infrastructure dimension, 6 indicators were selected. The objective of this dimension is to analyze the conditions of the infrastructures of the companies at the regional level and to evaluate whether the companies evaluate parameters such as the breaks and obsolescence and the complaints of the customers.

Table 1: Logistics performance indicators. Source adapted from LPI World Bank (2018)

Infrastructure indicators		How to measure
I1	Percentage of companies with implemented logistics performance indicators.	(Number of companies with performance indicators implemented / Total number of companies) * 100
I2	Percentage of companies with industrial management software (Ex.: PR, WMS).	(Number of companies with industrial software implemented / Total number of companies) * 100
I3	Percentage of companies that have established loading and unloading schedules.	(Number of companies with loading and unloading hours / Total number of companies) * 100
I4	Percentage of companies with implemented reverse logistics initiatives.	(Number of companies with implemented reverse logistics initiative / Total number of companies) * 100
I5	Percentage of companies that measure breaks and obsolescence.	(Number of companies that measure breaks and obsolescence / Total number of companies) * 100
I6	Percentage of companies that measure customer complaints.	(Number of companies that measure customer complaints / Total number of companies) * 100

Regional and international shipping indicators		How to measure
RIS1	Quality assessment of regional road, rail, sea, air, storage, and regional ICT infrastructures.	Very weak; Weak; Satisfactory; Good; Very good
RIS2	Quality assessment of road, rail, sea, air, storage and international ICT infrastructures.	Very weak; Weak; Satisfactory; Good; Very good
RIS3	Number of documents needed to receive merchandise internationally	0 to 2; 3 to 5; 6 to 10; More than 10
RIS4	Number of documents needed to receive goods domestically	0 to 2; 3 to 5; 6 to 10; More than 10
RIS5	Number of documents needed to send goods domestically	0 to 2; 3 to 5; 6 to 10; More than 10
RIS6	Number of documents needed to send goods internationally	0 to 2; 3 to 5; 6 to 10; More than 10

Timeliness Indicators		How to measure
T1	Import shipments shipped and delivered on schedule	Never; Rarely; Sometimes; Oftentimes; Ever
T2	Export shipments shipped and delivered on schedule	Never; Rarely; Sometimes; Oftentimes; Ever
T3	Delays due to pre-shipment inspection	Never; Rarely; Sometimes; Oftentimes; Ever
T4	Delays due to sea transshipment	Never; Rarely; Sometimes; Oftentimes; Ever
T5	Delays due to mandatory storage/transshipment.	Never; Rarely; Sometimes; Oftentimes; Ever

Customs Indicators		How to measure
C1	Efficiency in transparency in customs clearance	Never; Rarely; Sometimes; Oftentimes; Ever
C2	Efficiency in transparency in the release of goods at the border	Never; Rarely; Sometimes; Oftentimes; Ever
C3	Classification of the competence of customs brokers	Never; Rarely; Sometimes; Oftentimes; Ever
C4	Classification of the competence of customs agencies	Never; Rarely; Sometimes; Oftentimes; Ever

Quality indicators of logistical services		How to measure
QILS1	Receiving timely information on regulations	Never; Rarely; Sometimes; Oftentimes; Ever
QILS2	Experiencing criminal activities (stolen cargo)	Never; Rarely; Sometimes; Oftentimes; Ever
QILS3	Percentage of companies that evaluate the quality of logistics services.	(Number of companies evaluating the quality of logistics services / Total number of companies) * 100
QILS4	Classification of road, rail, sea, air and storage and transport service providers.	Very low; Low; Satisfactory; Good; Very good
QILS5	Monthly collection of port and airport taxes; highways; railway; service and agent service.	0 to 5 times; 6 to 12 times; 13 to 20 times; 21 to 30 times; More than 30 times

Tracking and Tracing Indicators		How to measure
TT1	Average distance of shipments/receipts	Up to 20 km; Up to 100 km; Up to 700 km; More than 700 km
TT2	Export activities	(Number of companies with international shipments / Total number of companies) * 100
TT3	Tracking of shipments by the company	(Number of companies that track / Total number of companies) * 100
TT4	Number of companies using other means of transport than road	(Number of companies using other means of transport than road / Total number of companies) * 100

For the Tracking and Tracing dimension, 4 indicators were selected. Table 1 shows the indicators selected for this dimension. This dimension aims to analyze whether companies in

the region track their goods shipped as received goods, identify the main modes of transport that companies in the region handle and which are the main markets in which they operate. For Regional and International Shipping dimensions, 6 indicators were selected. Table 1 shows the indicators selected for this dimension that aim to assess the competence and quality of the different logistical services provided in the region and the country, at the level of regional and international shipments and infrastructure.

For the dimension of Customs aspects, 4 indicators were selected. Table 1 shows the indicators selected for this dimension that aim to assess the main difficulties that companies face in terms of the release of goods at customs and borders and how they evaluate the services provided by these logistics agents.

For the Timeliness dimension, 5 indicators were selected. Table 1 shows the indicators selected for this dimension that aim to assess whether companies experience delays in receiving and sending goods.

For the dimension of Quality of Logistical Service, 5 indicators were selected. Table 1 shows the indicators selected for this dimension, which aim to assess whether companies receive timely information about changes in regulations, experience control load theft, how service providers classify and the times they are charged fees for logistical services.

After selecting the indicators referred to in Table 1 an evaluation tool should be carried out, which can be used by companies as an initial attempt to evaluate its logistics performance in a regional level. This tool aims to verify whether companies have difficulties in answering questions and will make it possible to validate the proposed logistical indicators. This work is part of an ongoing work, the results presented here are a summary of the first outcomes from the literature. In the next step the authors developed a questionnaire to be used as tool to validate the proposed indicators through a set of companies in Portugal. The questionnaire was designed inspired by the Logistics Performance Index methodology. This tool aims to verify whether companies have difficulties in answering questions and will make it possible to validate the proposed logistical indicators.

5 CONCLUSIONS AND FUTURE RESEARCH

In this research, logistics activities and RD were discussed behind economic and social aspects. The work was based on a review of the scarce literature concerning logistics and RD. The conclusions presented in this section summarizes the novelty of this research, which lies in two main aspects, namely, bringing to the light the need for further discussion concerning the contribution of logistics activities to regional development; and the importance of developing frameworks to support companies and regional governments on measuring logistics performance at regional level. Due to the lack of research matching these topics, the research attempted to analyze data from governmental reports and scientific literature. The results of this research showed that indicators presented here can be considered as key measures to evaluate the contribution of logistics activities for different regions. If applied as good practices between companies supported by stakeholders, it can be used as positive learning process as well a benchmarking strategy among regions in a micro and macro level. As a main result, a framework for the assessment of regional logistics performance is proposed together with several logistics performance indicators to assess the impact of logistics on regional development.

The results presented here is part of ongoing work, aiming to demonstrate the benefits of logistic activities to RD. Although being initial research, the approach used here is essential for future developments integrating logistics into socio-economic development. The authors are now proceeding to develop a model resorting to a set of logistic indicators to be used in a

real case with a set of companies from a region in Portugal, aiming to understand their logistics behavior in the different regions.

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