CRISIS AND RISKS ENGINEERING FOR TRANSPORT SERVICES

Co-funded by the Erasmus+ Programme of the European Union

www.creng.eu

CRISIS AND RISK ENGINEERING FOR TRANSPORT SERVICES

Collective monograph

CRISIS AND RISK ENGINEERING FOR TRANSPORT SERVICES

CRISIS AND RISK ENGINEERING FOR TRANSPORT SERVICES

Collective monograph

Edited by Nataliia Chernova, Konrad Lewczuk

Kyiv
Talcom
2022

UDC 656.073:005.334](02)
I-62

The monograph was recommended for publication by the decision of the Academic Council of the Ukrainian State University of Science and Technology of the Ministry of Education and Science of Ukraine, protocol No. 7 dated June 6, 2022.

Author team: Nataliia Chernova, Nofal Hajiyev, Viacheslav Matsiuk, Iuliia Bulgakova, Ilgar Khurshudov, Valiyeva Sapargul, Hudaygulyyev Nuraly, Yevhen Demchenko, Andrii Dorosh, Maryna Khara, Iryna Nikolaienko, Andrii Lyamzin, Valerii Samsonkin, Maral Meredova, Habib Halmamedov, Yolly Myradov, Atageldi Garajayev, Fuad Dashdamirov, Nijat Zohrabov, Sharifov Allahverdi, Olha Halan, Oksana Yurchenko.

Edited by Nataliia Chernova, Konrad Lewczuk.

Scientific editors:

Nataliia Chernova, Ph.D. in Economics, Associate Professor of the Department of Economics and Management, Ukrainian State University of Science and Technology (Dnipro, Ukraine);

Konrad Lewczuk, Vice-dean for science and development of the Faculty of Transport, Ph.D., Associate Professor of the Faculty of Transport, Warsaw University of Technology (Warsaw, Poland).

Reviewers:

Yevhen Aloshynskyi, Doctor of Technical Sciences, Professor of Cracow University of Technology;

Viktor Myronenko, Doctor of Science (Technology), Professor, Head of Department Railway commercial activities management of the State University of Infrastructure and Technologies (Kyiv, Ukraine);

Marianna Jacyna, Dean of the Faculty of Transport, Full professor of the Warsaw University of Technology (Warsaw, Poland).

Crisis and Risks Engineering for Transport Services: collective monograph /
I-62 Nataliia Chernova, Valerii Samsonkin, Iuliia Bulgakova etc.; edited by Nataliia Chernova, Konrad Lewczuk. — Kyiv : Talcom, 2022. — 206 c.

ISBN 987-617-8016-57-9

Materials of scientific and practical research within the framework of the implementation of the project of the program of the European Union Erasmus+ «Crisis and Risks Engineering for Transport Services» (CRENG) are presented in the monograph.

Issues of the impact of crisis situations on the work of transport enterprises and ways to increase the efficiency of the functioning of transport and logistics systems in conditions of crises and risks are considered.

The publication is intended for scientific and pedagogical workers, graduate students and students of higher education, as well as managers and specialists of industrial enterprises and business structures, who are interested in the current state and prospects of the development of scientific research.

UDC 656.073:005.334](02)

ISBN 987-617-8016-57-9

AUTHOR TEAM

Nataliia Chernova, Head of International Relations Department, Ph.D. in Economics, Associate Professor of the Department of Economics and Management, Ukrainian State University of Science and Technologies (Dnipro, Ukraine);

Nofal Hajiyev, Head of IT department, lecturer in the department of Computer Engineering at Azerbaijan Technological University (Ganja, Azerbaijan);

Olha Halan, PhD in Information Technologies, Associate Professor of the Department of Information Technologies and Design of the State University of Infrastructure and Technologies (Kyiv, Ukraine);

Viacheslav Matsiuk, Doctor of Engineering Sciences, Professor of the Department Transport Technologies and Means in AIC, National University of Life and Environmental Sciences of Ukraine (Kyiv, Ukraine);

Iuliia Bulgakova, PhD in Engineering, Associate Professor of the Department of Railway Commercial Activities Management of the State University of Infrastructure and Technologies (Kyiv, Ukraine);

Mr. Ilgar Khurshudov, Senior Lecturer of Industrial Engineering Department of Baku Engineering University (Baku, Azerbaijan);

Mr. Arif Najimov, Chief Specialist of Baku Engineering University, Technopark, BEU Coordinator for Technology Commercialization and Transfer (Baku, Azerbaijan).

Valiyeva Sapargul, head of department Management and innovation technologies, Institute of Telecommunications and informatics of Turkmenistan (Ashgabat, Turkmenistan);

Hudaygulyyev Nuraly, lecturer of department Energy supply International University of Oil and Gas (Ashgabat, Turkmenistan);

Yevhen Demchenko, Ph.D in Technical Science, Associate Professor of the Transport Hubs Department, Ukrainian State University of Science and Technologies (Dnipro, Ukraine);

Andrii Dorosh, Ph.D in Technical Science, Associate Professor of the Transport Hubs Department, Ukrainian State University of Science and Technologies (Dnipro, Ukraine);

Maryna Khara, Deputy Dean of the Faculty of Transport Technologies, PhD in Engineering, Associate Professor of the Department of Transportation Technologies of Industrial Enterprises, Priazovskyi State Technical University (Mariupol, Ukraine);

Iryna Nikolaienko, Ph.D. in Engineering, Associate Professor of the Department of Technologies of International Transportation and Logistics, Pryazovskyi State Technical University (Mariupol, Ukraine);

Andrii Lyamzin, Head of the Department of Technologies of International Transportation and Logistics, Associate Professor, Dr. Sc. in Engineering, Pryazovskyi State Technical University (Mariupol, Ukraine);

Valerii Samsonkin, DSc in Technique, Professor of the Department of Transport Technology and Process Control Traffic, State University of Infrastructure and Technology (Kyiv, Ukraine);

Maral Meredova, PhD in Mathematics, MA in Economics, dosent of Exact and Natural Sciences department, International University for the Humanities and Development (Ashgabat, Turkmenistan);

Habib Halmamedov, Master of Education Management, instructor of Social Sciences department, International University for the Humanities and Development (Ashgabat, Turkmenistan);

Oksana Yurchenko, PhD in Engineering, Associate Professor of the Department of Railway Commercial Activities Management of the State University of Infrastructure and Technologies (Kyiv, Ukraine);

Yolly Myradov, Head of the educational department, candidate of technical sciences, Turkmen State Institute of Architecture and Construction на Turkmen State Architecture and Construction Institute (Ashgabat, Turkmenistan);

Atageldi Garajayev, Head of the department of Road construction, senior lecturer, Turkmen State Institute of Architecture and Construction на Turkmen State Architecture and Construction Institute (Ashgabat, Turkmenistan);

Fuad Dashdamirov, Director of the Institute of Logistics and Transport, Head of CRENG Service Office, Associate Professor, PhD, Azerbaijan Technical University (Baku, Azerbaijan);

Nijat Zohrabov, senior lecturer of the department «Transport equipment and management technologies», PhD, Azerbaijan Technical University (Baku, Azerbaijan);

Sharifov Allahverdi, Dean of the Faculty of Transport and Logistics, Associate Professor, PhD, Azerbaijan Technical University (Baku, Azerbaijan);

CONTENT

PREAMBLE 6

CHAPTER 1. PRINCIPLES OF WORKING WITH BIG DATA. METHODS AND TECHNIQUES OF BIG DATA ANALYSIS 11
Nofal Hajiyev, Olha Halan

CHAPTER 2. RISK AND CRISIS FORECAST, ANALYSIS AND REDUCTION METHODS AND TOOLS 26
Fuad Dashdamirov, Nidjat Zohrabov, Allahverdi Sharifov

CHAPTER 3. SIMULATION OF COMPLEX TRANSPORT PROCESSES AND SYSTEMS THAT OPERATE IN CONDITIONS OF RISKS 42
Viacheslav Matsiuk, Iuliia Bulgakova

CHAPTER 4. HUMAN FACTORS IN DESIGN & OPERATIONS 63
Mr. Ilgar Khurshudov, Mr. Arif Najimov

CHAPTER 5. HUMANITARIAN LOGISTICS AND TRANSPORT SERVICES IN DISASTERS CONDITIONS 101
Valiyeva Sapargul, Hudaygulyyev Nuraly

CHAPTER 6. NEW CHALLENGES FOR RISK AND CRISIS MANAGEMENT OF TRANSPORT SYSTEMS 124
Yevhen Demchenko, Andrii Dorosh

CHAPTER 7. SUPPLY CHAIN MANAGEMENT AND NETWORKS 142
Maryna Khara, Iryna Nikolaienko, Andrii Lyamzin

CHAPTER 8. HEALTH, SAFETY & ENVIRONMENTAL MANAGEMENT SYSTEMS 161
Valerii Samsonkin, Maral Meredova, Habib Halmamedov, Oksana Yurchenko

CHAPTER 9 PROJECT TEAM MANAGEMENT AND PERSONAL EFFECTIVENESS 179
Andrii Dorosh, Nataliia Chernova, Yolly Myradov, Atageldi Garajayev

PREAMBLE

The monograph is the result of cooperation of the educators of Ukraine, Turkmenistan, Azerbaijan with foreign partners in the framework of the implementation of the project of the program of the European Union Erasmus+ «Crisis and Risks Engineering for Transport Services» (CRENG) № 598218-EPP-1-2018-1-PL-EPPKA2-CBHE-JP.

The development of risk and crisis engineering in transport is now a very current direction in the world. In the context of globalization, there is a steady increase in freight and passenger traffic. The development of technology dictates changes in the structure of supply chains and their technical equipment. Such changes make the transport system difficult to manage, increase the risk of errors and the cost of overcoming crises.

Practice has shown that even in the EU there are not enough specialists in risk and crisis engineering. One example is the recent events in the EU in 2014 related to the military conflict in Syria. There were no optimal solutions, sufficient information support for the organization of refugee transportation. European universities have analyzed this experience and started developing master's degree programs in risk and crisis engineering in transport and logistics.

In Partner Countries (Ukraine, Azerbaijan, Turkmenistan), the relevance of training future specialists in risk and crisis engineering is dictated by the growing demand for relevant competencies, which arose against the background of the difficult political and economic situation in the countries and the state of uncertainty of key processes. Leading companies send employees abroad on advanced training. At the same time, Partner Countries have potential to educate such specialists on its own.

The CRENG project is interregional, bringing together the EU countries, the Eastern Partnership countries (Ukraine, Azerbaijan) and Central Asia (Turkmenistan). The relevance exactly of the interregional partnership is that the transport systems of all partner countries play a key role in the development of the transport route TRACECA (Transport Corridor Europe-Caucasus-Asia) and have great prospects to be part of the New Silk road. In such conditions the question of harmonious development of transport systems of these countries and achievement of their full interoperability arises. It is the development of knowledge and education, based on the transfer of experience and best practices, should be the basis for harmonizing the transport systems of partner countries.

The global goal of the project is to support the development of crisis and risks engineering in the field of transport services to ensure the sustainability of transport systems of Ukraine, Azerbaijan and Turkmenistan for their integration into the global transport network. To contribute to the development of crisis and risk engineering in the field of transport services in the partner countries, an environment will be created for the training of highly qualified specialists in demand in the labor market, based on European best practices and the Bologna Process. To achieve the global goal, the project has the following **objectives:**

– to develop, implement and accredit a new practice-oriented master's program «Crisis and Risk Engineering for Transport Services» in Ukraine, Azerbaijan and Turkmenistan;

– to bring higher education institutions of Ukraine, Azerbaijan and Turkmenistan closer to the labor market in the field of crisis and risk engineering for transport services;

– to stimulate cooperation between higher education institutions of the EU and Ukraine, Azerbaijan, Turkmenistan in the field of crisis engineering and risks for transport services.

The consortium of the CRENG project consists of organizations from the EU countries — Poland, Germany and France and organizations from EU partner countries — Ukraine, Azerbaijan and Turkmenistan. The European part of the consortium is represented by leading EU organizations and universities that have transferred scientific and practical experience in the field of risk and crisis management in the field of transport services and best practices in managing large-scale international projects. The consortium of partner countries includes the best higher education institutions, transport companies, Ministries of Education, joint hard work and cooperation which allowed to transfer EU experience and ensure sufficient impact of the project results on the development of transport industry in Ukraine, Azerbaijan and Turkmenistan.

CRENG project partners with the **EU** are: Warsaw Polytechnic, Poland (project coordinator); Berlin Technical University, Germany; Polytechnic University of Hauts-de-France, France; Exolaunch GmbH, Germany.

Ukraine is represented in the consortium by: Pryazovskyi State Technical University, Ukrainian State University of Science and Technology, State University of Infrastructure and Technology, JSC «Ukrzaliznytsia».

From **Azerbaijan**, the project is attended by: Baku Engineering University, Azerbaijan Technical University, Azerbaijan Technological University, Baku Transport Agency, Ministry of Education of the Republic of Azerbaijan.

Partners from **Turkmenistan** are: the Institute of Telecommunications and Information Technologies of Turkmenistan, the International University of Humanities and Development, the Turkmen State Institute of Architecture and Civil Engineering, the Ministry of Education of Turkmenistan.

To achieve the goals of the project the following **tasks** were set and performed:

1. Improved qualification of teachers of partner countries universities in the latest approaches to crisis and risk engineering in the field of transport services in EU universities.

Teachers from partner countries have completed a two-week internship at leading EU universities. During the internship teachers:

– mastered the newest academic content and the newest teaching methodology of its, got acquainted with the laboratory base and current areas of research in the field of crisis and risks engineering for transport services;

– attended master classes on various aspects of project management;

– took part in round tables on the discussion and final formation of the content of new disciplines and the concept of the master's CRENG.

2. An environment has been created for teaching and studying new disciplines in crisis and risk engineering in the field of transport services, which includes

methodological support for teaching disciplines, e-courses based on the MOODLE platform, academic and research laboratories.

The new master's program is formed by disciplines, the names of which are consonant with the titles of the sections of the monograph.

CRENG Laboratory is a powerful complex for modeling and presenting the results of modeling complex transport processes, namely powerful workstations and specialized software Any Logic. The laboratories are unique and available only at CRENG partner universities.

3. New Master's Program «Crisis and Risk Engineering in Transport Services» launched in nine patner universities.

4. A new tool for cooperation between universities and employers «Skills Wallet» has been introduced, which consists in organizing the acquisition of certain competencies at the university by students exclusively at the request of a particular employer, crediting such learning outcomes and adequately presenting them to the employer to decide on the employment of the student.

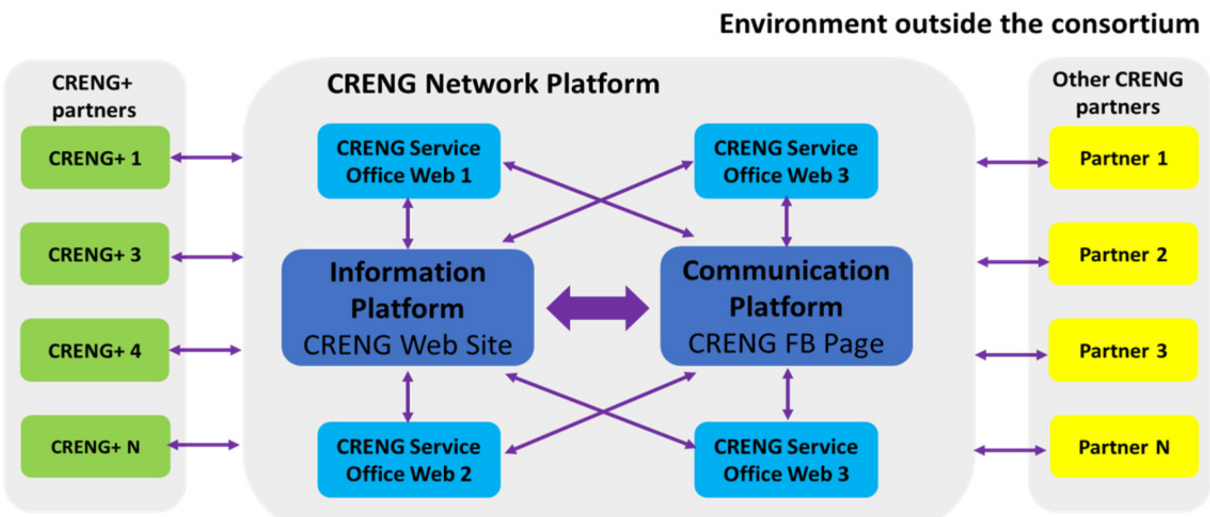
5. Introduced method of project-based learning in the international environment (International Project Based Learning, IPBL). The IPBL method is a strong tool for developing students' soft skills, which is based on the organization of long-term work of students in groups, including with foreign students, on a relevant project for the industry.

6. Pilot training of students for the new master's program «Crisis and Risk Engineering for transport services» was conducted.

At the stages of development of the master's program, content of academic disciplines, pilot training, the quality of results was monitored with the involvement of groups of external and internal stakeholders: teachers, students, employers.

This approach guarantees the provision of needs of students in quality education, employers — in obtaining a specialist with the necessary competencies, comprehensive development and improvement of education and a new master's program in accordance with changes in the economic environment.

7. Developed and launched a strategy to ensure the sustainability and dissemination of project results, including the creation of CRENG Network (Pic. 1) and CRENG web platform.



Pic. 1. CRENG Network diagram

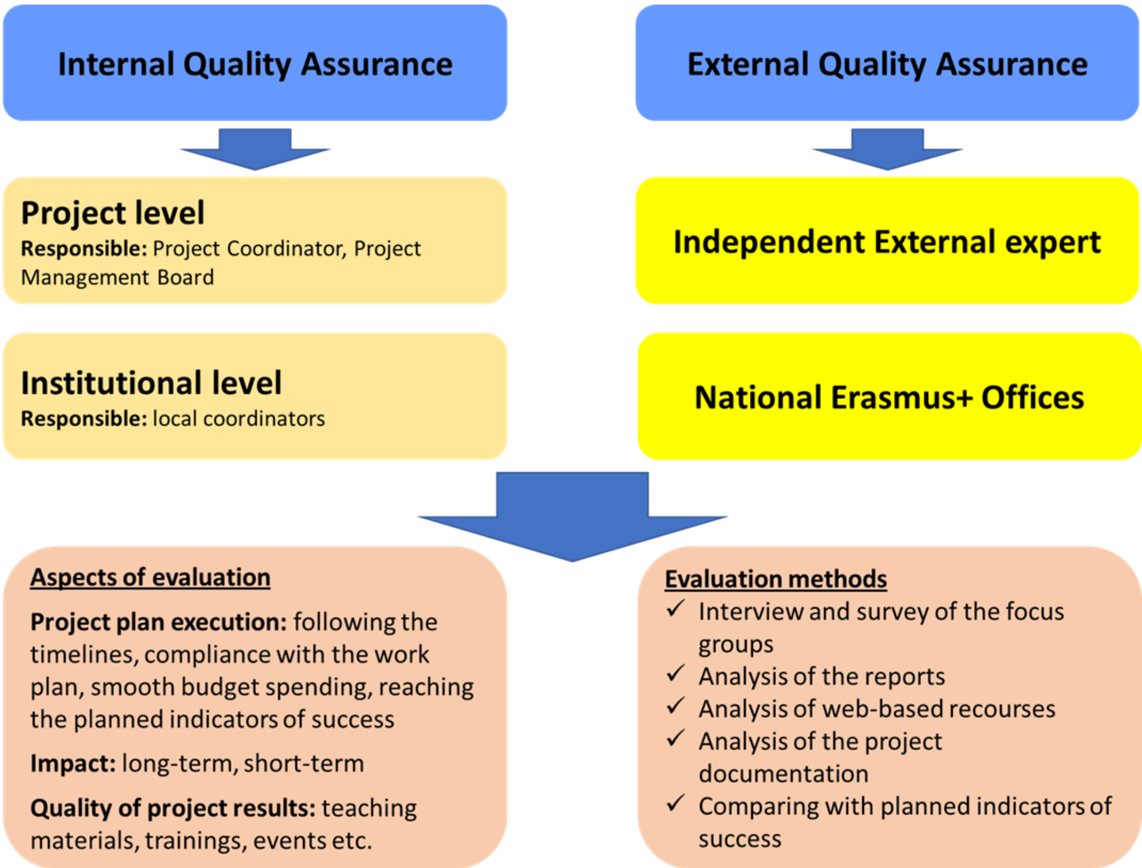
CRENG web platform — an electronic information resource based on the official website of the project and in addition to general information about the project activities contains all developed materials (project documentation, methodological support of disciplines, texts of master's programs, publications, lecturer presentations, etc.). Additional means of disseminating information about the project are the CRENG project pages on the official partners' websites, and the project group in the Face Book.

The impact of the CRENG project is expected at the individual, institutional, regional, national and international levels in the short-term (before the end of funding) and in the long-term (within 5 years after the end of funding) perspective.

To ensure and scaling the impact of the project at different levels, an action plan for communicating project results has been developed (Dissemination and Sustainability Plan) for different categories of target audience: students, academic and administrative staff of higher education institutions, transport industry managers, employing companies, etc.

The main tools for implementing the Dissemination and Sustainability Plan are:

CRENG web platform — an electronic information resource based on the official website of the project and in addition to general information about the project activities contains all developed materials (project documentation, methodological support of disciplines, texts of master's programs, publications, lecturer presentations, etc.). Additional means of disseminating information about the project are the CRENG project pages on the official partners' websites, and the project group in the Face Book.



Pic. 2. CRENG project Quality Assurance systems

CRENG service office — a structural unit created in each partner university, whose activities are focused on the established interactions of the academic and business environment in order to further develop the direction of crises and risks engineering in education and science. Among the main functions of the CRENG service office are: promotion of the CRENG project, labor market monitoring, involvement of employers in assessing the quality of training, involvement of companies in cooperation in the field of implementation and introduction of scientific research results, etc. In order to promote the activities for each CRENG service office, a page in the Face Book has been created.

CRENG + Cooperation agreement — is an agreement between the member organizations of a CRENG project consortium and interested organizations outside the consortium to shared effective use the results of the CRENG project. The agreement becomes effective upon signature of the CRENG + Cooperation Agreement between one member of the CRENG project consortium and a partner outside the consortium.

CRENG Network — a combination of all tools for implementing the Dissemination and Sustainability Plan based on the CRENG web platform in order to effective use the results of the project, ensure their sustainability and high impact at all levels. The information function of the network is performed by the CRENG web platform, the communication function is performed by the group in Face Book.

All information about the project, its results and events is posted on the official website of the CRENG project https://creng.eu/.

Iuliia Bulgakova, Konrad Lewczuk
CRENG Project Managers

CHAPTER 1
PRINCIPLES OF WORKING WITH BIG DATA. METHODS AND TECHNIQUES OF BIG DATA ANALYSIS

Nofal HAJIYEV
Olha HALAN

Data are formally described facts that need to be translated into information. Until recently, when we talked about data processing, we meant an integral combination of algorithmic, logical or statistical operations on relatively small volumes of data. However, the proximity of computer technology to the real world increases the need for data to be converted into information in the real world. The amount of data being processed is increasing, the demand for processing speed is increasing, and there is a need to create information technology (IT) solutions that can process very large arrays of data in various formats in real time.

IT is logically little different from material technology, with raw data at the input and structured information at the output in a form that is easier for human perception to use to turn information into useful knowledge. That is, the computer processes the raw data, separates the useful ones and writes them in a usable form. Joint analysis of data collected from different sources and in different formats and obtaining new knowledge and useful information from them is a common technological process. For this reason, general laws must be applied to information technology, as other technologies develop on this basis. This is, first of all, an increase in the volume of recycled raw materials and an increase in the quality of processing. Thus, under the name «Big Data» appeared a quality transition that will lead to significant changes in computer technology, and it is no coincidence that it is called the industrial revolution.

