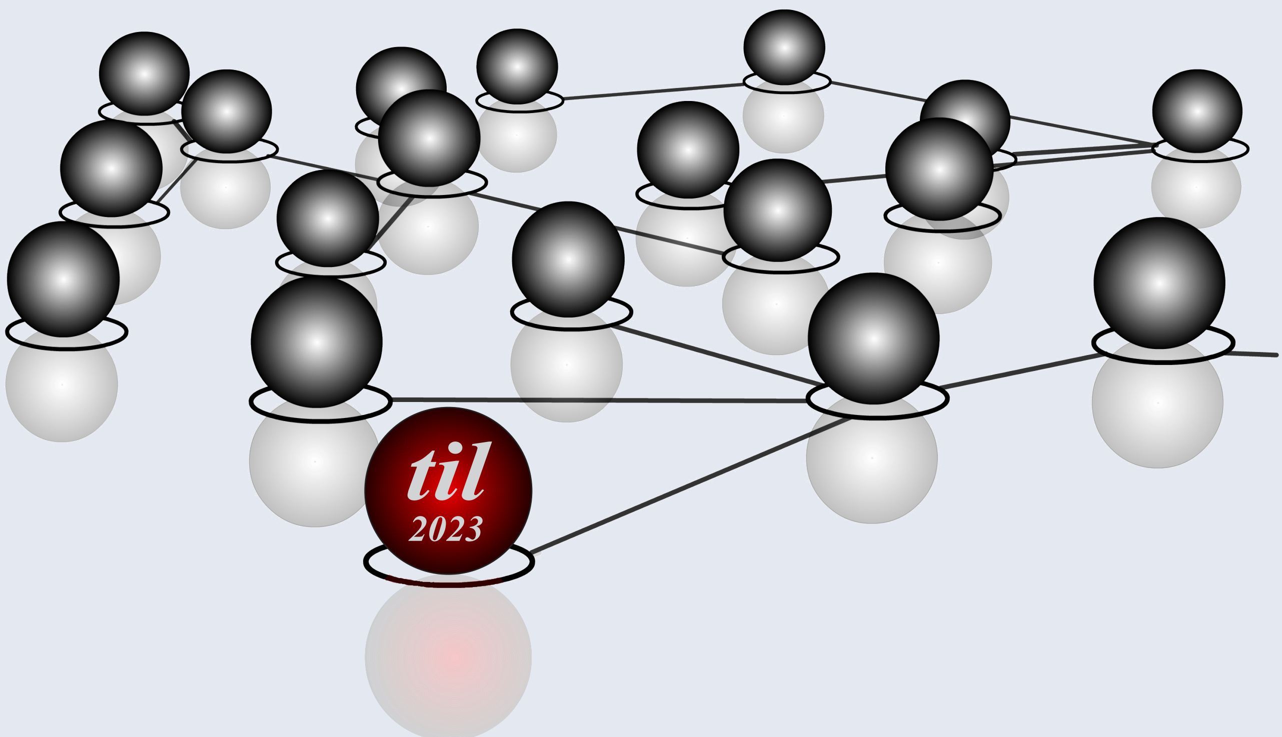
UNIVERSITY OF NIS
FACULTY OF MECHANICAL ENGINEERING
Department of Transport Engineering and Logistics

9th INTERNATIONAL CONFERENCE

TRANSPORT & LOGISTICS

PROCEEDINGS



Niš, Serbia 1 December 2023

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TRANSPORT AND LOGISTICS

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FOREWORD

In the field of transport, traffic and logistics, technical systems are created on the basis of strictly rational requirements but completely free forms of solutions and application of the latest technologies. This has led to more efficient systems, better adapted to processes, which in turn has given greater financial sustainability.

The intense global mobility of people, goods and information, with the expected tendency of further growth, indicates the need for education, research and development in the field of transport, traffic and logistics. Evaluating the importance of the development of transport and logistics in the Republic of Serbia and Southeast Europe, in 2002 the European Union, through the TEMPUS programme, adopted and allowed the funding of a three-year project entitled: *The Introduction and Development of a New Study Profile of Transport Flows and Logistics*, which was successfully implemented at the Department of Transport Engineering and Logistics of the Faculty of Mechanical Engineering, University of Niš.

With the aim of presenting the research results and plans in the field of transport and logistics, the Department of Transport Engineering and Logistics of the Faculty of Mechanical Engineering, University of Niš, has thus far organized seven scientific events under the title of Transport and Logistics. The first event was held in 2004, as a symposium, within the TEMPUS project.

The ninth international scientific conference Transport and Logistics – TIL 2023 is being held at the Faculty of Mechanical Engineering in Niš with the old aim but a new and wider scope of the field of transport and logistics, compared with the previous events. The conference is characterized by the participation of a great number of researchers from universities, faculties, institutes and various organizations from Germany, Croatia, Hungary, Macedonia, Turkey and Serbia.

Original, review and professional papers contained in the Conference Proceedings encompass the fundamental scientific areas of transport and logistics related to: transport flows, planning and control of logistics systems, design and maintenance of transport machines and vehicles. However, apart from the fundamental areas, the proceedings include, equally and legitimately, a number of papers from the scientific fields whose studies deal with urban mobility, sustainable development, environmental protection and decision-making criteria.

It can be said, as a general conclusion of the Conference, that the intense global mobility of people, goods and information, with the expected tendency of further growth, points to the needs and current trends of future research in the field of transport and logistics.

Asst. Prof. Dr. Vesna Jovanović

UNIVERSITY OF NIS
FACULTY OF MECHANICAL ENGINEERING
Department of Transport Engineering and Logistics

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PLENARY

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til 2023

DEVELOPING THE TOOL FOR ASSESSING RESILIENCE AND SAFETY CLIMATE ASPECTS IN THE TRANSPORT AND MINING COMPANIES

Ivan MIHAJLOVIĆ [1]
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Abstract

This manuscript is presenting the process of development of the original software application, e.g. the tool, to be used in assessment of the resilience level and the safety climate indicators in the industrial organizations in the transport and mining sector. The initial data that was used to develop the app was collected using the questionnaire in which employees, segmented in five different organizational levels (e.g. transport and mining machines operators, support workers, first line managers, middle level managers and top level managers), were assessing the present state and the importance of each of the investigated safety indicators. Based on this initial database the starting measurement model was developed that was used to develop the application which calculate the resilience levels of the organizations, based on adequate MCDA methods and four resilience corners approach.

***Key words**: resilience, safety climate, software application, artificial intelligence*

1 INTRODUCTION

Organizational resilience in industrial processes is a critical aspect of ensuring a company's ability to withstand and recover from disruptions, whether they are related to workplace safety disruptions, natural disasters, supply chain issues, or other unexpected events. Accordingly, organizational resilience can be defined as the ability of an organization to adapt, recover, and thrive in the face of adversity, uncertainty, and change. It encompasses various aspects of an organization, including its processes, people, technology, and culture.

In accordance to the recent literature, there are four key elements of the organizational resilience, which can be considered as the trends of research in respected field. Those are:

- *Supply Chain Resilience*: which is dealing with ensuring of the resilience across the supply chain, as vital element for industrial processes [1].
- *Change Management*: observed as the ability to adapt to changing circumstances and implement changes smoothly in the process [2].
- *Business Continuity Planning*: Developing and maintaining robust business continuity plans ensures that critical processes can continue in the event of disruptions [3].
- *Risk Management*: Effective risk assessment and management are crucial for identifying potential vulnerabilities in industrial processes. [4].

Besdes being able to define the main goals of organizational resilience in the company, which can be considered as the element of organizational strategy, it is mandatory to set the mechanism for assessment, e.g. the measurement, of the present level of achieved organizational resilience. Organizations can use various resilience indices or metrics to measure and assess their resilience. The instrument that can be proposed as adequate for this purpose is the Resilience Index. [5].

There are lots of recent publications dealing with different models of Resilience Indexes [6-8]. Special aspects of such measurement scales development are those which are implementing advanced technologies such as IoT, AI, and data analytics, which can help to predict and mitigate risks in industrial processes.