Over time, computer programs come closer to the real world in their versatility. The increase in the volume of unprocessed data, combined with the need for real-time analysis, makes it necessary to develop and implement tools that can effectively solve the problem of Big Data Analytics. As a result, the accumulation of large amounts of information, as well as their rapid growth, has recently begun to attract more attention, both in the academic environment and in the IT industry. According to statistics from the analytical company Miniwatts Marketing Group, in the first quarter of 2015, more than 3 billion people, or 42.4% of the world's population, were connected to the Internet and the number of mobile subscribers reached 7.1 billion. By 2020, the number of devices connected to the Internet is expected to reach 50 billion. In 2012, the volume of digital information in the world was 2.7 zetabytes. In 2015, this volume is projected to increase threefold and by 40% for the next year. However, such a rapid growth of digital information, the diversity of data, the high growth rate of their transmission cause many problems. As noted, the storage, processing, analysis, and management of large data in real time have already created problems. However, the big data (BV) problem is still at the level of preliminary research, ie this area has not yet been fully analyzed. The research allows to classify the concept of «Big Data», its essence, various characteristics, to study the sources of BV, the possibilities, problems and security issues of this technology. Studies show that the processing and analysis of BV requires advanced analytical technologies and tools.

Recently, numerous conferences, symposiums, seminars and forums dedicated to the Big Data problem have been held with the participation of influential international organizations, scientific institutions and giant companies in the field of IT. Various aspects of processing large volumes of data are discussed and researched here. Based on a number of open-ended questions, future directions and opportunities for future research in this field are identified. These research areas provide the basis for the development of optimal methods for solving the problems of BV. Therefore, it is important and relevant to study the scientific and theoretical problems of this technology as an object of scientific research.

Today, Big Data is a concept used by IT giant vendors and international analytics agencies. It should be noted that when studying Big Data technology and the features that distinguish this technology from others, one can come across different opinions. According to experts, Big Data is a set of technologies and has the following features [9–16]: — Very large volume. Currently, the scale of BV is characterized by a volume from terabytes to zetabytes. Today, such a volume of data at the enterprise level is no longer surprising. — Numerous sources of information. It is well known that business intelligence (BA — Business intelligence) is a method and tool needed to turn unprocessed information into a meaningful, convenient form. There are several sources of information in traditional BA, and Big Data has dozens, thousands of external sources. — Unstructured information. The Traditional Database (VD) is based on a relational database and is a tool for searching for structured information. There is a need to create a new tool to address issues such as the collection and storage, retrieval, security, and analysis of various types of unstructured information in the hundreds of terabytes and exabytes that ordinary relational databases cannot process. The bulk of Big Data sources are also unstructured and partially structured data. In this case, the Big Data approach offers a search based on templates, which in principle is a more perfect solution, which in turn implies a structure for storing information that is different from a relational database. — Dynamically changing information. BV is characterized by the collection of very large arrays of information, which is a problem facing any organization today. Large volumes primarily create storage problems, which require large-scale storage and distributed processing. Even filtering data at the entrance is becoming increasingly expensive. It is known that storage technologies are expensive and their depreciation is slower than the emergence of new data sources. In this regard, at the organizational level, it is necessary to determine exactly how long this or that data will be stored. For example, some data may be required by the organization for many years, while others may be useless after a few hours (after analysts have taken what they need). Recently, the application of grid and cloud computing technologies for data processing and storage has almost eliminated the problems in the field of storage. Thus, Big Data addresses similar issues with BA's traditional tools in a broader context in terms of volume, source, structure, and distribution. As a result, Big Data and BA differ significantly in terms of technology.

Most of the current research is aimed at solving the technological problems of BV. The main sources of Big Data are digital sensors and social networks, data transmitters in various fields, banking operations, geographic information systems (GIS), Global Positioning System signals (GPS), scientific experiments, e-mail, digital photos and videos taken via smartphones, large companies' markets, large sales centers, domain name servers (DNS), etc. contane. Appropriate technologies are needed for the productive use of large amounts of data generated by these sources. These include data collection, storage and analytical processing systems. The following technology groups can be used in its various parts:

– analytical algorithms;
– parallel programming methods;
– cloud computing resources;
– computing systems from personal computers to strategic supercomputers;
– storage systems;
– networks;
– various types of input devices, from complex telescopes and tomographs to simple Radio Frequency Identification (RFID) technologies, etc.

2. DATA MINING AND MACHINE LEARNING

Machine learning is a set of tools that, broadly speaking, allow us to «teach» computers how to perform tasks by providing examples of how they should be done. For example, suppose we wish to write a program to distinguish between valid email messages and unwanted spam. We could try to write a set of simple rules, for example, flagging messages that contain certain features (such as the word «password» or obviously-fake headers). However, writing rules to accurately distinguish which text is valid can actually be quite difficult to do well, resulting either in many missed spam messages, or, worse, many lost emails. Worse, the spammers will actively adjust the way they send spam in order to trick these strategies (e.g., writing «p@ssw0rd»). Writing effective rules — and keeping them up-to-date — quickly becomes an insurmountable task. Fortunately, machine learning has provided a solution. Modern spam filters are «learned» from examples: we provide the learning algorithm with example emails which we have manually labeled as «ham» (valid email) or «spam» (unwanted email), and the algorithms learn to distinguish between them automatically. Machine learning is a diverse and exciting field, and there are multiple ways of defining it:

1. The Artifical Intelligence View. Learning is central to human knowledge and intelligence, and, likewise, it is also essential for building intelligent machines. Years of effort in AI has shown that trying to build intelligent computers by programming all the rules cannot be done; automatic learning is crucial. For example, we humans are not born with the ability to understand language — we learn it — and it makes sense to try to have computers learn language instead of trying to program it all it

2. The Software Engineering View. Machine learning allows us to program computers by example, which can be easier than writing code the traditional way.

3. The Stats View. Machine learning is the marriage of computer science and statistics: computational techniques are applied to statistical problems. Machine learning has been applied to a vast number of problems in many contexts, beyond the

typical statistics problems. Machine learning is often designed with different considerations than statistics (e.g., speed is often more important than accuracy).

Often, machine learning methods are broken into two phases:

1. Training: A model is learned from a collection of training data.

2. Application: The model is used to make decisions about some new test data.

For example, in the spam filtering case, the training data constitutes email messages labeled as ham or spam, and each new email message that we receive (and wish to classify) is test data. However, there are other ways in which machine learning is used as well

Types of Machine Learning

Some of the main types of machine learning are:

1. Supervised Learning, in which the training data is labeled with the correct answers, e.g., «spam» or «ham.» The two most common types of supervised learning are classification (where the outputs are discrete labels, as in spam filtering) and regression (where the outputs are real-valued).

2. Unsupervised learning, in which we are given a collection of unlabeled data, which we wish to analyze and discover patterns within. The two most important examples are dimension reduction and clustering.

3. Reinforcement learning, in which an agent (e.g., a robot or controller) seeks to learn the optimal actions to take based the outcomes of past actions.

There are many other types of machine learning as well, for example:

1. Semi-supervised learning, in which only a subset of the training data is labeled

2. Time-series forecasting, such as in financial markets

3. Anomaly detection such as used for fault-detection in factories and in surveillance

4. Active learning, in which obtaining data is expensive, and so an algorithm must determine which training data to acquire and many others.

A simple problem

Figure 1 shows a 1D regression problem. The goal is to fit a 1D curve to a few points. Which curve is best to fit these points? There are infinitely many curves that fit the data, and, because the data might be noisy, we might not even want to fit the data precisely. Hence, machine learning requires that we make certain choices:

1. How do we parameterize the model we fit? For the example in Figure 1, how do we parameterize the curve; should we try to explain the data with a linear function, a quadratic, or a sinusoidal curve?

2. What criteria (e.g., objective function) do we use to judge the quality of the fit? For example, when fitting a curve to noisy data, it is common to measure the quality of the fit in terms of the squared error between the data we are given and the fitted curve. When minimizing the squared error, the resulting fit is usually called a least-squares estimate

3. Some types of models and some model parameters can be very expensive to optimize well. How long are we willing to wait for a solution, or can we use approximations (or handtuning) instead?

4. Ideally we want to find a model that will provide useful predictions in future situations. That is, although we might learn a model from training data, we ultimately care about how well it works on future test data. When a model fits training data well, but performs poorly on test data, we say that the model has overfit the training data; i.e., the model has fit properties of the input that are not particularly relevant to the task at hand (e.g., Figures 1 (top row and bottom left)). Such properties are refered to as noise. When this happens we say that the model does not generalize well to the test data. Rather it produces predictions on the test data that are much less accurate than you might have hoped for given the fit to the training data.

Machine learning provides a wide selection of options by which to answer these questions, along with the vast experience of the community as to which methods tend to be successful on a particular class of data-set. Some more advanced methods provide ways of automating some of these choices, such as automatically selecting between alternative models, and there is some beautiful theory that assists in gaining a deeper understanding of learning. In practice, there is no single «silver bullet» for all learning. Using machine learning in practice requires that you make use of your own prior knowledge and experimentation to solve problems.

3. SYSTEMS OF ANALYTICAL DATA PROCESSING OLAP

Operational analysis of large amounts of data for various purposes is always a serious problem for managers. Analysis of the scientific and technical literature shows that the applied products, as well as other analytical systems still do not fully meet all the requirements. Gartner, McKinsey Global Institute, IDC (International Data Corporation) and others. In recent research by companies such as BV is presented as a growing, dynamically developing field. An analytical report by the McKinsey Global Institute lists the analysis methods used in Big Data.

• Data Mining class methods — association rule learning, classification, cluster analysis, regression analysis, etc.;

• online analytical processing (OLAP);

• crowdsourcing — processing of data by a group of people involved on the basis of a social contract, without labor relations;

• data fusion and integration — technical tools that allow you to integrate different data from different sources to provide in-depth analysis. Examples include digital signal processing and natural language processing (including tonal analysis);

• machine learning — this includes teacher and non-teacher learning, as well as collective learning, statistical analysis to obtain complex predictions based on basic models, or the use of machine-based models (constituent models, when a model is part of a larger model);

• genetic algorithms, including artificial neural networks, network analysis, optimization;

• image recognition;

• predicate analytics;

• imitation modeling;

• Spatial analysis — methods that use topological, geometric and geographical information in the data;

• statistical analysis, such as A / B testing and time series analysis;

• Visualization of analytical data — presentation of information using images, diagrams, interactive features and animation to obtain results, further analysis, use as primary data.

All available methods, starting with the classic B-trees, are useful for multi-dimensional operations on Big Data. Today, traditional VXs provide approximately the same set of data analysis tools [56–58]. Products that allow you to work with the methods listed in BVs, analytically process information in terabytes of RAM, for example, SAP HANA, Greenplum Chorus, Oracle Exalytics, Oracle Exadata, Aster Data nCluster. In addition, Netezza, Teradata, Greenplum and others. companies have software and hardware tools that efficiently process data in terabytes and exabytes based on traditional relational data management systems. To understand the potential of such solutions, it is necessary to look at the algorithms based on these methods, as well as to analyze the ways for their possible parallel calculations, which are key to the processing of BV. In this case, it should not be tied to specific distributed data processing technologies, but only the basic parameters (intensity of network interactions, volume, speed, etc.) characteristic of the BV should be taken into account. An important factor influencing the speed of any VBIS is the number of input / output operations and the efficiency of the generated indices. Thus, when working with Big data, as a first step in solving the problem, it is recommended to classify according to the data format to be processed, type of analysis, applied processing methods, as well as data sources that the target system will receive, download, process and analyze.

Online analytical processing. OLAP (On-line Analytical Processing) — means the operational, analytical, multidimensional processing of data online to support management decision-making. The essence of the method is to build a multi-dimensional cube and obtain its various sections. By organizing analytical data in the form of multidimensional cubes, a simple, meaningful model is obtained. The result of the analysis is usually a table with aggregate indicators in the cells (number, average, minimum or maximum value, etc.). The operation of the OLAP system generally consists of four stages:

– data collection;

– data storage;

– loading of data into multidimensional cubes of analytical subsystems;

– description of the data.

Depending on the realization, ie where the data used for analysis is stored, multidimensional analysis systems are divided into the following types

• MOLAP — Multidimensional OLAP. Both data and aggregates are stored in a multidimensional VB.

• ROLAP — relational OLAP. The data is stored in its previous relational VB, and the aggregates are collected in special worksheets created in that VB.

• HOLAP — hybrid OLAP (Hybrid OLAP). The data is stored in relational, and the aggregates are stored in multidimensional VB.

• DOLAP — desktop OLAP (Desktop OLAP). It is a product for local, multidimensional analysis that does not support multi-user mode and is used to process small volumes of data.

The most common of these are ROLAP systems based on relational VBIS, and they are more transparent and studied. The internal structure of MOLAP and HOLAP systems is usually more closed and belongs to the know-how area of specific commercial products. MOLAP describes the data in a multidimensional model, but internally uses a «star» and «snowball» scheme from ROLAP. From the point of view of VBIS, the ROLAP database is an ordinary relational database and supports all operations for it. However, it has a number of shortcomings. For example, it is not possible to control the data entry phase, it is not possible to collect statistics and select the optimal structure for storing indexes. It is not possible to optimize the placement of data on disk to ensure high input / output speeds, and there is no possibility to cache intermediate aggregate values. Finally, due to the need for high speed when performing analytical surveys, it is not possible to conduct in-depth statistical analysis and work with an optimal implementation plan of the solution. ROLAP uses relational query optimizations that do not take into account database multidimensionality. MOLAP technologies do not have these shortcomings and therefore allow to obtain high analysis speeds.

The choice of MOLAP, ROLAP, HOLAP technology during the analysis of Big data depends on the frequency of database updates. From the point of view of parallel processing, at first glance, any multidimensional cube can be «cut» on the distribution of one of the dimensions and distributed between several servers. For example, the cube is divided by time periods (years and months), by area (each server is responsible for its own region), and so on. can be divided. It is known that during the division of the cube, the execution of a multidimensional query is not on one, but on several servers, after which the results are collected as a whole. For example, if the user asks for the required statistics for the country during the specified period, and the data is distributed on several regional OLAP-servers, then each server returns its own specific answer, and as a result, all the data is collected together. If the data is distributed over time, then the entire load falls on one server during the execution of the query sample in question. This situation causes the following problems.

– it is difficult to predict the optimal distribution of data on servers;

— It is not known in advance which data will be needed for which part of the analytical queries, from which servers.

In Big data, this means that existing approaches to multidimensional analysis can be well scaled, and they allow for the collection of distributed information. Thus, each server can independently collect information, clean it and upload it to the local database.

5. MAP REDUCE AND HADOOP TECHNOLOGIES OF BIG DATA PROCESSING

Hadoop

Hadoop, in plain terms, is an open source library used to process big data on ordinary servers. It provides massive storage for any kind of data, very high processing power, and the ability to manage an almost unlimited number of simultaneous tasks.

It enables you to efficiently manage and process big data in a distributed computing environment. Hadoop consists of four main modules.

1. HDFS (Hadoop Distributed File System)

It is Hadoop's file system. It is a distributed file system used to process big data on clusters of ordinary servers. It provides better data throughput compared to traditional file systems. It combines ordinary server disks and creates a large virtual disk. This makes it possible to store and process very large files.

YARN (Yet Another Resource Negotiator)

YARN facilitates scheduled tasks, overall management, and monitoring of cluster nodes (Cluster Nodes) and other resources.

MapReduce

Hadoop MapReduce module helps programs to process data simultaneously. The threads are dispersed over the cluster and perform simultaneous processing. MapReduce's Map task transforms input data into key-value pairs. The Reduce task takes the input, aggregates the information, and produces the result. This is where the great power of Hadoop comes into play. Network traffic is not busy because the read of the processed files is always over the local disk of the respective node. Moreover, the performance increases proportionally as the number of nodes in the cluster increases.

Hadoop Common

It is the common module that helps in big data processing and supports all Hadoop modules.

Why is Hadoop in Big Data Important?

Hadoop is a great solution for big data processing and an essential tool for businesses dealing with big data.

It has the ability to quickly store and process all kinds of data in different formats.

Hadoop's distributed processing model processes big data quickly. The more computing nodes you use, the more processing power you have.

It is protected against hardware failure. If a node fails, jobs are automatically redirected to other nodes. Make sure that the operation does not fail. Multiple copies of all data are automatically stored.

Unlike traditional relational databases, you don't need to preprocess data before storing it. You can store as much data as you want and then decide how to use it. This is true even for unstructured data such as text, images and videos.

Its cost is low. The open source framework is free. It uses ordinary hardware to store large amounts of data.

It is suitable for enlargement. You can easily grow it by adding nodes to your system to process more data.

Hadoop's Big Data Tools

There are many open source tools that improve Hadoop's ability to handle big data.

Hive: Data warehouse for processing large datasets stored in Hadoop's file system.

Zookeeper: Monitoring tool.

Hbase: An open source unbound database for Hadoop.

Flume: A distributed service that streams large amounts of log data.

Sqoop: It is a command line tool for moving data between Hadoop and relational databases.

Pig: Allows you to perform complex data transformations without the need for Java. The software language used is Pig Latin.

Oozie: It is a scheduling system that facilitates the management of Hadoop jobs.

Hcatalog: It is a storage and table management tool used to organize data from different data manipulation tools.

Hadoop is highly efficient at handling big data, especially in networks where millions of data flow. It is an extremely useful tool for companies that deal with large amounts of data. Today, giants such as Amazon, Facebook and LinkedIn also analyze their big data with Hadoop.

With its Big Data and Advanced Analytics Services, GTech provides consultancy services to determine the most suitable big data platform (Hadoop, NoSQL, etc.) and capacity for your company's big data needs and to establish the infrastructure. It also provides maintenance support for the development and continuity of the created big data ecosystem.

You can request a demo on issues such as installation of Hadoop (Oracle BDA, Cloudera etc.) environments, Kerberos and LDAP security settings, Installation/maintenance of technologies such as Elasticsearch, Cassandra, MongoDB, Creation of data lakes, Data analytics support, Oracle Big Data SQL technology and integration of Oracle Databases and big data environments

What is Hadoop? Let's Get to Know Its Components 1 (HDFS,MapReduce)

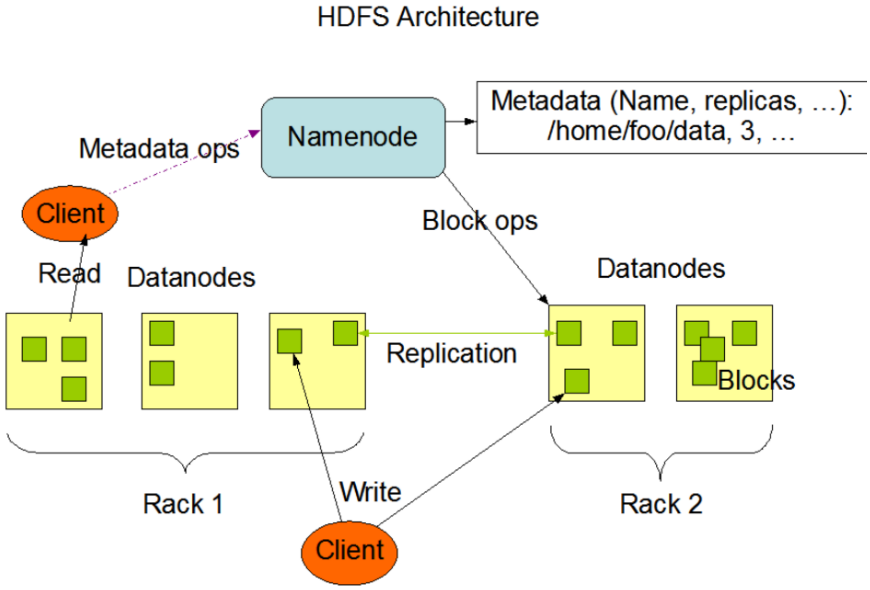
Hadoop is a popular, open source Apache project developed with the JAVA programming language using the MapReduce programming model. Available through the Apache open source license, this software enables secure and scalable computing at its core, responsible for low cost, fault tolerance, load balancing, data distribution and processing.

6. HBASE AS A MEANS OF STORING AND PROCESSING DATA IN THE HADOOP ECOSYSTEM

HDFS (Hadoop Distributed File System)

HDFS, one of the fundamental building blocks of Hadoop, is a self-healing distributed file system capable of fault-tolerant, reliable and scalable data storage. Since it supports the distributed structure, it works in relation to MapReduce in operations related to storage and computation. It can create a large disk space even by combining the disks of simple servers and offers a longer cost solution.

HDFS accepts all types of data and automatically optimizes data while providing high bandwidth. One of the most important features of HDFS is fault tolerance. In the event of a failure in any of the nodes in the distributed file system, it provides the transfer of data and allows the service to continue. This structure is similar to the Raid structure and prevents data loss.



The HDFS file system stores metadata and application data separately. It stores metadata on a special server called NameNode, and application data on other servers called DataNode. All servers communicate with each other via TCP-based protocols.

Nodes called DataNodes in DHFS do not use a Raid structure. Instead, they replicate the file content in the Google File System (GFS) across multiple DataNodes for reliability.

2.1. NameNode

NameNode stores and manages its metadata about the file system in a file called fsimage. They are retrieved in main memory to provide faster access to clients on read/write requests. NameNode manages and controls how files are divided into blocks. The information on which nodes the fragments and copies of the file are on is located here.

2.2. DataNode

They are the primary storage elements of HDFS, controlled by NameNode. There can be more than one DataNode. On DataNodes, each block copy is represented by two files on the host. The first file contains the data itself, while the second file contains the metadata including the checksums of the block data and the creation stamp of the block.

Initially, a handshake (handshake) is performed on the NameNode. At this stage, the namespace identity and software versions of the DataNode are checked. All nodes in the cluster have the same island space. Nodes with different namespaces will not be able to join the cluster, thus preserving the integrity of the file system.

NameNodes communicate with DataNodes via signals.

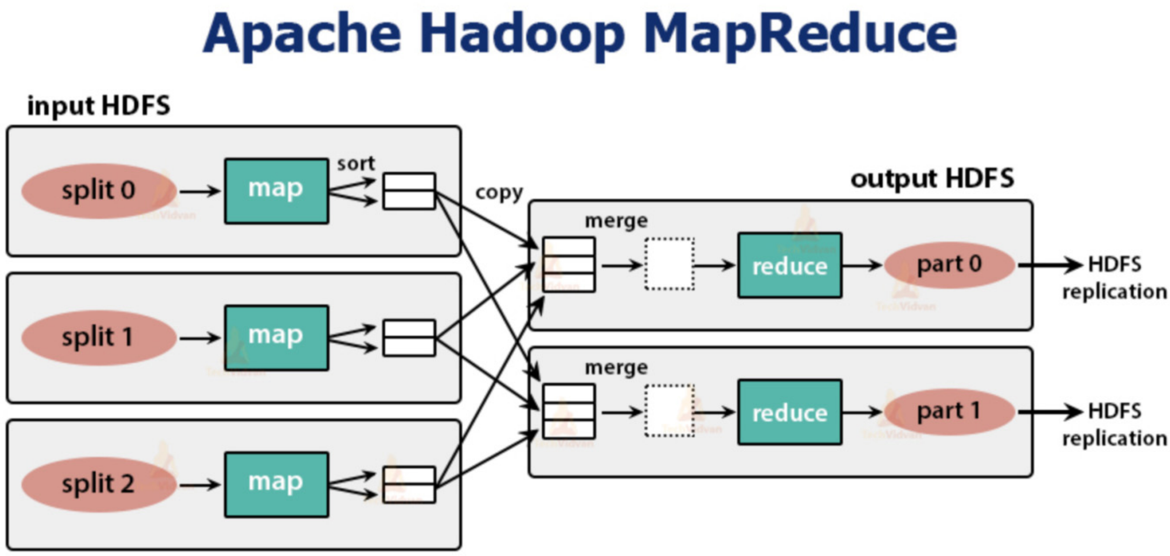
2.3 HDFS Client

When an application reads a file, the HDFS client first communicates with the NameNode to request a list of DataNodes where copies of the file block it wants to read are hosted. It then communicates with any DataNode and requests the transfer of the desired block.