This manuscript is presenting the research that is conducted in frame of the project: "*Support Systems for Smart, Ergonomic and Sustainable Mining Machinery Workplaces – SmartMiner"* supported by the Science Fund of the Republic of Serbia, under the GRANT No. 5151. The SmartMiner concept proposes a paradigm shift from pure technology to a Human and Data-Centric Engineering, which can be easily transferred to other industries, and develops solutions for raising the level of environmental quality in complex interactions between physical, behavioural and organizational processes field, by matching advanced operator I4.0&5.0 and society S5.0 standards. Our original idea approval route starts with mining machinery operator wellbeing in its microenvironment and its cyclical alignment with stakeholders in value chain. The initial goal of the project is development of smart, ergonomic, non-invasive and reliable operator aid systems for regulation of physical environment job stressors - noise, human vibration, lighting, temperature, air quality, and workplace layout issues etc., which solve environmental and human health issues and influence overall performance. This goal is sustained with improvements in operator macro environment determined by organizational contextual factors which also impair sustainable development results (https://smartminer.mas.bg.ac.rs/). The project was initiated in May 2023 and will last until May 2025, so at this point, only the results developed until present date can be presented.

One of important issues, set to be addressed at the beginning stage of the project is assessment of the organizational resilience, based on the observed safety climate factors at the workplaces in the mining companies, which include heavy machinery operators and transport and logistics workplaces. This stage of the research is crucial element in the future direction of achievement of defined project goals.

Development of the digital tool to be used in assessment and measurement of the organizational resilience is presented in the remaining of this manuscript.

2 METHODOLOGY

The starting Organizational Resiliance Index (ORI) measurement model is presented on Figure 1. In that direction, building up on the starting model, the practical app is being designed that will be used to measure the ORI in any company.

The app is based on the user-friendly graphical user interface (GUI) in which the decision makers (top and medium level management structures) can directly rate offered list of safety indicators. Also, mining and transportation machinery operators will be able to rate the same offered list of safety indicators, however, using the online survey, built up using the Google forms.

To be able to create the GUI, initial research stage included extensive literature research aimed to select adequate set of questions to be included in the survey. The resulting survey is consisted of six parts. The first part of the survey is used for collecting the demographic data about respondents, such are: Age, Years of working experience, Qualifications, Position in the organization, Previous experience with injuries at work, … Second part of the survey included the questions aiming to collect the data about the organization: Number of employees, The age of the company, The industrial area of operations, …. Third part of the survey is dealing with technical factors of the working places. Two subgroups of technical factors were analysed: workplace equipment and the working environment conditions. Fourth part of the survey was dealing with investigation of human factors, classified in three subgroups: Knowledge about workplace safety, Employees motivation regarding the workplace safety issues, Accepting the regulations on workplace safety. Fifth part of the survey was dealing with organizational factors and was segmented in 8 subgroups of questions: Organizational support, Co-workers support, Superiors support, Employees engagement, Work safety training, Superiors dedication, Regulations and procedures on workplace safety, Employees encouragement towards workplace safety. Sixth part of the survey was dealing with sustainability issues of the organization, including Economic, Environmental, Social, Stakeholder and Voluntariness dimensions. Each of this subgroups consisted of 3 to 11 questions, making the total number of 71 questions in the survey.

Collected responses are stored in the Google cloud database and assessed by the GUI for the purpose to calculate the organizational resilience index from two aspects. The resilience index is calculated from the aspects of safety climate factors and from the aspects of four resilience corners. The safety climate aspects are the same as the sections of the survey (starting from third to sixth part of the questionnaire). The four resilience corners addressed are React, Anticipate, Monitor and Learn (RAML corners). Belonging of each of the survey questions in each of the resilience corners is done based on the opinions of the experts, obtained during the panel evaluation. This stage is of high importance, because accurately application of the resilience indicator measurement methodology strongly depends on this segment of the research [9]. Also, to be able to use adequate Multi -criterion decision making methods for analysis (MCDM), besides obtaining the ratings from the respondents on the present values of each of evaluated questions of the survey, it is mandatory to also obtain the importance of each of the safety climate factors. Accordingly, the respondents were asked to do two evaluations, first for the present value and second for the importance of each of the survey question. The entire procedure and methodology of resilience index calculations, based on mentioned two aspects, is described in detail in the reference [10].