When an application wants to write a file, it first asks the NameNode to choose a DataNode to host the replicas of the first block, and the client sends the data.

3. MapReduce

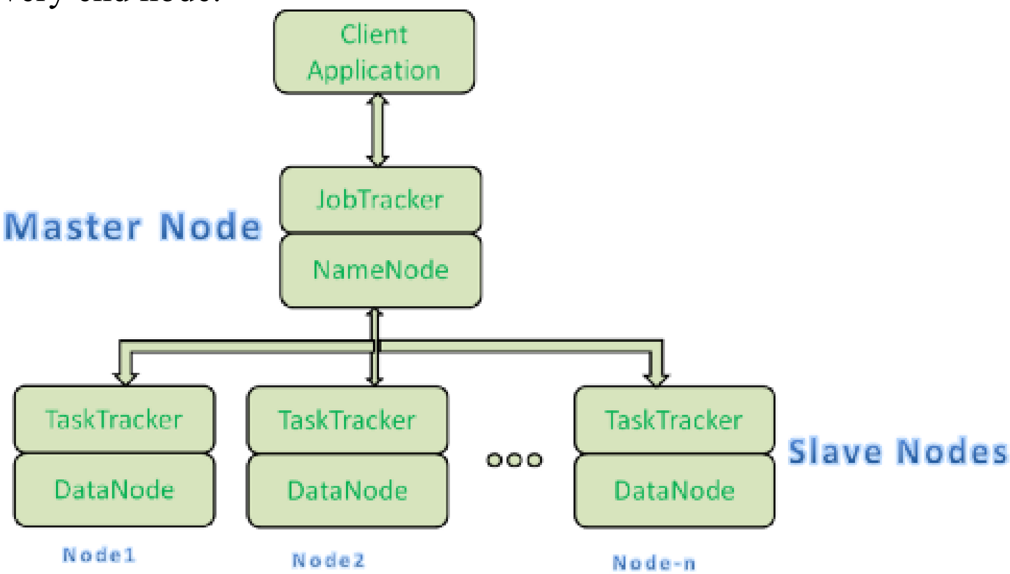
MapReduce, a distributed programming model developed by Google, is used for applications that perform parallel processing and analysis of large data sets.



First, the Map phase takes place, the data is filtered, and then the Recude (reducing) operation is performed to obtain results.

When a Map operation is completed, it can switch to the Recude operation. There is no need to wait for all Map operations.

Similar to HDFS, MapReduce runs on JobTracker master node and TaskTracker runs on every end node.



3.1. JobTracker

It runs on NameNode and monitors MapReduce tasks executed by TaskTracker on DataNode. The application sending the request to the master node sends the job to JobTracker, and then JobTracker contacts the NameNode to find out the location of the data to be processed in HDFS. After knowing its location, JobTracker finds the

TaskTracker on the relevant nodes and forwards the jobs to the slave nodes. While TaskTrackers are executing processes, it periodically sends signals to JobTracker and is informed whether the job is running or not.

If no signal is received by TaskTracker running on the edge nodes for a certain period of time, the job is run again by another TaskTracker. If JobTracker does not run, all execution will be stopped. This is considered a weak point for Hadoop MapReduce.

3.2. TaskTracker

They run on the DataNode. They accept jobs submitted by JobTracker and execute MapReduce operations. The TaskTracker MapReduce process ensures the continuity of work-related processes and signals JobTracker that it is alive.

8. IT AND BIG DATA SECURITY

IT and Big data security is a constant concern because Big data deployments are valuable targets to would-be intruders. A single ransomware attack might leave your big data deployment subject to ransom demands. Even worse, an unauthorized user may gain access to your big data to siphon off and sell valuable information. The losses can be severe. Your IP may be spread everywhere to unauthorized buyers, you may suffer fines and judgments from regulators, and you can have big reputational losses.

Securing big data platforms takes a mix of traditional security tools, newly developed toolsets, and intelligent processes for monitoring security throughout the life of the platform.

Big Data Security Overview

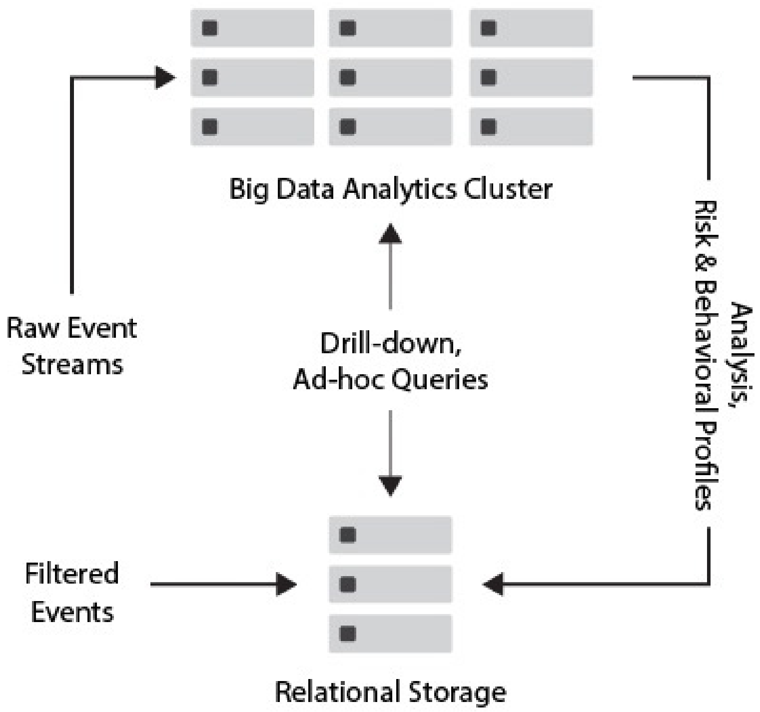
Big data security's mission is clear enough: keep out on unauthorized users and intrusions with firewalls, strong user authentication, end-user training, and intrusion protection systems (IPS) and intrusion detection systems (IDS). In case someone does gain access, encrypt your data in-transit and at-rest.

This sounds like any network security strategy. However, big data environments add another level of security because security tools must operate during three data stages that are not all present in the network. These are 1) data ingress (what's coming in), 2) stored data (what's stored), and 3) data output (what's going out to applications and reports).

Data Sources. Big data sources come from a variety of sources and data types. User-generated data alone can include CRM or ERM data, transactional and database data, and vast amounts of unstructured data such as email messages or social media posts. In addition to this, you have the whole world of machine generated data including logs and sensors. You need to secure this data in-transit from sources to the platform.

Stored Data. Protecting stored data takes mature security toolsets including encryption at rest, strong user authentication, and intrusion protection and planning. You will also need to run your security toolsets across a distributed cluster platform with many servers and nodes. In addition, your security tools must protect log files and analytics tools as they operate inside the platform.

Output Data. The entire reason for the complexity and expense of the big data platform is being able to run meaningful analytics across massive data volumes and different types of data. These analytics output results to applications, reports, and dashboards. This extremely valuable intelligence makes for a rich target for intrusion, and it is critical to encrypt output as well as ingress. Also, secure compliance at this stage: make certain that results going out to end-users do not contain regulated data.



One of challenges of Big Data security is that data is routed through a circuitous path, and in theory could be vulnerable at more than one point.

Big Data Security Challenges

There are several challenges to securing big data that can compromise its security. Keep in mind that these challenges are by no means limited to on-premise big data platforms. They also pertain to the cloud. When you host your big data platform in the cloud, take nothing for granted. Work closely with your provider to overcome these same challenges with strong security service level agreements.

Typical Challenges to Securing Big Data:

- Advanced analytic tools for unstructured big data and nonrelational databases (NoSQL) are newer technologies in active development. It can be difficult for security software and processes to protect these new toolsets.
- Mature security tools effectively protect data ingress and storage. However, they may not have the same impact on data output from multiple analytics tools to multiple locations.
- Big data administrators may decide to mine data without permission or notification. Whether the motivation is curiosity or criminal profit, your security tools need to monitor and alert on suspicious access no matter where it comes from.
- The sheer size of a big data installation, terabytes to petabytes large, is too big for routine security audits. And because most big data platforms are cluster-based, this introduces multiple vulnerabilities across multiple nodes and servers.

• If the big data owner does not regularly update security for the environment, they are at risk of data loss and exposure.

Big Data Security Technologies

None of these big data security tools are new. What is new is their scalability and the ability to secure multiple types of data in different stages.

• **Encryption:** Your encryption tools need to secure data in-transit and at-rest, and they need to do it across massive data volumes. Encryption also needs to operate on many different types of data, both user- and machine-generated. Encryption tools also need to work with different analytics toolsets and their output data, and on common big data storage formats including relational database management systems (RDBMS), non-relational databases like NoSQL, and specialized filesystems such as Hadoop Distributed File System (HDFS).

• **Centralized Key Management:** Centralized key management has been a security best practice for many years. It applies just as strongly in big data environments, especially those with wide geographical distribution. Best practices include policy-driven automation, logging, on-demand key delivery, and abstracting key management from key usage.

• **User Access Control:** User access control may be the most basic network security tool, but many companies practice minimal control because the management overhead can be so high. This is dangerous enough at the network level, and can be disastrous for the big data platform. Strong user access control requires a policy-based approach that automates access based on user and role-based settings. Policy driven automation manages complex user control levels, such as multiple administrator settings that protect the big data platform against inside attack.

• **Intrusion Detection and Prevention:** Intrusion detection and prevention systems are security workhorses. This does not make them any less valuable to the big data platform. Big data's value and distributed architecture lends itself to intrusion attempts. IPS enables security admins to protect the big data platform from intrusion, and should an intrusion succeed, IDS quarantine the intrusion before it does significant damage.

• **Physical Security:** Don't ignore physical security. Build it in when you deploy your big data platform in your own data center, or carefully do due diligence around your cloud provider's data center security. Physical security systems can deny data center access to strangers or to staff members who have no business being in sensitive areas. Video surveillance and security logs will do the same.

Big Data Security Companies

Digital security is a huge field with thousands of vendors. Big data security is a considerably smaller sector given its high technical challenges and scalability requirements. However, big data owners are willing and able to spend money to secure the valuable employments, and vendors are responding. Below are a few representative big data security companies.

• Thales (Vormetric): Vormetric Data Security Platform offers security controls and encryption across all three stages of data and big data platforms: incoming data, stored data, and results output. Its technologies include encryption, key management, and access control. It also audits and reports for governance and compliance purposes.

- Cloudwick: Cloudwick Data Analytics Platform (CDAP) builds on Intel Xeon and Cloudera's Hadoop distribution. CDAP is a managed data security hub that aggregates security features from multiple from multiple analytics toolsets, machine learning projects, and traditional IDS and IPS.
- IBM: IBM Security Guardium monitors security and compliance and big data and NoSQL environments. It includes sensitive data discovery and classification, vulnerability assessment, and data and file monitoring. Guardium also masks, encrypts, blocks, alerts, and quarantines suspicious access attempts.
- Logtrust: Logtrust partnered with Panda Security to provide the Advanced Reporting Tool (ART) and Panda Adaptive Defense. ART automatically reports attacks and suspicious digital behaviors and detects internal threats to big data systems and networks. Panda Adaptive Defense correlates data from multiple sources, which is critical in big data environments with multiple nodes and data sources.
- Gemalto: Gemalto SafeNet protects big data platforms in the cloud, data center, and virtual environments. The toolset includes strong authentication and digital signing solutions, data-at-rest and in-motion encryption, and cryptographic key security and management. Gemalto integrates with leading big data providers including MongoDB, Cloudera, Couchbase, DataStax, Hortonworks, IBM, and Zettaset.
- Who Is Responsible for Big Data Security?
- A big data deployment crosses multiple business units. IT, database administrators, programmers, quality testers, InfoSec, compliance officers, and business units are all responsible in some way for the big data deployment. Who is responsible for securing big data?
- The answer is everyone. IT and InfoSec are responsible for policies, procedures, and security software that effectively protect the big data deployment against malware and unauthorized user access. Compliance officers must work closely with this team to protect compliance, such as automatically stripping credit card numbers from results sent to a quality control team. DBAs should work closely with IT and InfoSec to safeguard their databases.
- Finally, end-users are just as responsible for protecting company data. Ironically, even though many companies use their big data platform to detect intrusion anomalies, that big data platform is just as vulnerable to malware and intrusion as any stored data. One of the simplest ways for attackers to infiltrate networks including big data platforms is simple email. Although most users will know to delete the usual awkward attempts from Nigerian princes and fake FedEx shipments, some phishing attacks are extremely sophisticated. When you are administering security for your big data platform — or you are an end-user combing through your email — never ignore the power of a lowly email.
- Secure your big data platform from high threats and low, and it will serve your business well for many years.

CHAPTER 2
RISK AND CRISIS FORECAST, ANALYSIS AND REDUCTION METHODS AND TOOLS

Fuad DASHDAMIROV,
Nidjat ZOHRABOV,
Allahverdi SHARIFOV

INTRODUCTION

Transport is a complex adaptive system with multiple modes and assets at different stages of their lifecycle, and upstream and downstream interdependencies with other infrastructure systems, including water, Information Communications and Technology (ICT), energy, and the built environment. These manmade assets interact in turn with the natural assets in their environment. All these manmade and natural assets and systems are delivered, maintained, operated, and regulated by a range of agents and institutions. The complex interactions between these different physical, social, economic, and institutional elements are often non-linear, chaotic, and unpredictable. Unknown risks can also emerge over time and cascade throughout the system.

Physical man-made infrastructure originates and exists in socio-economic contexts and interacts with the surrounding social, economic, financial, political, manufactured, and ecological environment. Transport is a particular form of infrastructure where this is evident. Transport networks have developed over long periods of time and evolved into a patchwork of physical networks consisting of varied transport links and modes, and old and new infrastructure with different design lives. These are governed by multiple institutions and actors, both public and private, with different funding streams, regulatory authorities, operations and maintenance processes.

In order to understand the behavior of transport infrastructure and why «disasters» occur it must be seen and modelled as a *complex adaptive system*. A system is defined as complex when its behavior cannot be reduced to the properties and behaviors of its individual components. The technical, human, organizational, and societal components of the system interact in complex and unpredictable ways. Risks can emerge through these interactions across different Complex *adaptive* systems are also characterized by their capacity to self-organize and adapt in response to the feedback received from the environment. Transport systems have this capacity for adaption as they include decision makers, infrastructure providers, and users who will «adapt» to changing circumstances.

ABBREVIATIONS

RAE — Relative Absolute Error
UMBRAE — Unscaled Mean Bounded Relative Absolute Error

1. RISK AND RESILIENCE

1.1. Defining resilience

Resilience is best seen as an emergent property of what a system does, rather than what it has. Resilience encompasses a longer timescale of analysis and acknowledges that in a complex system failure is inevitable and there will always be unknown shocks and stresses. A system may not recover to its previous state, but contains the ability to adapt, self-organize, renew, learn, innovate, and transform. This definition particularly emphasizes «bouncing forward» rather than «bouncing back» to the conditions that might have resulted in the disaster in the first place. These qualities are critical in an uncertain and unpredictable environment.

Resilience refers to the ability of a system to withstand and absorb disruption (through reducing vulnerability, exposure, and increasing the system's coping and adaptive capacities), continue to maintain functionality during an event and recover, and learn and adapt from adverse events. Resilience is also a useful bridging concept between disaster risk reduction and climate change adaptation as it ties together risk mitigation and recovering from an event when it does occur.

1.2. Risk-based approaches

Versus Resilience

Risk analysis is a process that characterizes the vulnerabilities and threats to specific components to assess the expected loss of critical functionality.

Two key elements of complex engineered systems pose issues for the applicability of risk assessment: (1) The interconnectedness of social, technical, and economic networks and (2) Unexpected extreme shocks.

• A resilience approach involves adapting to changing conditions and designing in controlled failure (safe to fail) to reduce the possibilities of cascading failures affecting the entire system. Risk management and resilience approaches are complementary and both are needed to build resilience in a transport system. Sometimes conflicts can arise between increasing robustness (fail-proof design) and resilience, however, this can be managed if robust structures are planned and designed with the overall system's resilience in mind.

1.3. Measuring resilience

The key challenge to combining risk and resilience approaches is developing a common understanding of how to quantify resilience, particularly given the different perspectives of resilience (ecological, socio-ecological, and engineering). The second challenge is to go beyond assessing physical coupling, which is easier to quantify, and take into account resilience characteristics and interdependencies at the institutional, organizational and economic scale.

1.3.1. Quantitative measures

Probabilistic measures of resilience tend to measure the joint probability of meeting robustness and rapidity objectives in the event of a failure in the system. There are a number of challenges in determining a network's level of resilience.

Firstly, resilience is a property that emerges from the interactions between system elements over time, rather than a property of its individual elements. Furthermore, there are few effective measures to explain the effect of transportation on the region's economy and society and poor data at the network level. The resilience of a system also depends on whether the system meets the user's needs in terms of journey time and reliability. Yet each user has a different understanding of resilience and tolerance for failure, posing additional challenges in accurately capturing and measuring a «resilient» transport system. Finally, quantitative measures of resilience entail significant time and cost constraints and require a high level of skill and training, as well as detailed information about the system.

1.3.2. Qualitative measures

An alternative is to develop a proxy for measuring resilience by identifying the qualitative characteristics of a resilient system. Whilst these are subjective, they are more flexible and involve engaging more of the key stakeholders in a system, which is an important component of identifying and planning transport projects.

2. ELEMENTS OF RISK

The risk associated with a particular hazardous situation depends on the following elements:

a) the severity of harm that can result from the considered hazard;

b) the probability of occurrence of that harm, which is a function of:

– the exposure to the hazard;

– the occurrence of a hazardous event;

– the possibilities of avoiding or limiting the harm.

The elements of risk are shown in figure 2.1.

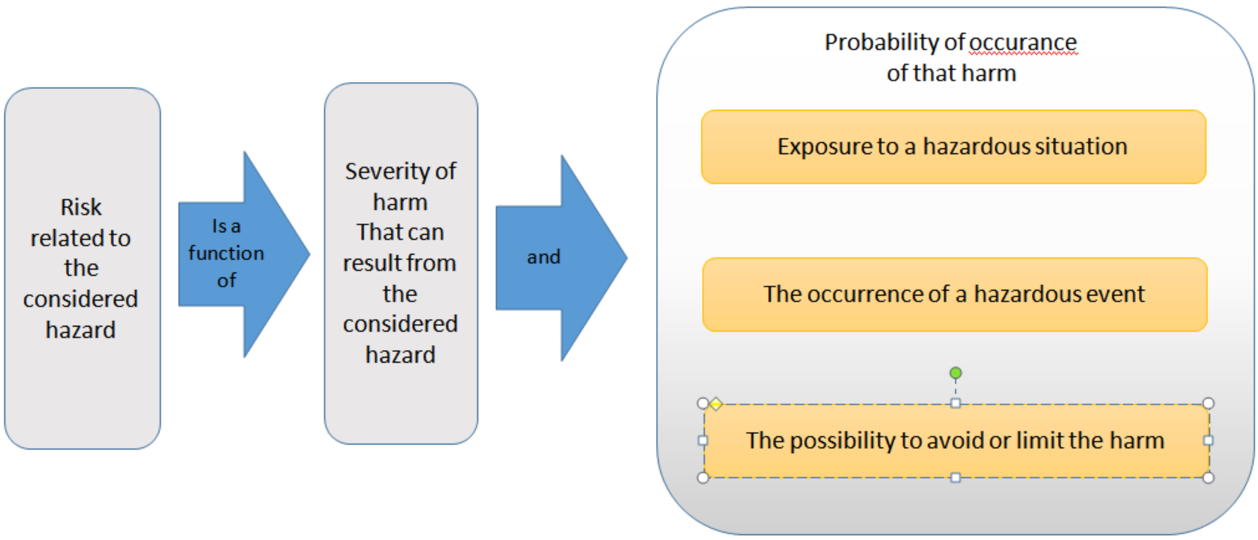


Figure 2.1. Elements of risk

3. CRISIS PLANNING INCREASING EFFECTIVENESS, DECREASING DISCOMFORT

The old saying goes, into each life some rain must fall. Likewise, we might say, into each business some crisis must occur. Whether loss of data from a computer glitch, loss of equipment, or life due to a full-scale natural disaster, adversity strikes businesses with alarming frequency and little warning. Just as individuals save for rainy days to mitigate their ill-effects, businesses can benefit from employing a proactive strategy toward potential crises. Crisis management entails minimizing the impact of an unexpected event in the life of an organization. Oxford Executive Research Centre study showed that publicly traded companies able to execute disaster recovery plans reduced the initial negative capital impact by 60%; companies unable to execute plans had initial losses equating to 11% of their capitalization and average stock price losses of almost 15% (West, 2003). In fact, evidence shows that the effective execution of well-developed crisis plans can not only control crises; it can create competitive advantage for the «afflicted» organizations.

3.1 Crisis planning process

As a necessity, businesses are viewing crisis planning with increased interest. But understanding the importance of crisis planning is different from developing effective plans, particularly when management may have to sell the need for crisis planning to organizational cultures that previously looked upon the effort as a waste of time and money. Attempting to plan for all the potential crises that could conceivably strike a business can be time-consuming, tiresome, and difficult. As such, even organizations that choose to plan for crises may find their plans shallow, overly-simplistic, or ineffective when crises occur and plans are put to the test. To effectively tackle adversity then, management must not only believe in the value of crisis planning, they need to understand the components of effective crisis planning and implement those components in their organizations. Discussed here is a five-step process that management can follow to create sufficiently detailed, comprehensive crisis plans. By following the process of forming a team, analyzing vulnerabilities, creating strategies, working the plans, and assessing performance, managers can decrease their discomfort regarding crisis planning and increase the probability that their organizations will survive, or perhaps even benefit from, times of crisis.

4. RISK EVALUATION AND MODELLING PROCESS

Evaluation of risk is made up of several stages (Figure 4.1). First stage involves diagnose of potential risk in oversized or heavyweight loads transportation process. A model could not be developed unless there is a clear understanding of its definition and identification of issues involved in the process. is necessary to identified reasons/factors which could cause denial impact of a transport process.

The evaluation of the results let's to estimate risk reducing techniques and helps to choose a strategy for reduction negative impact in order to minimize risk The process involves a cycle of risk estimation, evaluation of risk estimates, identification of risk reduction strategies and implementation of risk reduction strategies In load transportation process the most important factor for calculating of accident probability.

Evaluation of potential participants in accident can be divided into two groups of vehicles: cargo and passenger vehicles used for commercial purposes and private cars. According to the character of load carried by commercial vehicles it is appropriate to distinguish perishable, not perishable and dangerous goods. All these factors influence risk level.

Vehicles during the transportation process cause some negative affects such as delay, damaging of the load, drivers or other road users death, negative impact to the physical road condition and people, who are living in environment of road.