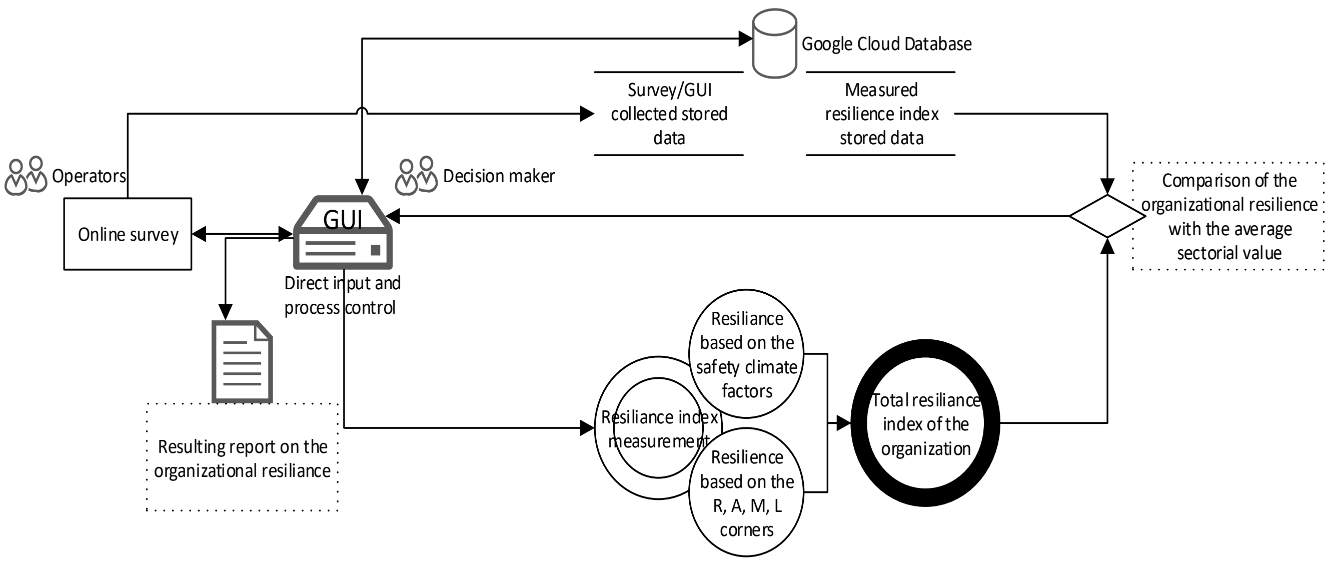

Fig. 1 Organizational Resilience Index measurement model

Obtained calculated resilience index partial values, are used for determining the overall resilience index of the organization. This value is stored in the same cloud database, together with the values calculated for previously assessed organizations. This way, using the app, based on the integrated AI models, ratings of each individual decision maker, as well as of each operator, will be used for additional updating of the database and training of the app, as well as for the comparison with the average values of all previous respondents.

Accordingly, individual ORI values calculated for any organization, will be compared to the values calculated in other organizations included in the research. There will be opportunity to make comparison among organization, without dependence on their industrial sector or to make the comparison among the organizations from same industry (sectorial comparison). This sort of benchmarking evaluation, will lead to generation of the practical advices on the operational optimization of the investigated workplaces in the investigated heavy industry sector. Those advices can be used by the organizations for their future strategic planning, as well as for operational activities targeting the improvement of their assessed level of organizational resilience.

3 RESULTS

The entire application, described in this paper, is being developed using the Python v3.10.6. The GUI is coded in the Tkinter as a Python binding to the Tk GUI toolkit [11].

The database used for this project is stored under the Google cloud console, which is open source free of charge, for up to 30 projects, of course with some limitations. Such database is limited on up to 10 reads per second and up to 10 writes per second. Considering that in this project, in its initial stage, the GUI will be used in individual organizations on the one-per-time bases, where the respondents will enter the responses through the Google form, it is not expected that this quota will be reached.