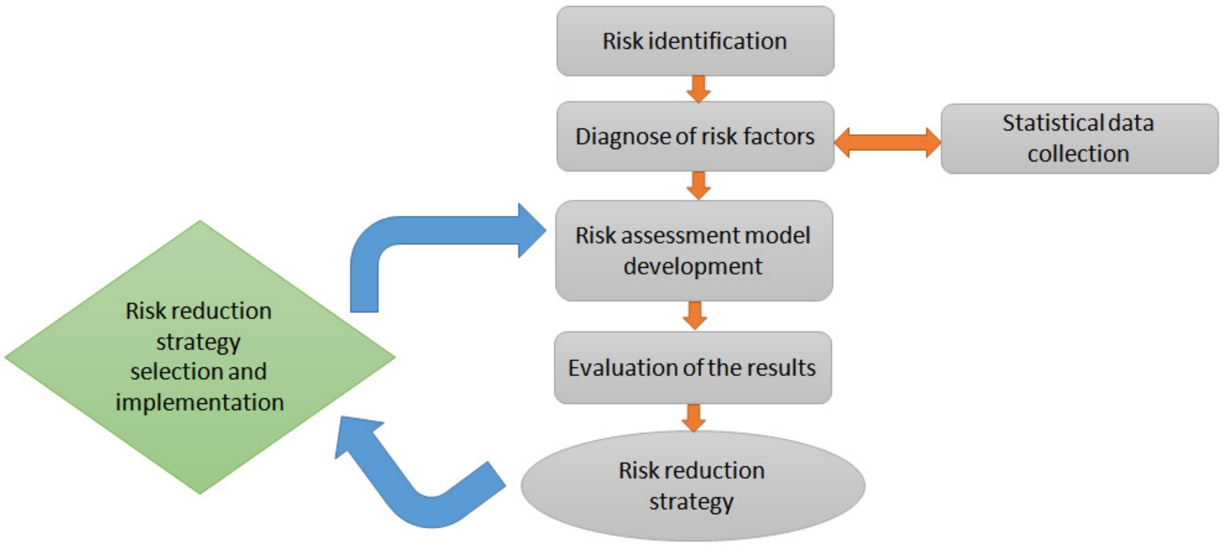


Figure 4.1. Risk evaluation process

In transportation process of oversized and heavyweight loads it is possible temporary to prohibit the movement of other transport means in order to reduce the risk in section of the route or along the route.

In classical risk model for calculating the risk is as follows:

$$R = p \times C$$

Where R — risk; p — accident probability; C — the consequences of an accident.

Accident probability calculation is based on the assumption that calculation unit is clear and is modelled using Poisson distribution:

$$f(k;\lambda) = \frac{e^{-\lambda}\lambda^{k}}{k!}$$

Where e — is the base of natural logarithm (e = 2.71828…); k — is number of occurrences of an event; λ — is a positive real number, equal to the expected number of occurrences during the given interval.

An accident is measured per unit of time (accident per year) or space (accident per vehiclekilometre).

If heavyweight and oversized load is moving without limiting the movement of other road users in section of the route in that case it should be measured number of accidents within the road section within a given unit of time per kilometre. The annual accident rate per thousand is calculated using the following formula:

$$R_A = \frac{A \times 100}{TNA \times 365}$$

Where: R_A — accident rate; A — the number of accident involving heavyweight vehicles per year; TNA — transportation distance.

Probability of an accident in the transportation route depends on various factors such as load carrying frequency, heavyweight vehicle traffic, transportation distance, road technical parameters, pavement quality, daytime and seasonality (Figure 4.2).

Risk evaluation scheme may include more factors. Evaluating the probability of an event needs to analyses the frequency of load carrying and travel distance.

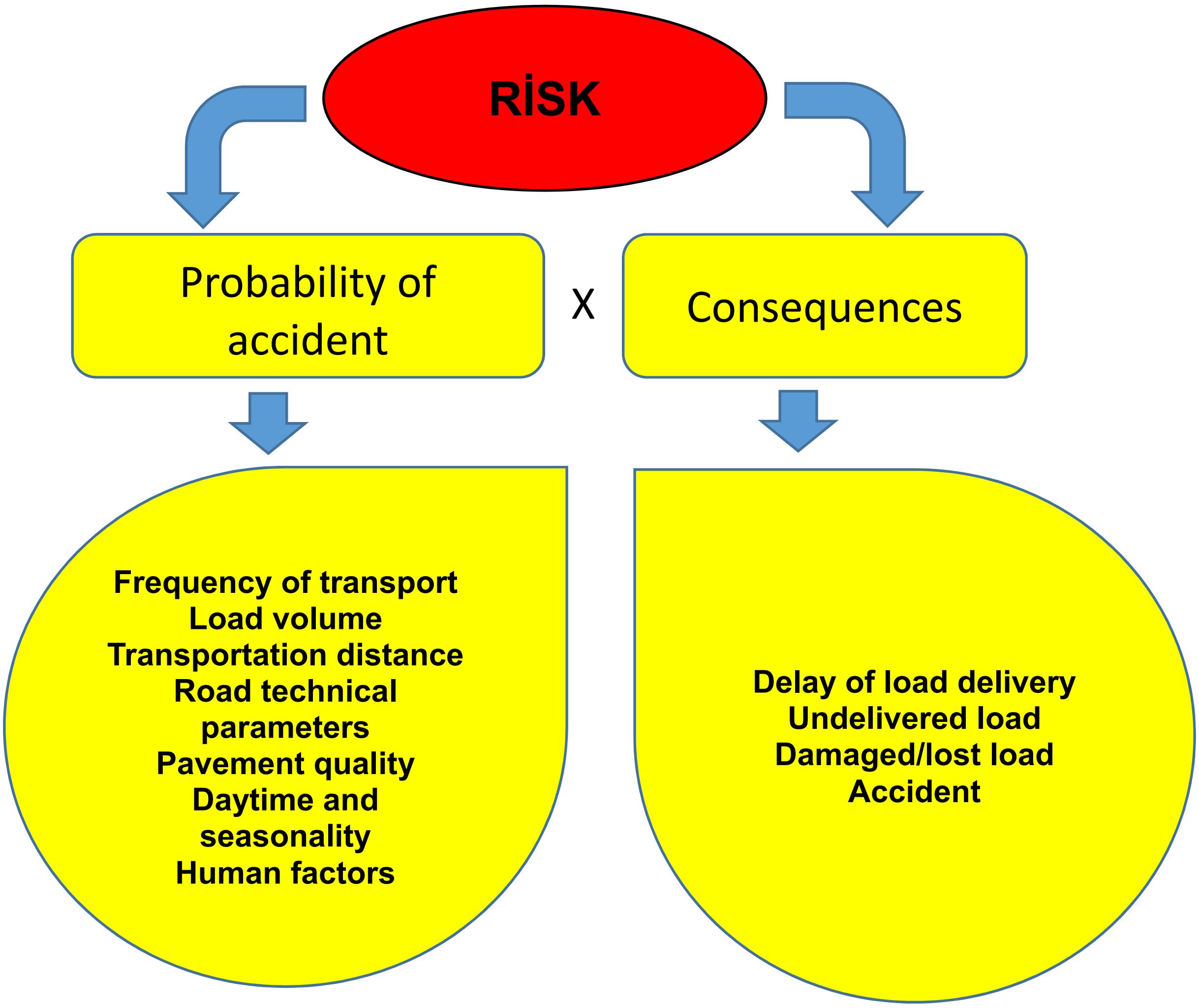


Figure 4.2. Risk evaluation scheme

Consequences. Consequences may be determined by the potential effect. As example could be late delivery of goods lost or damage, the number of fatalities. Evaluation of consequences in road section depends on access of data about accidents and consequences. Negative consequence per year can be calculated using the following formula:

$$C = VMTPS \times 365 \times M \times c$$

Where $VMTPS$ — is the average daily amount of heavyweight transport means passing route segment; M — average weight of the load; c — cost for carrying 1 ton of load.

The risk of road segment from point to point can be expressed:

$$R_{ij} = P_{ij} \times VMTPS_{ij} \times 365 \times M \times c$$

Where: R_{ij} — risk of road segment $i - j$, per year; P_{ij} — accident probability in road segment $i - j$.

The modelling process involves three main components mentioned in the risk assessment process: development of database, risk estimation and evaluation of results.

5. RISK ASSESSMENT TECHNIQUES

Organizations of all types and sizes face a range of risks that may affect the achievement of their objectives. These objectives may relate to a range of the organization's activities, from strategic initiatives to its operations, processes and projects, and be reflected in terms of societal, environmental, technological, safety and security outcomes, commercial, financial and economic measures, as well as social, cultural, political and reputation impacts. All activities of an organization involve risks that should be managed. The risk management process aids decision making by taking account of uncertainty and the possibility of future events or circumstances (intended or unintended) and their effects on agreed objectives.

Risk management includes the application of logical and systematic methods for

– communicating and consulting throughout this process;

– establishing the context for identifying, analysing, evaluating, treating risk associated with any activity, process, function or product;

– monitoring and reviewing risks;

– reporting and recording the results appropriately.

Risk assessment is that part of risk management which provides a structured process that identifies how objectives may be affected, and analyses the risk in term of consequences and their probabilities before deciding on whether further treatment is required.

Risk assessment attempts to answer the following fundamental questions:

– what can happen and why (by risk identification)?

– what are the consequences?

– what is the probability of their future occurrence?

– are there any factors that mitigate the consequence of the risk or that reduce the probability of the risk?

– Is the level of risk tolerable or acceptable and does it require further treatment?

5.1. Risk assessment

Risk assessment is the overall process of risk identification, risk analysis and risk evaluation. Risks can be assessed at an organizational level, at a departmental level, for projects, individual activities or specific risks. Different tools and techniques may be appropriate in different contexts.

Risk assessment provides an understanding of risks, their causes, consequences and their probabilities. This provides input to decisions about:

– whether an activity should be undertaken;

– how to maximize opportunities;

– whether risks need to be treated;

– choosing between options with different risks;

– prioritizing risk treatment options;

– the most appropriate selection of risk treatment strategies that will bring adverse risks to a tolerable level.

5.2. Risk treatment

Having completed a risk assessment, risk treatment involves selecting and agreeing to one or more relevant options for changing the probability of occurrence, the effect of risks, or both, and implementing these options. This is followed by a cyclical process of reassessing the new level of risk, with a view to determining its tolerability against the criteria previously set, in order to decide whether further treatment is required.

5.3. Monitoring and review

As part of the risk management process, risks and controls should be monitored and reviewed on a regular basis to verify that (Figure 5.1)

– assumptions about risks remain valid;

– assumptions, on which the risk assessment is based, including the external and internal context, remain valid;

– expected results are being achieved;

– results of risk assessment are in line with actual experience;

– risk assessment techniques are being properly applied;

– risk treatments are effective.

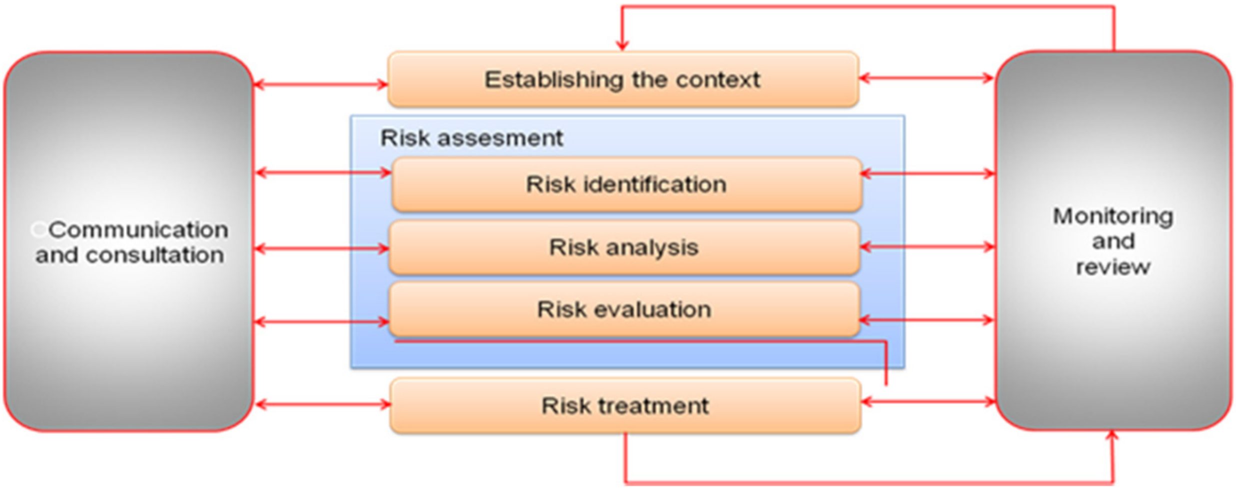


Figure 5.1. Contribution of risk assessment to the risk management process

5.4. Risk identification

Risk identification is the process of finding, recognizing and recording risks. The purpose of risk identification is to identify what might happen or what situations might exist that might affect the achievement of the objectives of the system or organization. Once a risk is identified, the organization should identify any existing controls.

The risk identification process includes identifying the causes and source of the risk (hazard in the context of physical harm), events, situations or circumstances which could have a material impact upon objectives and the nature of that impact. Risk identification methods can include:

– evidence based methods, examples of which are check-lists and reviews of historical data;

– systematic team approaches where a team of experts follow a systematic process to identify risks by means of a structured set of prompts or questions;

– inductive reasoning techniques such as HAZOP.

Various supporting techniques can be used to improve accuracy and completeness in risk identification, including brainstorming, and Delphi methodology. Irrespective of the actual techniques employed, it is important that due recognition is given to human and organizational factors when identifying risk.

5.5. Risk analysis

Risk analysis is about developing an understanding of the risk. It provides an input to risk assessment and to decisions about whether risks need to be treated and about the most appropriate treatment strategies and methods.

Risk analysis consists of determining the consequences and their probabilities for identified risk events, taking into account the presence (or not) and the effectiveness of any existing controls. The consequences and their probabilities are then combined to determine a level of risk.

Risk analysis involves consideration of the causes and sources of risk, their consequences and the probability that those consequences can occur.

Methods used in analyzing risks can be qualitative, semi-quantitative or quantitative. The degree of detail required will depend upon the particular application, the availability of reliable data and the decision-making needs of the organization. Some methods and the degree of detail of the analysis may be prescribed by legislation. Qualitative assessment defines consequence, probability and level of risk by significance levels such as «high», «medium» and «low», may combine consequence and probability, and evaluates the resultant level of risk against qualitative criteria.

Semi-quantitative methods use numerical rating scales for consequence and probability and combine them to produce a level of risk using a formula. Scales may be linear or logarithmic, or have some other relationship; formulae used can also vary. Quantitative analysis estimates practical values for consequences and their probabilities, and produces values of the level of risk in specific units defined when developing the context. Full quantitative analysis may not always be possible or desirable due to insufficient information about the system or activity being analysed, lack of data, influence of human factors, etc. or because the effort of quantitative analysis is not warranted or required. In such circumstances, a comparative semi-quantitative or qualitative ranking of risks by specialists, knowledgeable in their respective field, may still be effective. In cases where the analysis is qualitative, there should be a clear explanation of all the terms employed and the basis for all criteria should be recorded. Even where full quantification has been carried out, it needs to be recognized that the levels of risk calculated are estimates.

5.6. Selection of risk assessment techniques

Risk assessment may be undertaken in varying degrees of depth and detail and using one or many methods ranging from simple to complex. The form of assessment and its output should be consistent with the risk criteria developed as part of establishing the context. In general terms, suitable techniques should exhibit the following characteristics:

– it should be justifiable and appropriate to the situation or organization under consideration;

– it should provide results in a form which enhances understanding of the nature of the risk and how it can be treated;

– it should be capable of use in a manner that is traceable, repeatable and verifiable.

The reasons for the choice of techniques should be given, with regard to relevance and suitability.

6. STATISTICAL RISK MONITORING METHODS

In order to manage risk it is of key importance to be able to monitor the safety level of the operation. Key risk parameters are accident frequency and expected consequences in terms of human suffering, environmental damage or economic loss. It is clear that accidents are the result of complex interactions within the system, in relation to the operators and to the environment. This means that both the occurrence and outcome of accidents are to some degree stochastic in nature. It is therefore important that the risk manager has a good understanding of how statistics can be used in the monitoring of accident phenomena.

6.1. Statistical measures

Let us consider a random variable with a known probability density function. The variable may be characterized with certain statistical measures.

The mean of a random variable is also termed the average or expected value. It may be viewed as the centre of gravity of the associated distribution. The most straightforward way to compute the mean accident frequency rate (AFR) is to apply the sample mean for N observations with value X_i:

$$\overline{X} = \frac{1}{N}\sum_{i=1}^{N} X_i$$

Observe that we use the symbol μ for the mean of the true population (population mean). Recall that a sample is drawn from the true population and may therefore be seen as a subset. The mean may also be based on grouped observations of the random variable and the weighted mean may then be more relevant:

$$\overline{X} = \frac{1}{M}\sum_{i=1}^{M} p_i \cdot X_i$$

where p_i denotes the probability of observing a member of group i with mean X_i and M is the number of groups. Given that a group has Ni observations and the total number of observations is N, we have:

$$p_i = \frac{N_i}{N}$$

6.1.1. The binomial distribution

Let us assume that we are performing a series of n independent experiments where the outcome is either a success or a failure. The probability of success for each experiment is p. The number of successes in n experiments is given by a binomial distribution with the parameters (n, p):

$$p(x) = p(X = x) = \left(\frac{n!}{x!(n-x)!}\right)p^x(1-p)^{n-x} \qquad x = 0,1,....,n$$

The expected value and variance of X are given by:

$$E(X) = \mu = n \cdot p \qquad \operatorname{var} X = \sigma^2 = n \cdot p \cdot (1-p)$$

6.1.2. The poisson distribution

The Poisson distribution is widely applied in reliability and risk analysis. It is especially useful for describing the number of failures in a given period of time t. Like the binomial distribution it is a discrete distribution by only taking on integer values:

$$P\{C(t) = \mathrm{x}\} = \frac{1}{n!}(\theta \cdot t)^n e^{-\theta t}$$

where $C(t)$ — number of failures in the period t, and n = 1, 2, 3, ... By assuming a standardized period t and introducing the parameter λ:

$$\lambda = \theta t$$

Eq. can be given in a simplified form:

$$P\{X = \mathrm{x}\} = \frac{\lambda^x}{x!}e^{-\lambda}$$

As can be seen from the expression, the Poisson distribution has only one parameter, namely λ. It can further be shown that this parameter expresses both the mean and the variance:

$$\mu = \lambda$$

$$\sigma^2 = \lambda$$

7. FORECASTING METHODS AND PRINCIPLES

7.1. Checklists to improve forecasting

Using evidence-based checklists avoids memorization and simplifies complex tasks. In areas such as medicine, aeronautics and engineering, failure to comply with the appropriate checklist could be the basis for legal action.

The use of checklists is supported by numerous studies. One experiment evaluated the effects of using a 19-item checklist for a hospital procedure. The study compared the results of treatment of thousands of patients in hospitals in eight cities around the world before and after using a checklist. Using the checklist reduced mortality from 1.5% to 0.8% within a month after medical procedures. It is important to note that checklists improve decision-making, even if the knowledge they hold is well known to practitioners and considered important (Hales and Pronovost 2006). To ensure that they include the most recent evidence, checklists should be reviewed regularly.

7.2. Research methods

We reviewed previous experimental studies showing which forecasting methods and principles can improve forecast accuracy. To do this, we first identified relevant studies by:

1) Internet search, mainly using Google Scholar;

2) contacting leading researchers for proposals of important experimental results;

3) verification of key documents mentioned in experimental studies and meta-analyzes;

4) posting our working paper on the Internet with requests for evidence that we may have overlooked;

5) providing links to all articles in the OpenAccess version of this article so that readers can check our interpretation of the original results.

This article only considers studies that examine multiple ex ante predictions as evidence. For cross-sectional data, the folding knife procedure allows many predictions to be made using all but one data points to evaluate the model, making a prediction for an excluded observation, then replacing that observation and excluding another, and so on until there is forecasts. were done for all data points. Rolling refresh can be used to increase the number of out-of-sample forecasts for time series data. For example, to test the predictive validity of alternative models for predicting global mean temperatures over the next 100 years, annual forecasts were made for horizons from one to 100 years ahead, starting in 1851. The forecasts were updated as if in 1852 and then in 1853. and so on, which gives errors for 157 forecasts one year ahead ... and 58 forecasts one hundred years ahead.

We have attempted to contact the authors of all of the articles we have cited regarding the substantive findings. We did this on the basis of evidence that results cited in leading scientific journals are often misrepresented. We asked the authors if our summary of their findings was correct and if our description could be improved. We also asked them to suggest relevant documents that we overlooked, especially articles describing experiments whose results contradicted our conclusions. This practice has been shown to lead to a much more complete search for evidence than computer searches. In the case of six articles, we could not agree with the authors in the interpretation of the results. We declined to cite these articles as they were not essential for the purpose of this article.

As a result of our review, five checklists were developed. They provide evidence-based guidance on forecasting techniques, knowledge models, the Golden Rule of forecasting, simplicity and uncertainty.

7.3. Current forecasting methods: checklist and evidence

The predictive validity of a forecasting method is assessed by comparing the accuracy of the forecasts made using that method with the accuracy of the forecasts obtained using methods currently in use, or using simple reference methods such as the naive no-trend model, or other methods based on actual data. This test of many reasonable hypotheses is a requirement of the scientific method described by Chamberlin (1890).

For categorical predictions — for example, whether a, b, or c will happen, or which one will be better — accuracy is usually measured as the variation in percentage correctness. For quantitative predictions, accuracy is measured by the difference between the expected predictions and what actually happened. The benchmark error for evaluating prediction methods is the relative absolute error, or RAE. It has been shown to be more reliable than the root mean square error. Trials of a new method — RAE development — called unscaled bounded relative absolute error (UMBRAE) — show that it is superior to RAE and other proposed alternatives. We suggest using both the RAE and the UMBRAE until further testing is done to finalize the best measure.

Table 1 lists 15 separate evidence-based forecasting methods. They follow the principles of forecasting and have been shown to provide out-of-sample forecasts with excellent accuracy. The exhibit also identifies the knowledge required7 to use each method. Recommended to be combined within and between methods (checklist items 16 and 17).

Table 1. Forecasting methods application checklist

Method	**Knowledge needed**	
	Forecaster*	**Respondents/Experts†**
Judgmental methods		
1. Prediction markets	Survey/market design	Domain; Problem
2. Multiplicative decomposition	Domain; Structural relationships	Domain
3. Intentions surveys	Survey design	Own plans/behavior
4. Expectations surveys	Survey design	Others' behavior
5. Expert surveys (Delphi, *etc.*)	Survey design	Domain
6. Simulated interaction	Survey/experimental design	Normal human responses
7. Structured analogies	Survey design	Analogous events
8. Experimentation	Experimental design	Normal human responses

9. Expert systems	Survey design	Domain
Quantitative methods *(Judgmental inputs sometimes required)*		
10. Extrapolation	Time-series methods; Data	n/a
11. Rule-based forecasting	Causality; Time-series methods	Domain
12. Judgmental bootstrapping	Survey/Experimental design	Domain
13. Segmentation	Causality; Data	Domain
14. Simple regression	Causality; Data	Domain
15. Knowledge models	Cumulative causal knowledge	Domain
16. Combining forecasts from a single method.		
17. Combining forecasts from several methods.		

** Forecasters should always be aware of the forecasting problem, the solution of which may require consultation with the forecast customer and subject matter experts, as well as familiarization with the research literature.*

† Experts who are consulted by the forecaster about their subject matter knowledge should be aware of the relevant experimental results. Otherwise, the forecaster is responsible for obtaining this knowledge.

7.4. Forecasting principles: the golden rule

The golden rule is to be conservative. In particular, be conservative by adhering to aggregate knowledge of the situation and forecasting methods. The Golden Rule of Forecasting is also an ethical principle, as it implies «predict to others as you would like them to predict to you.» The rule is a useful reference when it is necessary to demonstrate objectivity, as in legal or public policy disputes.

Table 2. Golden Rule of Forecasting Checklist

1.	**Problem formulation**
1.1	Use all important knowledge and information
1.2	Avoid bias
1.3	Provide full disclosure to enable audits, replications, extensions
2	**Judgmental methods**
2.1	Avoid unaided judgment
2.2	Use alternative wording and pretest questions
2.3	Ask judges to write reasons against the forecast
2.4	Use judgmental bootstrapping
2.5	Use structured analogies
2.6	Combine independent forecasts from many diverse judges
3.	**Extrapolation methods**
3.1	Use the longest time series of valid and relevant data
3.2	Decompose by causal forces

3.3	Modify trends to incorporate more knowledge
3.4	Modify seasonal factors to reflect uncertainty
3.5	Combine forecasts from diverse alternative extrapolation methods
4.	**Causal methods**
4.1	Use prior knowledge to specify variables, relationships, and effects
4.2	Modify effect estimates to reflect uncertainty
4.3	Use all important variables
4.4	Combine forecasts from alternative causal models
5.	**Combine forecasts from diverse methods**
6.	**Avoid adjusting forecasts**

REFERENCES

1. Michelle G. Hough, Pennsylvania State University, McKeesport Campus John E. Spillan, (Pennsylvania State University, DuBois Campus. Crisis Planning: Increasing Effectiveness, Decreasing Discomfort. Journal of Business & Economics Research — April 2005 Volume 3, Number 4 .19-24

2. Mariusz Wasiak, Ilona Jacyna-Gołda, Mariusz Izdebski. Multi-criteria warehouses location problem in the logistics network. International Conference on Industrial Logistics. September 28 — October 1, 2016, Zakopane, Poland. 352-363.

3. Ramūnas Palšaitis1, Artūras Petraška. Heavyweight and oversized cargo transportation risk management. Transport and Telecommunication, 2012, Volume 13, No 1, 51–56. Transport and Telecommunication Institute, Lomonosova 1, Riga, LV-1019, Latvia. DOI 10.2478/v10244-012-0005-9

4. Safety aspects — Guidelines for their inclusion in standards. Guide 51. Third edition 2014-04-01

5. Cate Fox-Lent, Igor Linkov. Resilience Matrix for Comprehensive Urban Resilience Planning

6. Disaster Risk Management in the Transport Sector. A Review of Concepts and International Case Studies .June 2015blic

7. Güzin Tirkeş, Cenk Güray, Neş'e Çelebi. Demand forecasting: a comparison between the holt-winters, trend analysis and decomposition models.

8. Risk management — Risk assessment Techniques. International standard. IEC/FDIS. 31010.

9. Guidelines for Chemical Transportation. Safety, Security, and Risk Management. Center for Chemical Process Safety New York, New York. A John Wiley & Sons, inc., publication.

10. Svein Kristiansen. MaritimeTransportation Safety Management and Risk Analysis. Elsevier Butterworth-Heinemann Linacre House, Jordan Hill, Oxford OX2 8DP 30 Corporate Drive, Burlington, MA 01803 First published 2005.

11. Maria Cieśla, Bogna Mrówczyńska, Tadeusz Opasiak. Multimodal transport risk assessment with risk mapping. Zeszyty naukowe politechniki śląskiej. 2017.

12. Chruzik K., Drzewiecki A., Wachnik R.: The use of FMEA method for risk assessment in MMS. «Scientific Journal of Silesian University of Technology. Series Transport», Vol. 81, 2013.

13. McNeil A.J., Rüdiger F., Embrechts P.: Quantitative risk management: Concepts, techniques and tools. Princeton University Press, Princeton 2015.

14. Vanya Banabakova, Ivan Minevski. Problems and risk management options for the transport of dangerous goods. Globalization, the State and the Individual, No 2(14)/2017, s. 215-222.

15. Maja Kiba-Janiak. Risk management in the field of Urban Freight Transport. 2nd International Conference «Green Cities — Green Logistics for Greener Cities», 2-3 March 2016, Szczecin, Poland.

16. Zbigniew Lukasik, Andrzej Szymanek. Safety and risk in road traffic: selected problems. Transport problems. Volume 7 Issue 2. 2012. 83-93.

17. Bohus Leitner. A General Model for Railway Systems Risk Assessment with the Use of Railway Accident Scenarios Analysis.10th International Scientific Conference Transbaltica 2017: Transportation Science and Technology

18. Xiang Liu, M. Rapik Saat1, Christopher P.L. Barkan. Integrated risk reduction framework to improve railway hazardousmaterials transportation safety. Journal of Hazardous Materials. 260 (2013) 131-140

19. Zhaoguang Peng, Yu Lu, AliceMiller, Chris Johnson,Tingdi Zhao. Risk Assessment of Railway Transportation Systems using Timed Fault Trees. Published online 14 October 2014 inWiley Online Library.

20. C.P.L. Barkan, C.T. Dick, R. Anderson — Analysis of railroad derailment factors affecting hazardous materials transportation risk — TRB Annual. Meeting 2003.

21. A. Berrado, Em El-Koursi, A. Cherkaoui, M. Khaddour A Framework for Risk Management in Railway Sector: Application to Road-Rail Level Crossings. Submitted on 2 Dec 2010.

22. Aleksander Sładkowski, Maria Cieśla. Failure Mode and Effect Analysis of Air Cargo Freight Services Provider. Logistics and Transport No 2(38)/2018. 69-76.

23. Mariusz Zieja, Henryk Smoliński, Paweł Gołda. Qualitative and quantitave risk evaluation on the basis of military aviation event analysis. research works of afit issue 38, s. 85-94, 2016 r.

24. Juris Maklakovs, Jevgēnijs Tereščenko, Vladimirs Šestakovs. Risk Assessment of the Adverse Events in Air Transportation. Transport and Aerospace Engineering. 2019, vol. 7, pp. 5-13.

25. J. Scott Armstrong, Kesten Green (2017). Forecasting Methods and Principles: Evidence-Based Checklists. Working paper, ResearchGate.

26. Станиславчик, Е. Н. Риск-менеджмент на предприятии. Теория и практика — М.: Ось-89, 2009. 80 с.

27. Фомичев, А.Н. Риск-менеджмент: Учебник для бакалавров, 4-е изд. (изд:4) — М.: ИТК Дашков и К, 2016. — 372 с.

28. R. Dan Reid, Nada R. Sanders Operations Management An Integrated Approach. 5th EDITION.

29. Carbonara, N., Costantino, N., & Pellegrino, R. (2014, December). Mitigating supply chain risk: A real options approach. In Industrial Engineering and Engineering Management (IEEM), 2014 IEEE International Conference on (pp. 892-896). IEEE.

30. Chopra, S., & Sodhi, M. S. (2014). Reducing the risk of supply chain disruptions. MIT Sloan management review, 55(3), 73.

CHAPTER 3
SIMULATION OF COMPLEX TRANSPORT PROCESSES AND SYSTEMS THAT OPERATE IN CONDITIONS OF RISKS

Viacheslav MATSIUK
Iuliia BULGAKOVA

Introduction
1 General concepts of risks of the transportation process
2 Relevant scientific tools and technologies (IT, etc.) for the study and assessment of transport risks
3 Risk assessment of the multimodal (ship-to-rail) supply chain of iron ore concentrate by agent simulation in the Any Logic Researcher environment
3.1 Theoretical substantiation and problem statement
3.2 Initial data, limitations and assumptions of the simulation model
3.3 Development of a simulation model
References

INTRODUCTION

Meeting the deadlines of freight delivery (subject to safety) with a rational use of available production resources can be regarded as the main operational challenge of transport. Therefore, technical regulation, production planning and the overall arrangement of a transit system (hereinafter, RTS) should ensure an appropriate level of reliability.

In addition to purely technical and managerial (in terms of efficiency of decision-making by the personnel) components, the technological process itself, as a set of sequential queuing systems, must be reliable enough.

Therefore, a study of technological reliability — such as a study of the influence patterns of an existing set of parameters on the probability of failure and the average duration of trouble-free operational processes of transport systems — are important scientific and applied problems.

1. GENERAL CONCEPTS OF RISKS OF THE TRANSPORTATION PROCESS

The development of technological standards, as well as the organization of the transportation process by rail, is accompanied by the emergence of various risks of technical, technological and, in general, anthropogenic nature. Investigating the factors that lead to failures is a rather complex and time-consuming process. This statement is based on the fact that each technological process is a set of constantly interacting various queuing systems, each of which has its own set of service devices, its own intensity of operations, performance, nature of the process and more. The probabilistic nature of all procedures without exception adds special complexity to the transportation process: from the entry of orders in the service channels to their processing and dispatching.

Under the risk of transport processes should be understood as average, quantitative (in physical terms) losses per event, transportation. That is, the *average* loss «in general for each event»:

$$\bar{Z} = \frac{\sum_{i=1}^{n_п} Z_{пi}}{n}, \qquad (3.1)$$

$Z_{пi}$ — the amount of loss, in physical terms, of the i-th event that led to the loss;

$n_п$ — the number of events that led to losses;

n — number of all events.

The key in determining this level of loss is to establish the probability of loss and the amount (in physical units) of loss:

$$\bar{Z} = \overline{Z_{пi}} \cdot \frac{n_п}{n}, \qquad (3.2)$$

where $\frac{n_п}{n}$ — the probability of occurrence of the event, or the probability of failure of the technological process (systems, equipment, etc.).

The very concept of fault tolerance is often synonymous with the concept of reliability, i.e. the ability of the system to ensure the performance of its functions for a certain period of time. With regard to transport systems, this statement can be understood as the ability to provide the appropriate level of throughput when meeting the delivery times of goods and passengers over a period of time.

Therefore, the key quantitative sign of the reliability of any process is the probability of failure, or the inverse — the probability of «no failure» — fault tolerance of the system.

The amount of loss is a slightly broader concept than just the loss of freight (share of freight), as it is related to the working condition of transport and logistics infrastructure in general. The average value of the loss can be defined as the monetary equivalent of the share of loss of freight and the amount of costs for the restoration of the operational condition of the transport infrastructure, i.e.:

$$\overline{Z_{пi}} = \overline{В}_в + \overline{В}_{відн}, \qquad (3.3)$$

where $\overline{B}_в$ — average (in monetary terms) the amount of freight loss for the reporting period, USD;

$\overline{B}_{відн}$ — average (in monetary terms) amounts of losses on the restoration of transport infrastructure for the reporting period, USD.

It is an applied assessment of the risks of the transportation process that will be an assessment of the constituent expressions 3.1–3.3.

2. RELEVANT SCIENTIFIC TOOLS AND TECHNOLOGIES (IT, ETC.) FOR THE STUDY AND ASSESSMENT OF TRANSPORT RISKS

Risk forecasting and development of procedures to reduce the impact of their consequences — risk management — is a fairly common procedure for project and process management. On the other hand, it is a fairly young science of enterprise asset management, as a key element of risk management is the need to accurately forecast the probability of occurrence of «undesirable» events and the level of its consequences, in specific (monetary, material, etc.) terms. It is the difficulty to forecast that makes this area of management science young enough.

For a long time, the only applied tool for assessing the probability of an event was the eponymous section of applied mathematics — probability theory — which over time was supplemented by even more applied Queueing Theory and Reliability Theory.

Nevertheless, the development of information technology and the gradual increase in the power of computer equipment has made it quite simple and convenient for researchers and specialists in a wide range of activities the access to simulation tools, which converted probability theory and other applied branches of mathematical science to a completely different, much higher level of efficiency.

Simulation is performed when:

– solving of the scientific or applied problem requires high detail (low abstraction) of the mathematical model;

– it is impossible to build an analytical model: the system has time, causal relationships, consequence, nonlinearity, stochastic (random) processes and variables;

– it is necessary to simulate the behavior of the system over time, and in the long run, while ensuring a low probability of forecasting error;

– process (object, system) is a combination of a significant number of subsystems, sub-processes and elements. The state of the system is impossible (or very difficult) to formalize and implement by analytical models. The study requires a systematic approach (for example, in assessing reliability, fault tolerance).

Today, the most common ways to mock (or simulate) processes of different plan, structure and nature include:

– system dynamics;

– discrete-event simulation (DES).

– agent modeling (agent-based model, ABM).

System dynamics was first proposed in the 1950s. This paradigm allows us to assess the overall causal relationship between various factors and the outcome of the process. This method is most suitable for assessing the processes of transport systems at the macro level, such as the conditions to form the demand for transportation by national transport systems in the global (continental, world) transport markets.

The discrete-event method allows to simulate in detail the processes that conditionally consist of blocks isolated in time: each operation has conditional boundaries, i.e. the time points of the start and end. This paradigm also dates back to the 50s of last century. Discrete-event models are based on the principle that each elementary event has its conditional beginning, duration and end. That is, it can be discretely limited to the beginning of the procedure and its completion. Such models are sets of «blocks», each of which simulates a certain element of the process: queue, delay and more. This method is most suitable for «low level» processes, where the abstraction of the model should be minimal. For example, technological processes of railway stations (or their separate technological lines), transshipment terminals, passenger stations and more.

The process of discrete-event simulation is a gradual transition of the order through the program blocks. Each of the blocks corresponds to a specific technological operation. The underway time in each of the units will correspond to the time (set or calculated) of the duration of the respective technological operation. The boundary of the phase transition between technological operations will correspond to the moment of transition of the order from one block to another (Fig. 1). This principle allows the program to record the moment of entry of the order into the block of the program, which will correspond to the beginning of the corresponding technological operation, and the moment of exit of the order from the block, which will correspond to the end of the technological operation.

In essence, the collection of simulation results is to record the moments of transition of orders between certain blocks (between the phases of processing traincompositions), which will further process the data, determine the probability of failure and continuity of the transport system. The duration of the order in a particular block is defined as the difference between the moment of entry into the next block and the moment of entry of the order in the settlement block

$$\Delta t_{\text{dalay } z} = t_{\text{in,unit } z+1} - t_{\text{in,unit } z}, \text{ at } z = 1,\ 2,\ \ldots,\ m; \tag{3.4}$$

where $t_{\text{in, unit z}}$ — time of the orderentry to the unit z;
$t_{\text{in, unit z+1}}$ is the time of the orderentry to the unit z+1.

The latter time coincides with the time of the ordercoming out of the unit z.

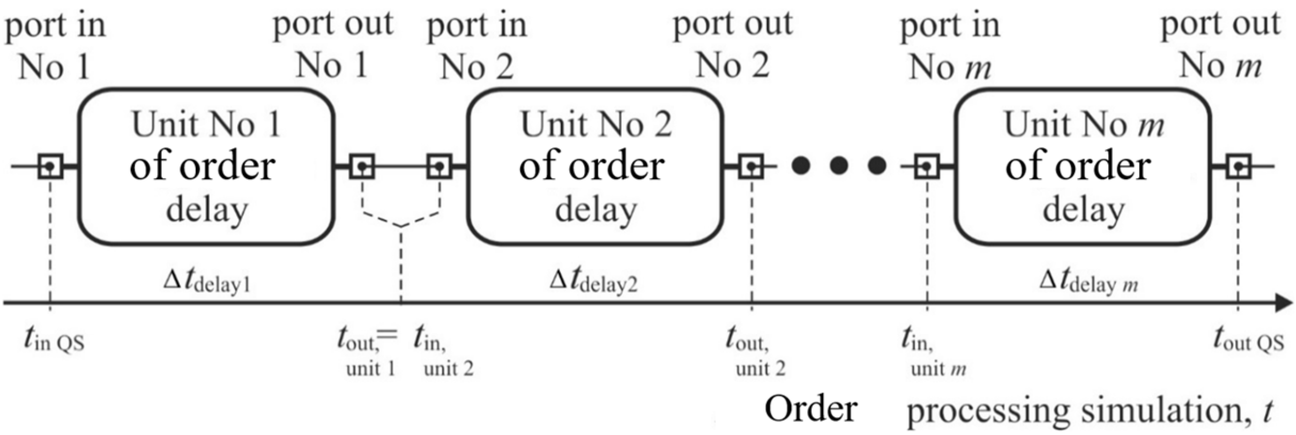


Figure 1. The principle of a discrete-event simulation of the technological process of a transport system at a sequential execution of operations

Thus, the discrete-event principle is quite simple and at the same time clear and effective in the study of any technological — transport, logistics, production and other processes — where the end of each operation is the beginning of the next operation (Fig. 2).

The agent modeling principle, in contrast to the previous two, is quite «young», and in fact is the result of the evolution of system dynamics and especially discrete-event approaches. Agent simulation has become available to a wide range of applied process researchers with the development of object-oriented programming languages such as Java, C # and others. In addition, thanks to the development of computer-based technology, every modern computer is a sufficiently powerful laboratory equipment capable of calculating and modeling complex simulation models.

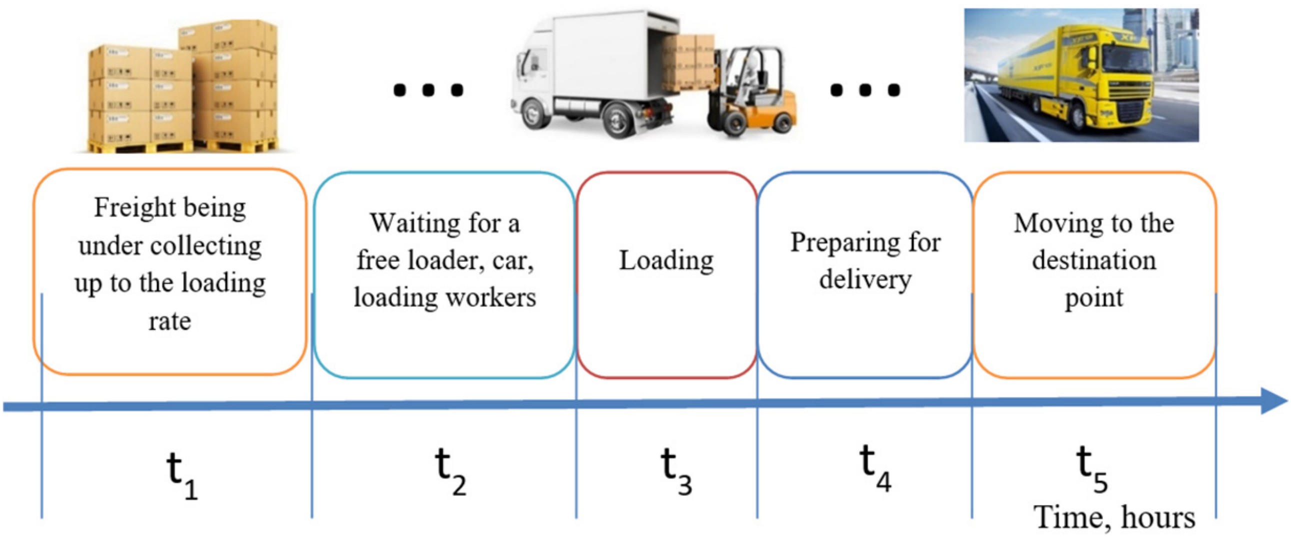


Figure 2. Discrete-event technological process of loading and dispatching the car

The agent approach is based on simulating the behavior of «independent» populations of agents. Each agent is a separate process, system, object that functions independently (by itself) and at the same time in the structure of the whole system. This approach allows us to model the most complex, multiphase and multi-element processes and most fully reflects the essence of the system approach, answering the question: how will the state of the whole system be influenced by the change of behavior (parameter, process logic) of a single agent?

Considering transport processes, the agent approach allows to model complex, multi-element multimodal supply chains quite effectively, taking into account not only direct transportation, but also the process of mass production, its accumulation to the rate of loading in transport units, coordination of delivery, cleaning, directing different transport modes, downtime at berths waiting for freight or release of the service channel. In addition, this approach allows us to most effectively investigate the reliability and risks of transportation and other transport processes.

3. RISK ASSESSMENT OF THE MULTIMODAL (SHIP-TO-RAIL) SUPPLY CHAIN OF IRON ORE CONCENTRATE BY AGENT SIMULATION IN THE ANY LOGIC RESEARCHER ENVIRONMENT

Optimization of business processes of supply chains by multimodal routes refers to complex, comprehensive application problems. The scale of such tasks is becoming increasingly relevant and widespread with the development and expansion of trade relations of the global economy.

However, one of the main tasks of optimizing the planning and organization of multimodal logistics are those related to the establishment of optimal parameters of transport, warehousing (terminal) and processing infrastructure. And the problem is that such tasks, due to their scale and complexity, require a systematic approach. However, analytical methods of applied mathematics are quite limited in optimizing the entire multimodal supply chain process. In addition, these scientific tools are difficult to use in the assessment of stochastic flows of transportation and freight handling. Therefore, computer simulation remains one of the few tools for applied research of complex multimodal routes.

This paper considers an example of a study of a multimodal supply chain of bulk freight (iron ore concentrate) by ship-to-rail multimodal route.

Objectives: to determine the parameters of the transport and technological line for the supply of iron ore concentrate, at which an acceptable level of risk of non-fulfillment of obligations under the contract for the production and delivery of products to the customer is ensured.

Consignor (supplier): ore mining and processing plant.

Recipient (client): metallurgical plant.

Products: iron ore pellet.

Supply chain: rail and sea transport.

3.1. Theoretical substantiation and problem statement

The multimodal delivery process is a process of interaction between two transport and technological lines — railway and sea — and three docking points: a railway station of shipment, a freight terminal of a seaport of dispatch and a freight terminal of a seaport of destination (Fig. 3).

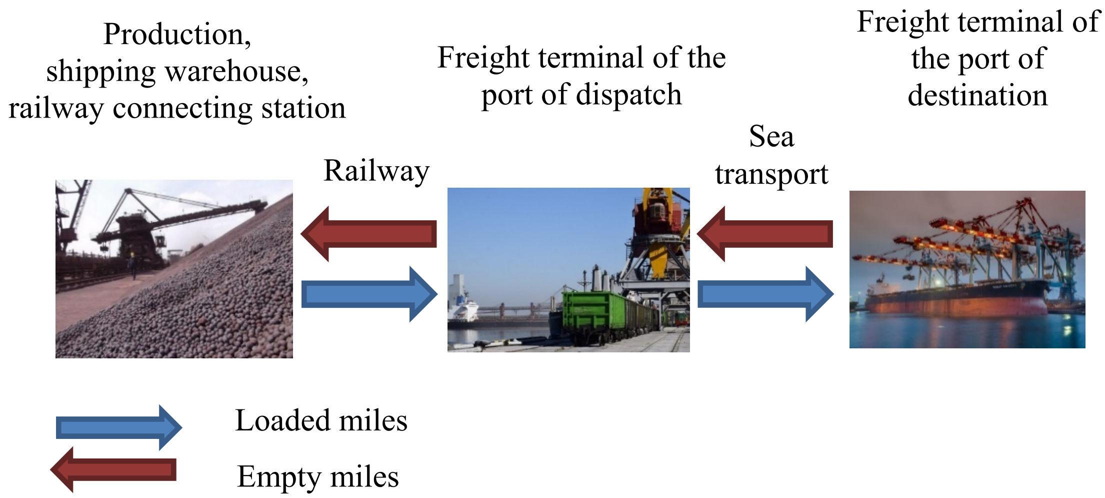


Figure 3. Logical scheme of interaction of the main subsystems of the multimodal supply chain of iron ore concentrate

The time of freight delivery from the point of production to the point of destination is one of the key indicators of the effectiveness of organizing a multimodal route. Most delivery times depend on the size of the rail and sea line fleets. Then the problem can be formally presented as:

$$\overline{t_{del.act}} = f\left(m_{train}, m_{ship}\right) \to min.$$

with restrictions
$$\begin{cases} p(t_{del.act} > t_{norm}) \le p(t)_{norm} \\ \varphi_{min} \le \varphi_{train} \le \varphi_{max}; \\ \varphi_{min} \le \varphi_{ship} \le \varphi_{max}. \end{cases}$$

where

$p(t_{del.act} > t_{norm})$ — the probability of exceeding the standard delivery time by the actual one;

$p(t)_{norm}$ — permissible (normative) probability of exceeding the normative delivery time by the actual one;

m_{train}, m_{ship} — a fleet of trains (railway routes) and ships (bulk carriers);

$\varphi_{train}, \varphi_{ship}$ — loading (degree of utilization) of rail and sea rolling stock fleets;

φ_{min} — the lower limit (rationality) of the use of rolling stock;

φ_{max} — the upper limit (reliability) of the use of rolling stock.