Communication among GUI and Google spreadsheets in the Google cloud database is facilitated using the Pandas – Python Data Analysis Library. The access to Google cloud and its protection is facilitated through API credentials in the form of JSON file.

At the moment of writing this manuscript, the application is still being developed. Some of the segments of the application are completed, however, due to the fact that the final product will be registered as the technical solution, its elements can not be given in the manuscript. However, until the TIL conference, most of the crucial parts of the final product will be completed, so it will be demonstrated to the conference audience in the presentation.

4 CONCLUSIONS

This paper explains the procedure of developing the software application, e.g. the tool, for measurement of the organizational resilience index, using the data obtained through the survey.

Measuring resilience through a survey involves collecting data and assessing individuals, communities, or organizations' ability to adapt and bounce back from adversity or stress. There are various methods and frameworks, available in the literature, for measuring resilience using surveys. Here is a general overview of the steps involved in creating a resilience index based on a survey, proposed in this manuscript:

1. Define the Scope and Purpose:

Determine the specific goals and objectives of intended resilience measurement. In this stage, it should be evaluated if we are interested in measuring individual, community, or organizational resilience? What aspects of resilience do we want to assess? Clarity in our purpose should be used to guide the survey design. In our case, we planned to measure organizational resilience, based on the individual opinions of its employees, so the future stages of the survey design were based on that conclusion.

2. Review Existing Models and Frameworks:

There are several established resilience models and frameworks that could be used to guide our survey development. Reviewing these existing models help us to structure our survey.

3. Select Survey Questions:

At this stage we developed and selected survey questions that align with our chosen resilience framework. These questions addressed various dimensions of industrial organizations resilience, such as technical, human, organizational factors and sustainability issues. It was important to ensure that questions are clear, concise, and easy to understand by the respondents.

4. Pilot Testing:

Before administering the survey on a larger scale, we conducted the pilot testing with a small group of respondents, to identify any issues with question clarity, length, or format. We made necessary adjustments based on the feedback.

5. Data Collection:

The survey was administered to our target population. The respondents are individuals from the mining and transport organizations. The survey included operators on the machinery, support workers, and managers of all three levels (lower, middle and top-level managers). The survey was organized using the hard copies as well as using the Google form online questionnaire. This stage of the project is still ongoing, considering that we want to ensure that we collected a representative sample to make meaningful conclusions.

6. Data Analysis:

The survey responses are being analysed using adequate statistical methods. Common statistical tools, that are used include factor analysis, regression analysis, and scale reliability assessments.

7. Scoring and Index Calculation:

In this case we are calculating overall resilience scores and scores for specific dimensions of resilience, depending on our research framework. The specific dimensions that we used are segmented as the resilience based on the safety factors and resilience based on the resilience corners. During this step we are assigning the scores to the responses based on our developed resilience model (Figure 1). This involve summing and averaging responses to specific questions and items. The resulting score is used to represent an individual's and organizational (e.g. group's) level of resilience.

8. Interpretation and Reporting:

In this stage, our model is interpreting the resilience scores in the context of our research objectives. It is considered how various factors, such as respondent's demographics or organizations descriptors, affect resilience levels. Obtained results are generated and compared with average values stored in the database. Final outcomes will be presented through reports, charts, and other visual aids to make them easily understandable.

9. Validation and Refinement:

Considering that this tool will be offered to be used by many different organizations, the database with stored survey results and calculated resilience indexes will be continuously growing. This requires continuously assess of the validity and reliability of our resilience measuring scale. In time, we may need to refine the survey questions or the scoring method based on ongoing research and feedback.

10. Use and Application:

Finally, we intend to use the resilience index measuring tool, and obtained results, to inform decision-makers, to initiate interventions, or strategy and/or policy changes aimed at enhancing resilience in the surveyed population.

At the end, it should be remembered that measuring resilience is complex operation, as it involves capturing both individual and contextual factors. The choice of resilience framework and survey design has to align with our specific research and programmatic goals. Additionally, but not less important, ethical considerations, such as ensuring participant consent and data privacy, were and still are crucial throughout the survey process.

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