3.2. Initial data, limitations and assumptions of the simulation model

Table 1. Initial data of the simulation model

Scheduled shipment delivery of finished products by the supplying plant:	$\lambda_{с.}$ = 1750000 tons a year
Technological parameters of the railway route:	
capacity of one train	$n_{ж.д.}$ = 3500 tons
loading/ uploading time	normal, average 2 hours, standard deviation 0.3 hours
time of loaded / empty miles	normal, average 2 days, standard deviation 0.5days
all points of loading / unloading railway trains	two-channel
Technological parameters of the sea route:	
capacity of one vessel (bulk carrier):	$n_{м.}$ = 70000 tons
loading / unloading time	normal, average 18 hours, standard deviation 0.3 hours
time of loaded / empty miles	normal, average 15days, standard deviation 0.3days
all points of loading / unloading of bulk carriers	single-channel

Limitations and assumptions made in the model:

1. Contractual obligations for the shipment of finished products: not less than 95% within five years.

2. Average delivery time: the minimum possible, but no more than 18 days (432 hours).

3. Loading of vehicles should be optimal, be in the range:

$$0{,}5 \leq \varphi \leq 0{,}75$$

4. The throughput of transport lines, the productivity of freight terminals and other production resources are sufficient.

5. Transshipment in ports is carried out indirectly, that is, through the freight terminal.

6. The model does not take into account the risks associated with economic, political, weather and other external factors.

3.3. Development of a simulation model

Important! *The following material requires basic skills in building simulation models in the Any Logic environment. To gain such skills, the authors strongly recommend that you study the reference materials on the official website <u>https://www.anylogic.com/resources/books/</u>, especially the guide* ***Ilya Grigoryev. AnyLogic 8 in Three Days****.*

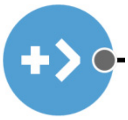
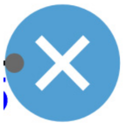
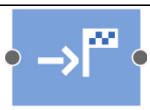
Sincerely, the team of authors

For a comprehensive assessment of process efficiency: production $\rightarrow$ supply chain $\rightarrow$ consumption, agent modeling will be used in combination with discrete-event modeling.

The simulation model involves the creation of algorithms for the interaction of the following agents:

1. Agent *Main* — the root (main) agent for coordinating and modeling the interaction of all other agents.
2. Agent *RailWayLine* — agent for modeling production processes throughout the railway line, including the point of dispatching of finished products:
   – generation of orders for dispatching finished products;
   – railway trains processing on the way;
   – processing at unloading terminals in the port.
3. Agent ***SeaLine*** — agent of modeling of production processes of the sea line:
   – processing of bulkers in the port of departure;
   – modeling of navigation (movement) of ships;
   – processing in the destination port.
4. Populations (sets) of ***Trains*** and ***Ships*** agents:
   – modeling the movement of trains and ships in the marked space of the model.
5. Populations (sets) of ***CargoByTrain*** and ***CargoByShip*** agents:
   – agents of formation of information orders for a shipment dispatch by train and ship, respectively.

Table 2. The main units of the *Enterprise* library of the *AnyLogic* 8.5 development environment used in modeling

Icon of the unit in the development environment	Function and conditions of use
	block of type Source — order generator. Generates an input flow according to the set parameters
	block of type Sink — end. Simulates the completion of the simulation process
	block of type Delay.Simulates the delay of agents when processing or waiting for processing
	block of type moveTo. simulates the running of vehicles
	block of type ResourcePool.Simulates the management of the working fleet of resources (loaders, vehicles).
	element of type parameter — used to specify the initial simulation parameters
	element of type variable — used for intermediate simulation calculation
	element of type data. Used to collect statistical information during the simulation process

Step-by-step order of building a model.

1. Layout of the model space, setting up the nodes of the layout of the space **nodeProduction**, **nodeTransitSeaPort**, **nodeDeliverySeaPort**. Connecting nodes with **path** elements. Signing nodes with **text Production, TransitSeaPort, DeliverySeaPort** elements. Presentation decoration with **rectangle** elements. Using the elements of the *picture* type (Fig. 4):

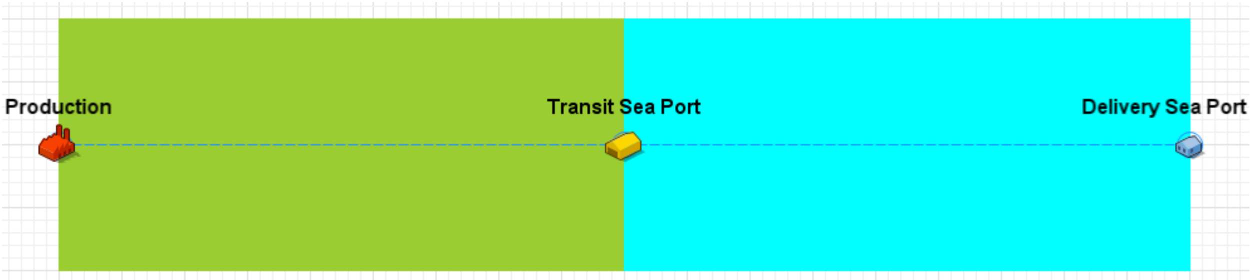


Figure 4. Layout of the *Main* agent space

2. Adding five elements of **parameter** (initial data):
– annual production volume **production (int)**;
– the number of trains (cars and locomotives) **trainsNumber (int)**;
– the number of bulk carriers **shipsNumber (int)**,
– average train weight, net, **trainsCapacity (double)**;
– average bulk carrier weight, net, **shipsCapacity (double)**.

We indicate the production volume in the trains, 1,750,000 / 3,500 = 500 trains per year (Fig. 5).

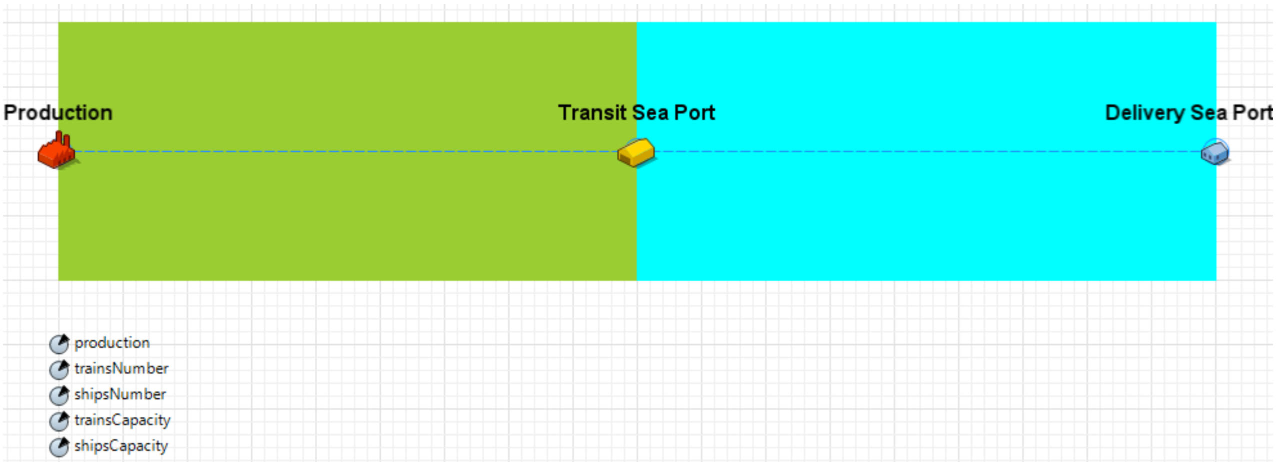


Figure 5. Adding initial model parameters to the *Main* agent

3. Creation of **RailWayLine**, **SeaLine** agents, **Trains** and **Ships** agent populations. In the agents **RailWayLine**, **SeaLine**, neither animation drawing nor initial parameters are specified. These agents will be used to simulate production processes. We indicate their location on the animation in the columns**The initial location** for the **RailWayLine** and **Trains** agents in the **nodeProduction**node, for the **SeaLine** and **Ships** agents in the **nodeTransitSeaPort** node.

4. For populations of **Trains** and **Ships** agents, we specify animation from the 2D version of pictures. In the «Population size» column, we specify **0**. Everything else is left as default. We reduce the resulting **train** icon, leave the **ship** as it is (Fig. 6).

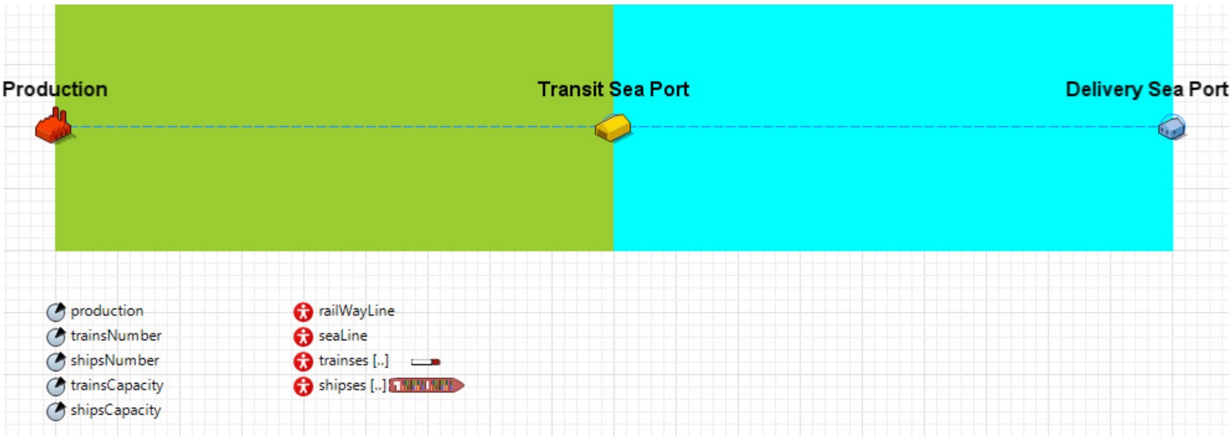


Figure 6. Adding *RailWayLine*, *SeaLine* agents, *Trains* and *Ships* agent populations to the *Main* agent

5. We go to the **railWayLine** agent and build the logic of the train handling process and railway line operation:

5.1. We add a block of type ***resourcePool***, call it ***trainsPool***. In the **Numberof resources**, we enter the expression **main.trainsNumber**. In the **New resource**column, we select ***Trains***. In the block **Specific** (second in order) / Resource type block, we select **Trains** as well. In theblock **Specific** (first in order), in the **Add resources** column, we indicate the **Other populationof agents** and in the line **Population of agents**, we enter the code **main.trains**. Everything else is as default (Fig. 7).

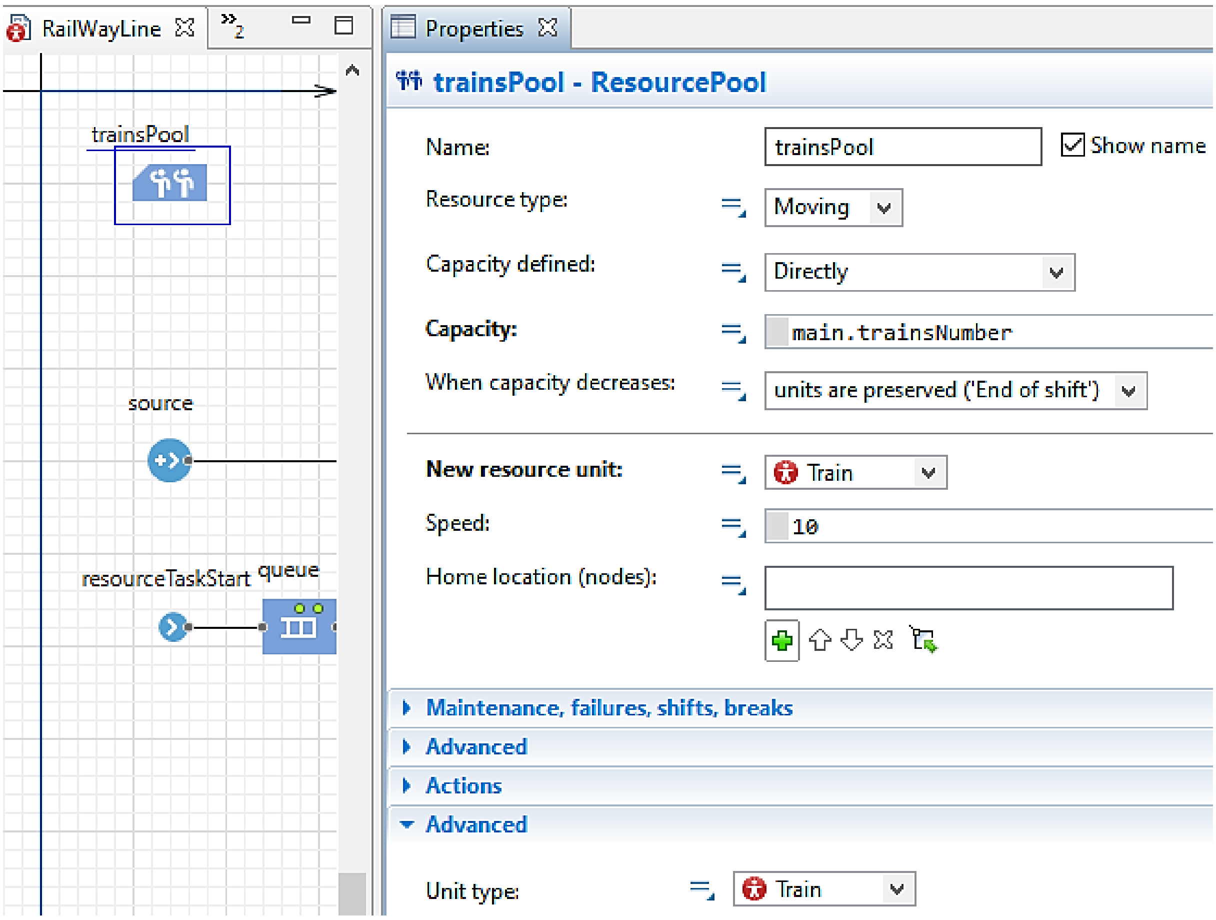


Figure 7. Configuring the *trainsPool* element of the *railWayLine* agent

5.2. We add the **source** block. The intensity of arrival is indicated in the **main.production** time units **per year**. In the **Agent** section, we create a new type of agent **cargoByTrain** (to track the time spent by the freight on the railway transport). We leave everything as default.We add one parameter **timeCargoSource** (double) (Fig. 8).

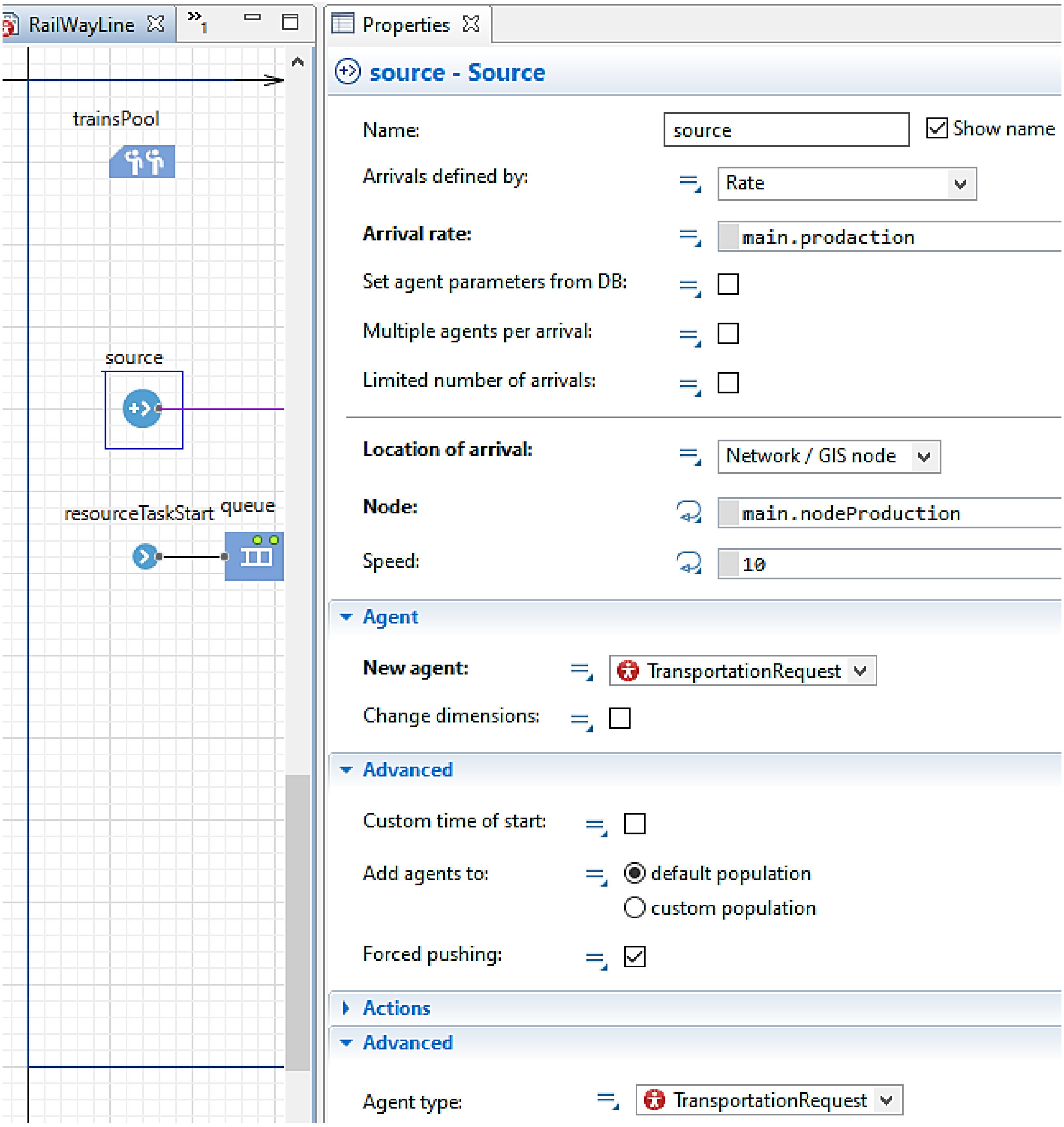


Figure 8. Configuring the *source* element of the *railWayLine* agent

5.3 We add a **seize** block, in which we specify **trainsPool**in the **Set of resources** section. The maximum capacity is indicated. Everything else is as default.

5.4 We add two sub-processes to the **seize** block. First: the action after capturing the resource in the **trainsPool** block. The sub-process starts with the **resource-TaskStart**block, in which we select the **Trains** agent. Next, we create a loading front process in **queue** block (place in the queue maximum) and **delayLoading** block (capacity 2, since there are two loading fronts). We set the delay time (i.e. loading) by the normal distribution **normal (0.1, 20, 2, 0.3)**, time units are **hours**, where 0.1 / 20 — min / max possible values during generation, 2 — average, 0.3 — standard deviation.

5.5 To move the **Train** agent, we use the **moveToTransitSeaPort** block, in which we specify the **main.nodeTransitSeaPort** destination node. In the column **Move is set**, we select the **Time of movement**, and write **normal (0.1, 20, 2, 0.5),** days. We connect with the **seize** block (Fig. 9).

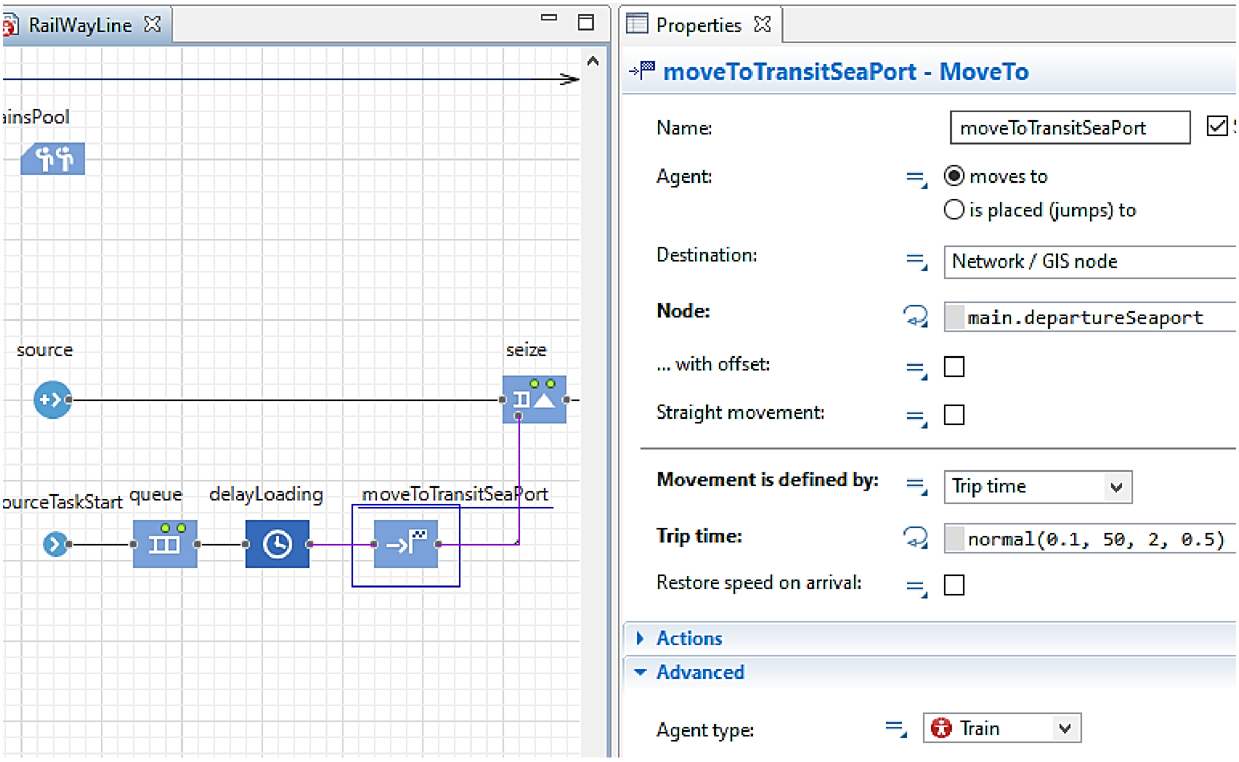


Figure 9. Configuring the *moveToTransitSeaPort* element of the *railWayLine* agent

5.6 Next, the second sub-process of the agent **moveToTransitSeaPort** is simulated: processing the train upon arrival at the port. Add the **queue** block (queue space maximum) and **delayUnloading** block (capacity 2, since there are two unloading fronts). All other elements are configured in the same way as the **queue** element.

5.7 Next, we add a **release** block that releases the **Train** resource after use. We destroy the transport order itself in the **sink** block, and send the resource (**Train**) back to the base point of **nodeProduction** using the **moveTo** block. In the **Node**column, we specify **main.nodeProduction**, the delay (movement) time is **normal (0.1, 20, 2, 0.5) days**. We **specify** the agent type **Train!** Lastly, we destroy the order for using the resource with the **resourceTaskEnd** block.

6. We go to the **SeaLine** agent and build the logic of the processing of trains and the operation of the sea line. The nautical line process diagram itself is identical to the process of railway lines.

6.1 We add a block of type **resourcePool**, call it **shipsPool**. In the Number of resources, we select **main.trainsNumber**. Then we select the new resource **Ships**.

The **Specific** (second in order) / **Resource type** block should also contain **Ships**. In the **Specific** (first in order) / **Add resources** block, we select the Other population of agents and enter the **main.ships** code in the **Population of agents** line. Everything else is as default (Fig. 10).

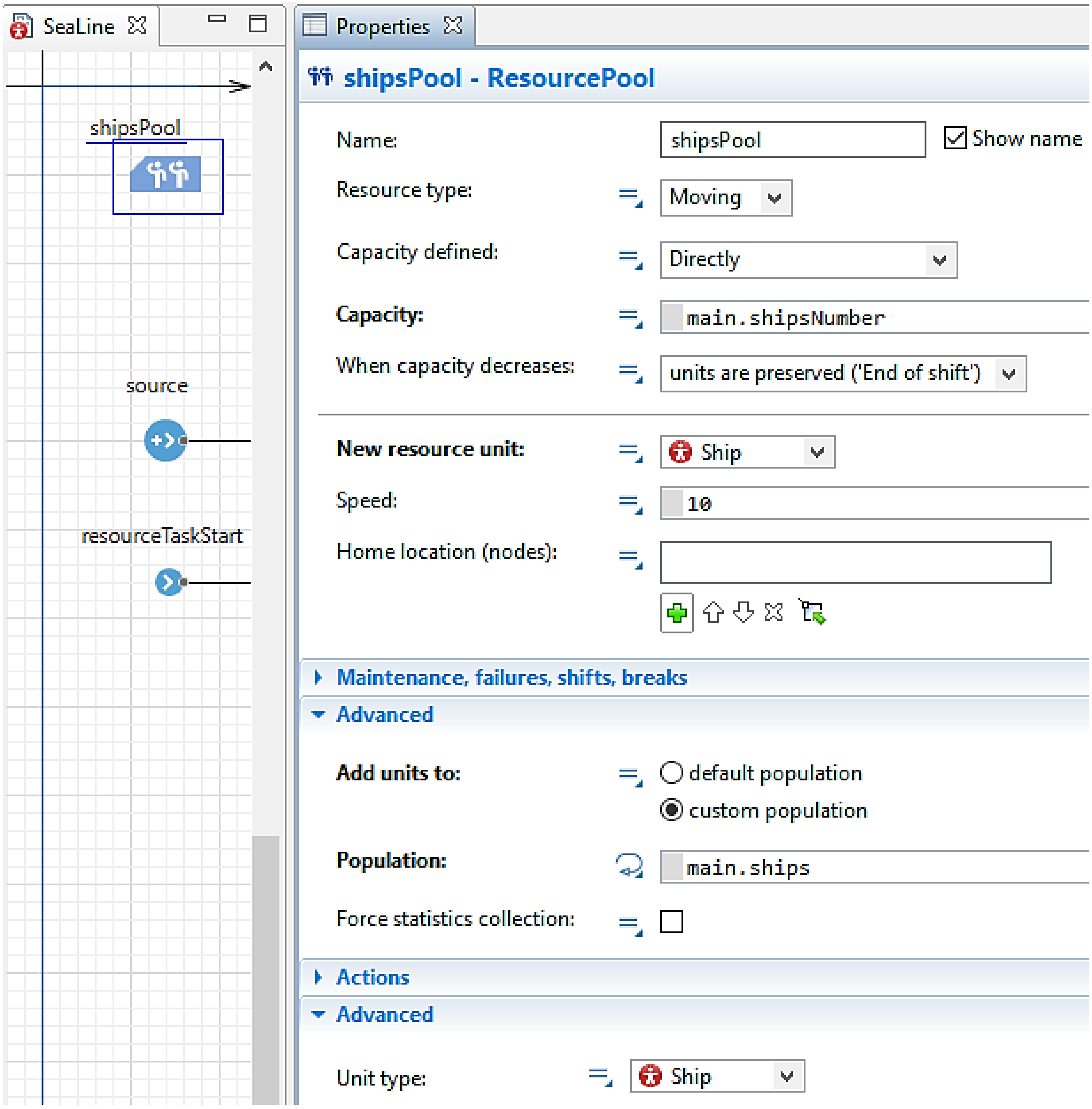


Figure 10. Configuring the *shipsPool* element of the *SeaLine* agent

6.2 We add the **source** block. In the column**Arrive as specified**we indicate **by Calling the function inject** (). In the **Agent** section, we create a new type of agent **cargoByShip** (to track the time spent by the freight on the railway transport). We leave everything as default.We add one parameter **timeCargoSource** (**double**) (Fig. 11).

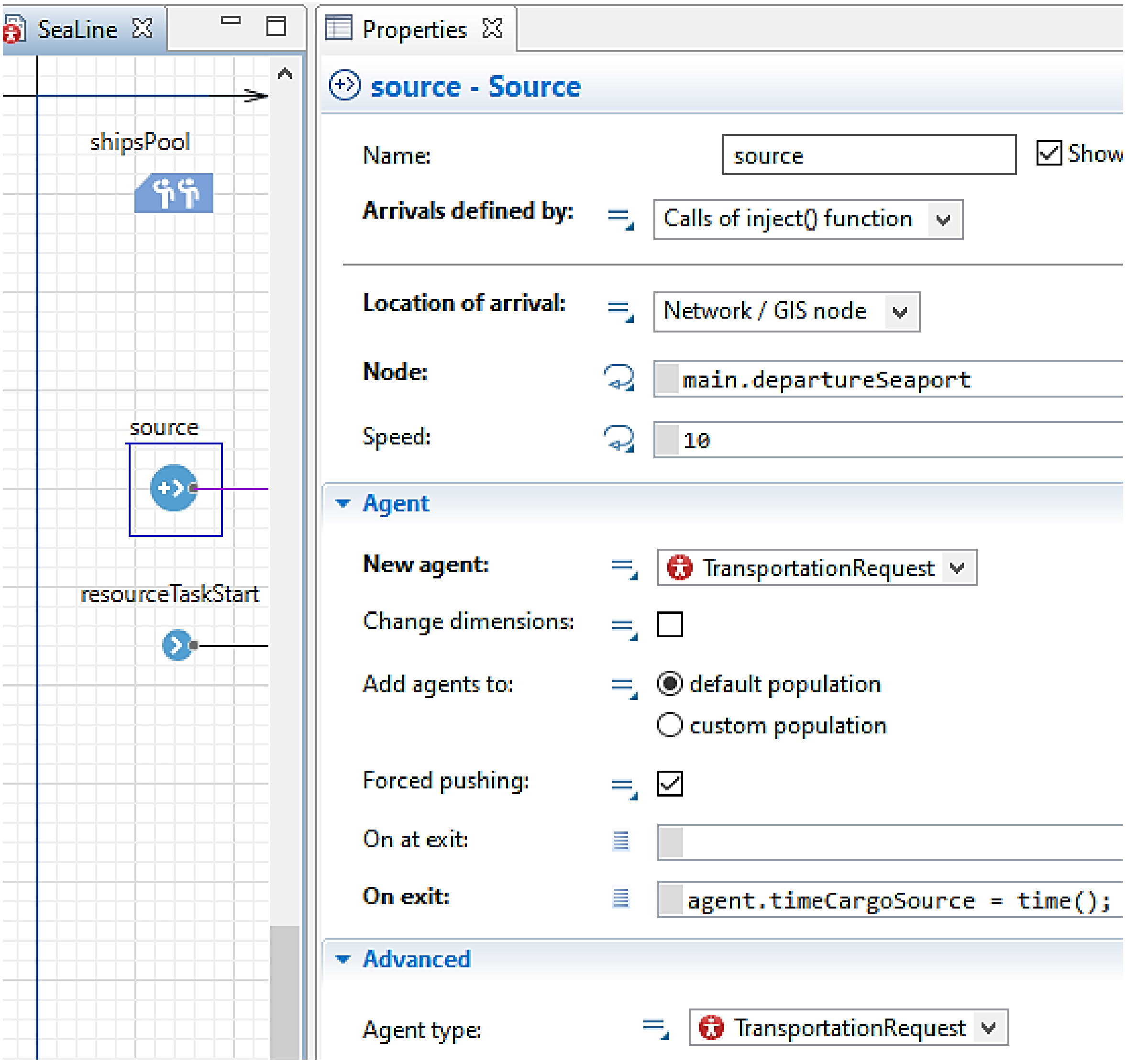


Figure 11. Configuring the *source* element of the *SeaLine* agent

6.3 We add a **seize** block, in which we add ***shipsPool*** to the **Set of resources** section. The maximum capacity is indicated. Everything else is left as default.

6.4 We add two sub-processes to the **seize** block. First: the action after capturing the resource in the **shipsPool** block. The sub-process starts with the **resourceTaskStart** block, in which we select the **Ships** agent. Next, we create a loading front process in blocks **queue** (place in the queue maximum) and **delayLoading** (capacity 1, since there is one loading front). We set the delay time (i.e. loading) by the normal distribution ***normal (0.1, 100, 18, 3)*** with time units of **hours**.

6.5 To move the **Ship** agent, we use the **moveToDeliverySeaPort** block, which specifies the **main.nodeDeliverySeaPort** destination **node**. In the column **Move is set**, we select the **Time of movement**, and write **normal (0.1, 20, 15, 3)** days. We connect with the **seize** block (Fig. 12).

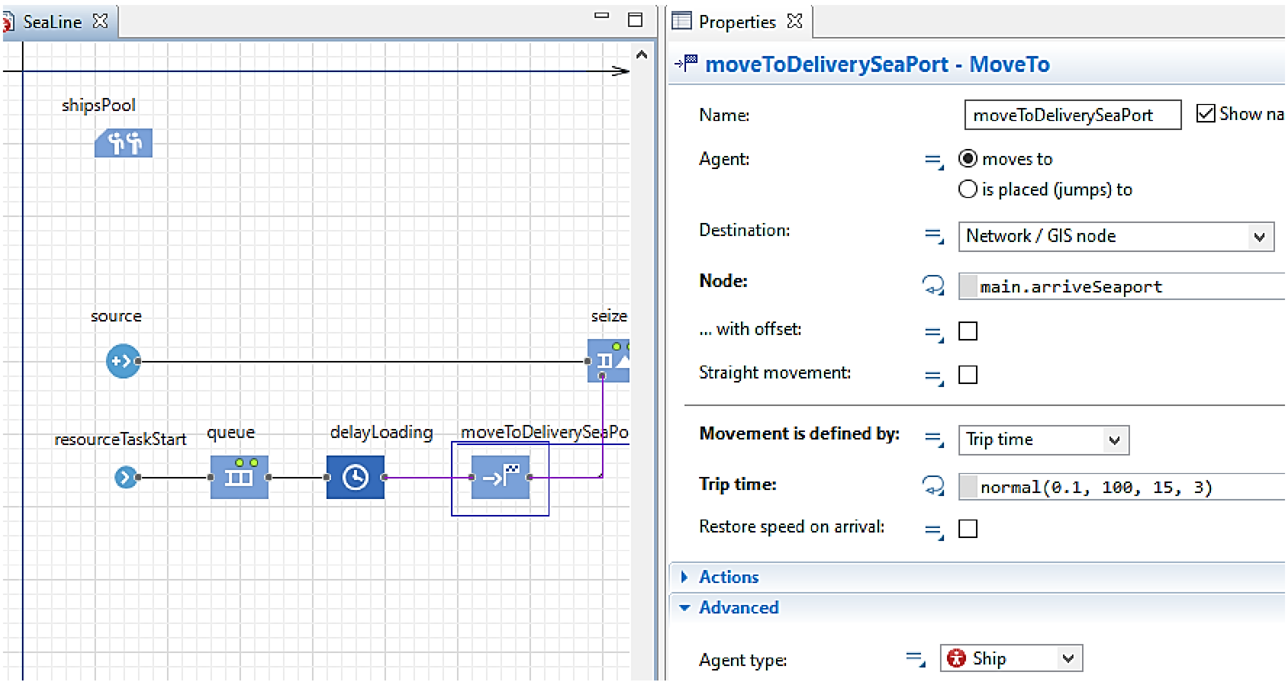


Figure 12. Configuring the *moveToDeliverySeaPort* element of the *SeaLine* agent

6.6 Second: processing the train upon arrival at the port. We add a **queue** block (queue space maximum) and **delayUnloading** block (capacity 1, since there is one unloading front). All other parameters are configured in the same way as in the **queue** block.

6.7 Next, we add a **release** block that releases the **Ships** resource after use. The transport order itself ends in the **sink** block, and the resource (**Ships**) is sent back to the base point **nodeTransitSeaPort** using the **moveTo** block. In the **Node**column, we specify **main.nodeTransitSeaPort**, the delay (movement) time is **normal (0.1, 20, 15, 3), days**. We specify the agent type as **Ships**. The resource use order ends in a **resourceTaskEnd** block.

6.8 The **source** block in the **SeaLine** agent will be controlled from within the **RailWayLine**agent process. After the necessary freight consignment has been accumulated in the sea terminal, an order for transportation by one ship will be generated. To simulate the accumulation process, we add an auxiliary variable **cargoForShip** (**double**), in which the freight transported by rail will be accumulated. Further, in the **delayUnloading** block of the **RailWayLine** agent in the **On exit**column, the **Java code** is written:

```
cargoForShip = cargoForShip + main.trainsCapacity;
if (main.shipsCapacity<cargoForShip)
{
main.seaLine.source.inject(1);
cargoForShip = cargoForShip — main.shipsCapacity;
}
```

6.10 We make an intermediate compilation of the model (F7) and, if there are no compilation errors, we runthe model.

7. The model is ready and operational. Now, to solve the task, it is necessary to calculate the indicators: products produced, products delivered, the level of fulfillment of contractual obligations, the average delivery time. We add four corresponding variables to collect simulation results: **produced** (double), **delivered** (double), **performing** (double), **timeDeliveryInFact**(double).

7.1 To calculate **produced** in the **source** block of the **RailWayLine** agent, in the **On exit** column, we enter the **Java code**:

```
main.produced += main.trainsCapacity;.
```

7.2 To calculate **delivered** in the **delayUnoading** block of the **SeaLine** agent, in the **On exit**column, we enter the **Java code**:

```
main.delivered += main.shipsCapacity;.
```

7.3 To calculate **performing** in the **source** block of the **RailWayLine** agent, in the **On exit**column, we enter the **Java code**:

```
main.performing = main.delivered / main.produced;.
```

7.4 We run the model. Before starting, we set up the presentation. We activate the **Simulation** agent, the Model time column, we set the simulation period in the **Model time** column to **5 years**.

7.5 To calculate the average delivery time, we will introduce two additional elements of the type **data** (histogram data), **dataTimeOnRail** (**20 bits**) and **dataTimeOnSea** (**20 bits**), in which information on the actual delivery time of freight will be collected and processed, respectively, by the railway and the sea.

7.6 **dataTimeOnRail** is calculated in the **RailWayLine** agent, **dataTimeOnSea** in the **SeaLine** agent.

7.7 To calculate the **timeDeliveryInFact** variable in the **source** block of the **RailWayLine** agent, in the **On exit**column, enter the **Java code**:

```
main.timeDeliveryInFact = main.dataTimeOnRail.mean() +
main.dataTimeOnSea.mean();.
```

7.8 The model is ready. The final compilation and test run of the model are carried out.

8. To determine the optimal parameters of transport and technological systems of the supply chain, we create an **Optimization Experiment**. The optimization experiment is set up in accordance with (1) and (2) of the problem statement in paragraph 1.2.1.

8.1 To create an experiment, select the **Experiment** tab in the **New** tab (Fig. 13).

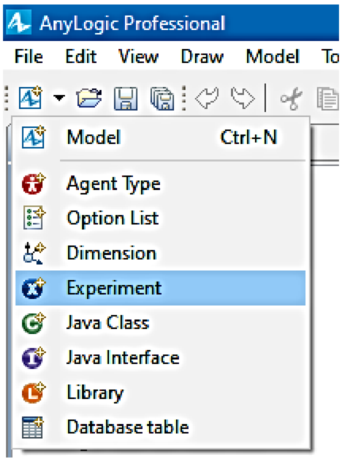


Figure 13. Tab New

8.2 Then we set the type of experiment **Optimization**. There is an option of changing the name of experiment. Then we click **Finish** (Fig. 14).

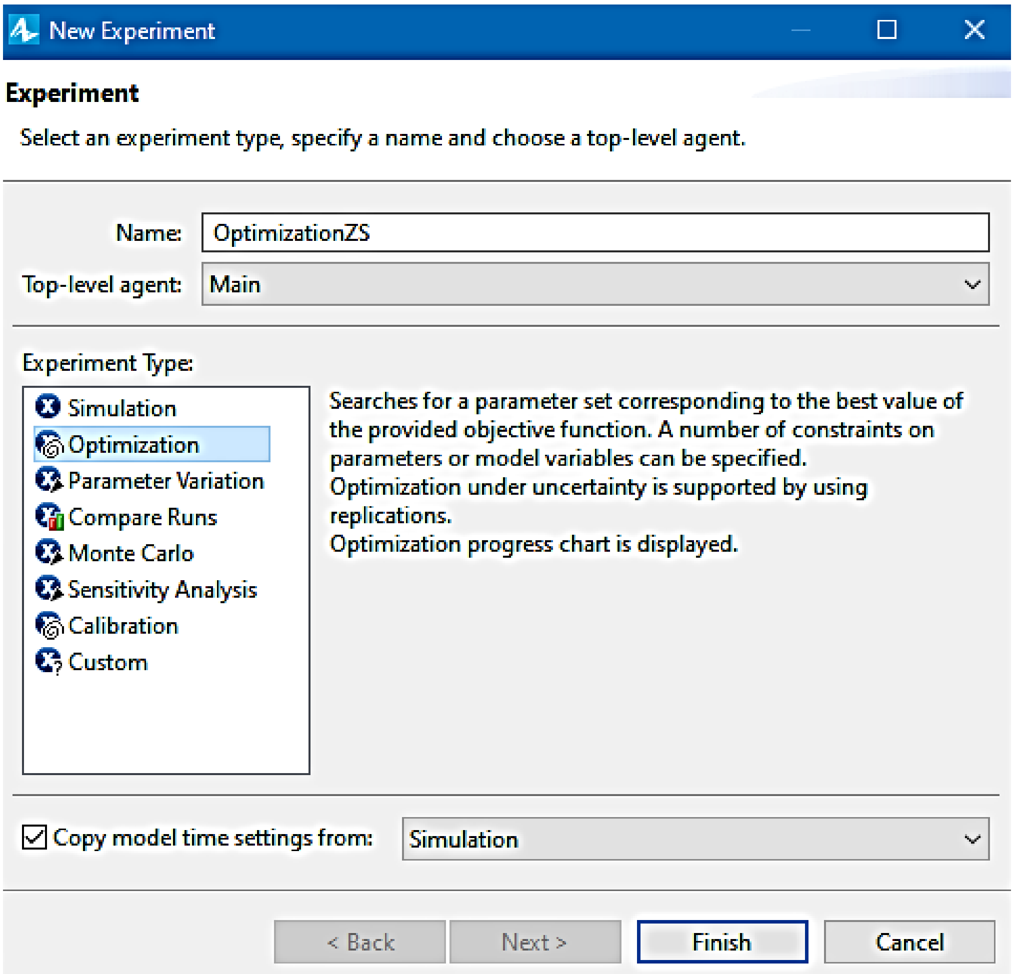


Figure 14. Setting the type of experiment Optimization

8.3 Afterwards the window of the created experiment is opened. The experiment settings need to be adjusted. All variables are added into the experiment with reference to the root agent via **root** (Fig. 15).

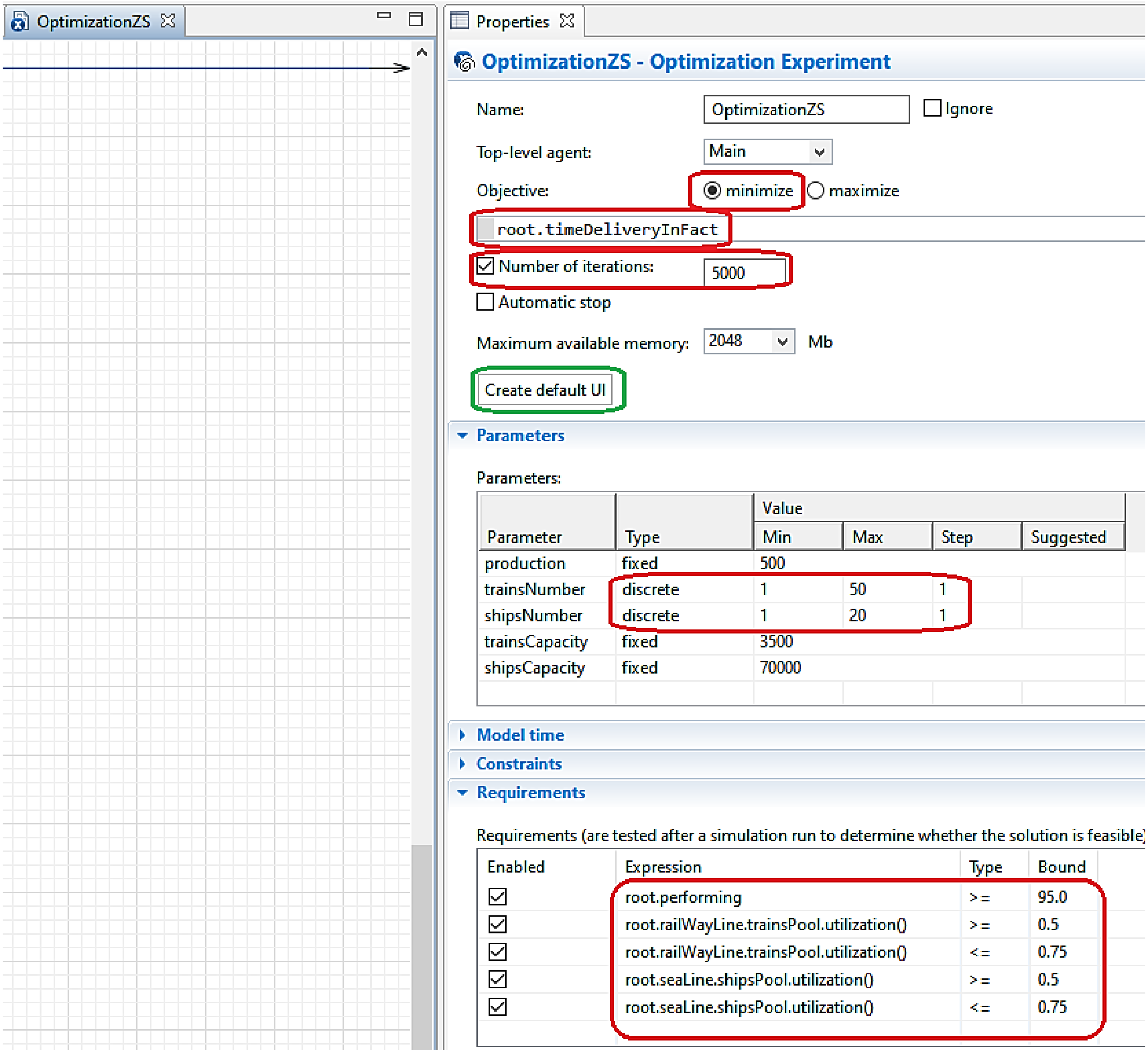


Figure 15. Setting the type of experiment Optimization

8.3.1 The **Objective** object indicates the result of the objective function, which is the variable **timeDeliveryInFact** — the average time of one cargo unit delivery.

8.3.2 The type of **Objective** is set as **mimimize**.

8.3.3 The number of iterations (**Numberofiteration**) is 5000.

8.3.4 In the **Parameters** tab we select the optimization parameters.

8.3.5 The **Requirements** tab indicates optimization constrains.

8.4 After setting up the experiment the interface of the experiment window (**CreatedefaultUI**) is appeared (Fig.16).

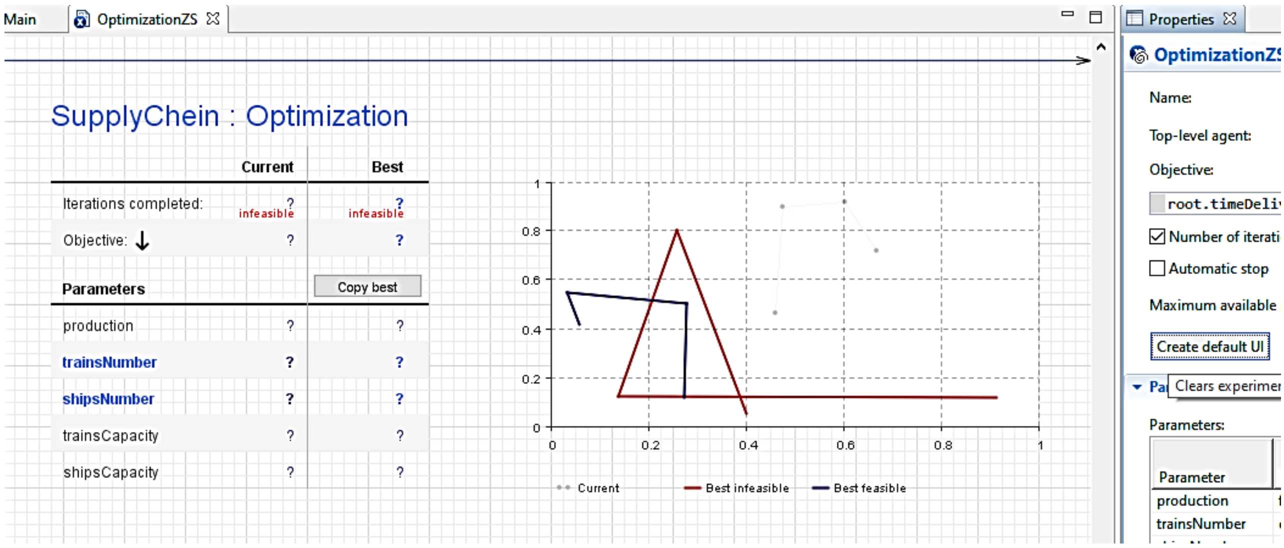


Figure 16. Window CreatedefaultUI

8.5 The experiment runs in **Run** tab (Fig. 17).

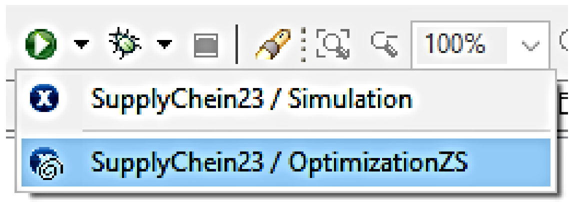


Figure 17. Run tab

8.6 When performing the experiment the results are displayed on the appropriate graph and recorded in the columns **Current and Best** (Fig. 18).

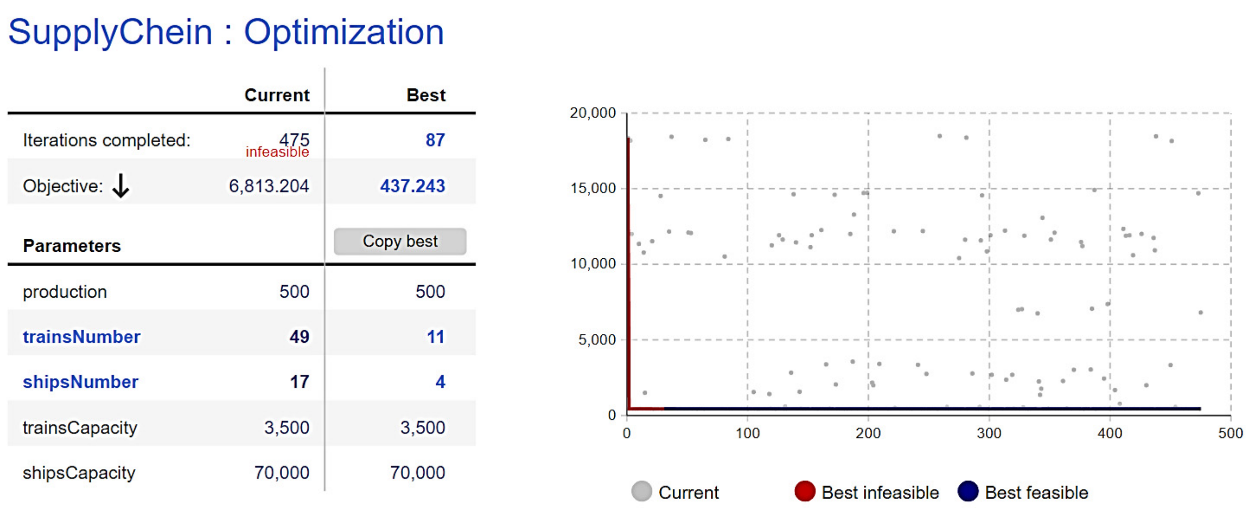


Figure 18. Displaying of experimental results

8.7 At the given settings and parameters of the model the experimental results are the following: minimum delivery time of a cargo unit is 437 minutes with 11 trains (70% load) and 4 bulker ships (51% load).

REFERENCES

1. World Wide Web: International standard 50(191) [Electronic resource] / — Mode of access: World Wide Web: https://webstore.iec.ch/publication/184.

2. Ivanov, D. Operations and supply chain simulation with AnyLogic: Decision oriented introductory notes for master students. 2nd Edition, E-Textbook [Electronic resource] / D. Ivanov / Berlin School of Economics and Law (preprint). — 2017. — Mode of access: https://www.anylogic.com/resources/books/

3. Katsman, M. D. Mathematical models of ecologically hazardous rail traffic / M. D. Katsman, V. K. Myronenko, V. I Matsiuk // Reliability: theory & applications. — 2015. — Iss. 10. — No.1 (36). — P. 28 — 39.

4. Matsiuk, V. I. Pryntsypy zabezpechennia tekhnolohichnoi nadiinosti zaliznychnykh transportnykh system [In Ukrainian: Principles of ensuring technological reliability of railway transport systems] / V. I. Matsiuk // Collection of Scientific Papers of the State University of Infrastructure and Technologies of the Ministry of Education and Science of Ukraine: Series «Transport Systems and Technologies». — K.: SUIT, 2016. — No.28. — P. 262-271.

5. Matsiuk, V. I. Doslidzhennia tekhnolohichnoi nadiinosti parkiv tekhnichnykh stantsii dyskretno-podiievym modeliuvanniam [In Ukrainian: Research of technological reliability of parks of technical stations by discrete-event modeling] / V. I. Matsiuk // Collection of Scientific Papers of the State University of Infrastructure and Technologies of the Ministry of Education and Science of Ukraine: Series «Transport Systems and Technologies». — K.: SUIT, 2015. — P. 268-272.

6. Matsiuk, Viacheslav. Improvement of efficiency in the organization of transfer trains at developed railway nodes by implementing a «flexible model» / V. Matsiuk, V. Myronenko, V. Horoshko, A. Prokhorchenko, T. Hrushevska and others // Eastern-European Journal of Enterprise Technologies. — 2019. — Vol. 2. — No 3. — P. 32-39.

7. Matsiuk, Viacheslav. A study of the technological reliability of railway stations by an example of transit trains processing / V. Matsiuk // Eastern-European Journal of Enterprise Technologies. — 2017. — Vol. 1. — No 3 (85) — P. 18-24.

8. Myronenko, V. K., Matsiuk, V. I. Matematychna model staniv ta nadiinosti zaliznychnoi transportnoi systemy pry perevezenniakh nebezpechnykh vantazhiv [In Ukrainian: Mathematical model of the states and reliability of the railway transport system for the transport of dangerous goods] / V. K. Myronenko, M. D. Katsman, M. M. Horbakha, V. I. Matsiuk // Journal: Information Processing systems. — 2015. — No 9 (134). — P. 161-167.

9. Sokolowski John A., Banks Catherine M. Principles of modeling and simulation: a multidisciplinary approach [Electronic resource] / John A. Sokolowski, Catherine M. Banks / John Wiley & Sons, Inc. — 2008. — Mode of access: https://onlinelibrary.wiley.com/doi/book/10.1002/-9780470403563

10. Babina O. I. Sravnitelnyiy analiz imitatsionnyih i analiticheskih modeley [In Russian: Comparative analysis of simulation and analytical models] / O. I. Babina // IMMOD-2009: Sektsiya 1 Teoreticheskie osnovyi i metodologiya imitatsionnogo i kompleksnogo modelirovaniya [IMMOD-2009: Section 1 Theoretical Background and Methodology of Simulation and Complex Modeling]. — Saint Petersburg, 2009. — P. 73-77.

11. Katalevskiy, D.Yu. Osnovyi imitatsionnogo modelirovaniya i sistemnogo analiza v upravlenii: uchebnoe posobie; 2-e izd., pererab. i dop. [In Russian: Fundamentals of simulation and system analysis in management: textbook; 2nd ed., rev. and added] / D.Yu. Katalevskiy / M.: Izdatelskiy dom «Delo» RANHiGS, 2015. — 496 pp.

12. Kupriyashkin, A.G. Osnovyi modelirovaniya sistem: ucheb. Posobie [In Russian: Fundamentals of systems modeling: textbook] / A.G. Kupriyashkin / Norilskiy industr. in-t. — Norilsk: NII, 2015. — 135 pp.

CHAPTER 4
HUMAN FACTORS IN DESIGN & OPERATIONS

Mr. Ilgar KHURSHUDOV
Mr. Arif NAJIMOV

1. INTRODUCTION TO HUMAN FACTORS

1.1. Definitions

Human factors is the scientific discipline concerned with the understanding of the interactions among humans and other elements of a system, and the profession that applies theory, principles, data, and methods to design to optimize human well-being and system performance. Synonymous with ergonomics.

Well-being, is a general term for the condition of an individual or group, for example their social, economic, psychological, spiritual or medical state; a high level of well-being means in some sense the individual or group's experience is positive, while low well-being is associated with negative happenings.

Ergonomics is the study of the interaction between people and machines and the factors that affect the interaction. Its purpose is to improve the performance of systems by improving human-machine interaction.

Systems can be improved by:

• Designing the user interface to make it more compatible with the task and the user. This makes it easier to use and more resistant to errors which people are known to make.

• Changing the work environment to make it safer and more appropriate for the task.

• Changing the task to make it more compatible with the user characteristics.

• Changing the way work is organized to accommodate people's psychological and social needs.

1.2. Brief History

The name «ergonomics» comes from the Greek words ergon, which means work, and nomos, which means law. In 1857, prof. Jastrzębowski produced a philosophical treatise on Ergonomics: The science of work but initially known only in Poland.

As one of the first research works in ergonomics one can determine the research from 1908, in which F.W. Taylor determined the relationship between the size of the blades, the mass of the load, the muscular strength of the worker and the efficiency of work with this tool. As a result of the trials, Taylor developed a recommendation for the optimal blade size. In order to always ensure an optimal weight of 8-9 kg, it recommended using larger surface blades for light materials and smaller for heavier materials.

A system called «Taylorism» was created from his name, which was considered the first system optimizing work.

The negative effects of the maladjustment of manufacturing technology to human capabilities at the beginning of the 20th century have been attempted to mitigate by promoting new forms of work organization:

• specialization of tasks (F. Taylor, 1856-1915),

• taking into account the principles of movement economics (Frank B. Gilbreth, 1868-1924),

• application of motivating measures, beginning of human relations techniques (Elton Mayo, 1880-1949),

• introduction of principles of management work rationalization (Henri Fayol, 1841-1925),

• harmonization of works (Karol Adamiecki, 1866-1933),

• and later — participative forms of work organization (eg. autonomous groups, quality circles, etc.).

As early as the Second World War, designers started paying attention to adjusting aircraft and other combat machinery to suit the capabilities of the pilots and drivers. Currently, when taking advantage of the discoveries in the field of ergonomics, emphasis is being put on designing work places. Human factors is a multidisciplinary field. There are many disciplines that contribute to it.

Some of these disciplines are as follows:

• Psychology
• Engineering
• Anthropometry
• Applied physiology
• Industrial design
• Environmental medicine
• Operations research
• Statistics

1.3. The scope of the human factor issue/ domains

Physical ergonomics is concerned with human anatomical, anthropometric, physiological and biomechanical characteristics as they relate to physical activity. (Relevant topics include working postures, materials handling, repetitive movements, work related musculoskeletal disorders, workplace layout, safety and health.)

Cognitive ergonomics is concerned with mental processes, such as perception, memory, reasoning, and motor response, as they affect interactions among humans and other elements of a system. (Relevant topics include mental workload, decision-making, skilled performance, human-computer interaction, human reliability, work stress and training as these may relate to human-system design.)

Organizational ergonomics is concerned with the optimization of sociotechnical systems, including their organizational structures, policies, and processes. (Relevant topics include communication, crew resource management, work design, design of working times, teamwork, participatory design, community ergonomics, cooperative work, new work paradigms, virtual organizations, telework, and quality management.)

Benefits of using human factors/ergonomics.

The implementation of human factors/ergonomics in system design should make the system work better by eliminating aspects of system functioning which are undesirable, uncontrolled, or unaccounted for, such as:

• Inefficiency: when worker effort produces suboptimal output

• Fatigue: in badly designed jobs people tire unnecessarily

• Accidents, injuries, and errors: due to badly designed interfaces or excess stress either mental or physical

• User difficulties: due to inappropriate combinations of subtasks making the dialogue/interaction cumbersome and unnatural

• Low morale and apathy

Unreliability of the human factor in transport systems

• A man in a transport system can be situated inside a vehicle as: a driver, passenger and in the system environment as a pedestrian, cyclist, etc. In relation to this, threats in the transport system caused by undesirable actions of people depend on their placement in the transport system

• Human reliability

This is the probability of accomplishing a task successfully by humans at any required stage in system operation within a given minimum time limit (if the time requirement is specified).

• Some statistical data.

1.4. Human-machine-environment system

A system is a set of elements, the relation between those elements, and the boundary around them.

Most systems consist of people and machines, and perform a function to produce some form of output.

Inputs are received in the form of matter, energy, and information.

For ergonomics, the human is part of the system and must be fully integrated into it at the design stage.

Compatibility between the user and the rest of the system can be achieved at a number of levels:

• Biomechanical,

• Anatomical,

• Physiological,

• Behavioral,

• Cognitive.

Poor system functioning can be caused by a lack of compatibility in some or all of the interactions involving the human operator. This incompatibility can occur due to a variety of reasons, for example:

• Human requirements for optimum system functioning were never considered at the design stage (e.g., there was a failure to consult appropriate standards, guidelines, or textbooks)

• Inappropriate task design (e.g., new devices introduce unexpected changes in the way tasks are carried out and these are incompatible with user knowledge, habits, or capacity, or they are incompatible with other tasks)

• Lack o prototyping (e.g., modern software development is successful because it is highly iterative. Users are consulted from the conceptual stage right through to pre-production prototypes)

1.5. Definitions of transport system

Transport or transportation is the movement of humans, animals and goods from one location to another. In other words, the action of transport is defined as a particular movement of an organism or thing from a point A to a Point B. Modes of transport include air, land (rail and road), water, cable, pipeline and space. Transport refers to any vehicle that you can travel in or carry goods in.

2. CAPABILITIES AND LIMITATIONS OF THE HUMAN FACTOR

2.1. Biomechanics of work

Biomechanics has been defined as the study of the movement of living things using the science of mechanics. Biomechanics provides conceptual and mathematical tools that are necessary for understanding how living things move. Specialists in biomechanics measure all kinds of linear and angular mechanical variables to document and find the causes of human motion. In order to understand the origins of human movement, it is essential to understand anatomy. Biomechanics of work — its subject is to consider the causes and effects of musculoskeletal system loads resulting from physical work. Occupational biomechanics plays an important role in the design of processes and workplaces that are safe for human health. This includes immediate (e.g. impact) and cumulative (e.g. vibration) effects of forces occurring in the work process.

Biomechanics of collisions (as a component of biomechanics of work) allows to evaluate the effects and design ways to prevent injuries to human body during collisions occurring both in the work process (e.g. falls from height) and during road accidents.

Typical methods of biomechanics of physical work include:

• study of the structure and function of the musculoskeletal system treated as a working apparatus (including selected anatomy and anthropometry problems),

• measurement of biomechanical parameters (forces and moments of forces acting on human body, displacements, velocities and accelerations of body segments during work) and electrical parameters(electromyography),

• mathematical modelling and computer simulation of the work process,

• methods of assessing the ability of the human body to perform typical work (e.g. carrying loads, working with a mechanical operator or a computer),

• classification of types of manual work and work movements.

2.2. Work physiology (physical effort), fatigue

One of the goals of using ergonomics/human factors is the optimization of biological work costs — that is physical effort and mental workload.

Physical effort consists of:

• Energy expenditure,

• Static load,

• Monotype of movements.

Psychophysiological definition of work — work is a conscious performance (executed by the human system) of any activities that require expending forces, spending and energy conversion, more than is necessary for the restful metabolism of the system, which happens even when there is no movement in the physical sense.

Physical work is carried out by our muscles and is therefore often called muscular work.

There are 2 types:

Static (or isometric meaning 'same length'): this is where a muscle remains contracted for a period of time but there is no movement. Holding a static or fixed posture can be very tiring as your muscles don't get time to relax. Dynamic work (or isotonic meaning 'same tension'): this is where there is rhythmical contraction and relaxation of a muscle which does result in movement. Dynamic work is less tiring and more efficient than static work. Dynamic work load measurement is the so-called energy expenditure (cost) of work, by which one should understand the amount of energy that a person consumes while performing a given work.

Fatigue can result from hard physical effort or prolonged but less physical activity.

Fatigue can describe a variety of conditions such as:

• Decrease of attention
• Slowed and impaired perception
• Decrease in motivation
• Decrease in the speed of physical and mental performance
• Decrease in accuracy and increase in errors
• Greater energy expenditure to keep up the same output
• Feelings of dullness, tiredness, irritability

2.3. Classification of user groups of transport systems.

A disability is any condition of the body or mind (impairment) that makes it more difficult for the person with the condition to do certain activities (activity limitation) and interact with the world around them (participation restrictions).

According to the World Health Organization, disability has three dimensions:

• Impairment in a person's body structure or function, or mental functioning; examples of impairments include loss of a limb, loss of vision or memory loss.

• Activity limitation, such as difficulty seeing, hearing, walking, or problem solving.

• Participation restrictions in normal daily activities, such as working, engaging in social and recreational activities, and obtaining health care and preventive services.

3. FUNDAMENTALS OF ANTHROPOMETRY

3.1. Genesis and types of anthropometry

The word «anthropometry» is derived from the Greek words «Anthropos» (man) and «Metron» (measure), and means measurement of the human body. Anthropometric data are used in HFE to specify the physical dimensions of workspaces, equipment, vehicles, and clothing to ensure that these products physically fit the target population.

Figure 3.1 provides a basic set of numbered static anthropometric variables and brief descriptions of their use. Table 3.1 provides mean and standard deviation values of the corresponding numbered variables for different populations. The variable numbers in the table correspond to the numbered variable descriptions in the figure (data derived mainly from estimated values from a variety of sources including Pheasant, 1986; Peebles and Norris, 1998).

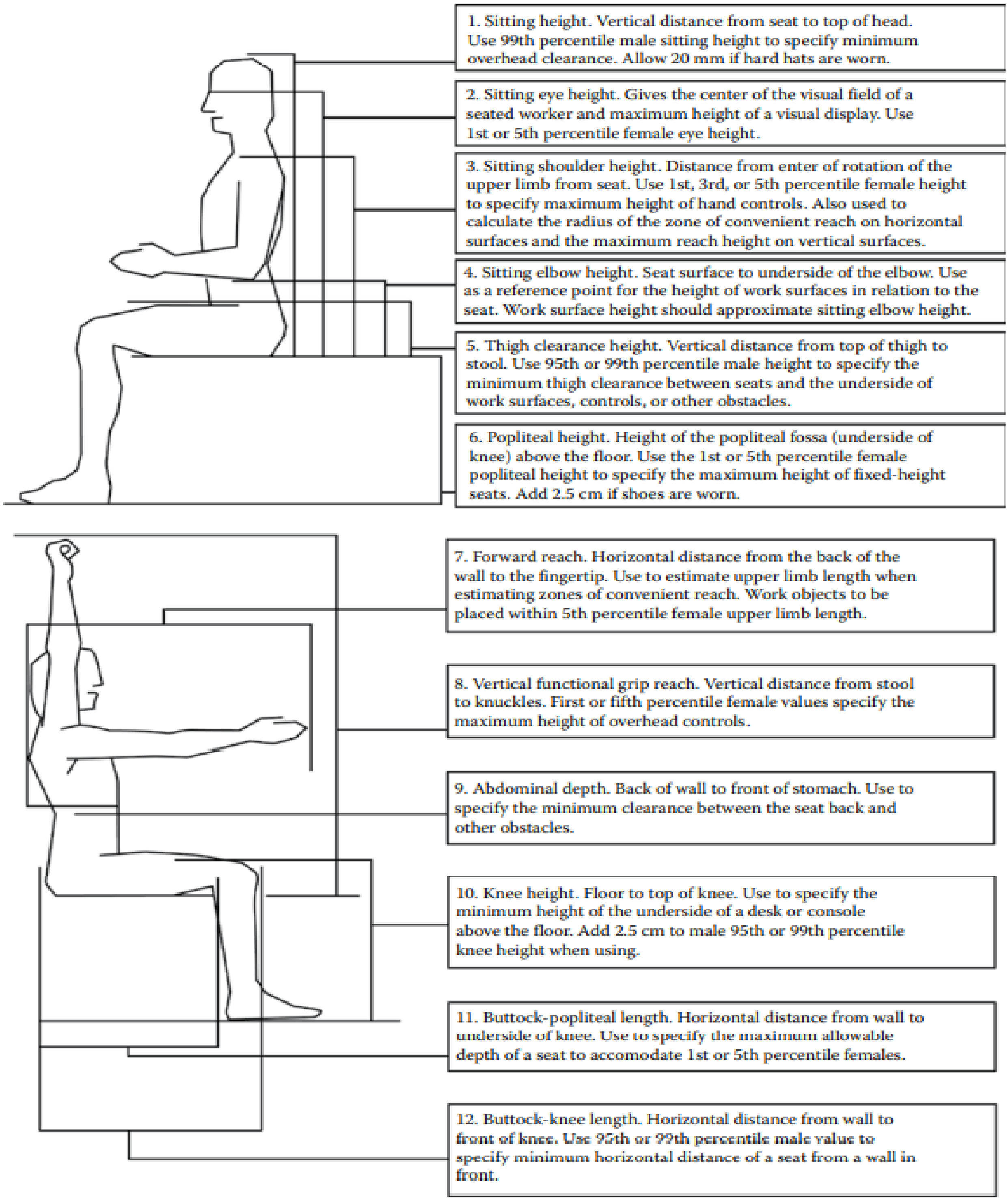


FIGURE 3.1. Static anthropometric measurements commonly used in ergonomics. (Refer to Table 3.1 for mean and standard deviations of these in a variety of populations.)

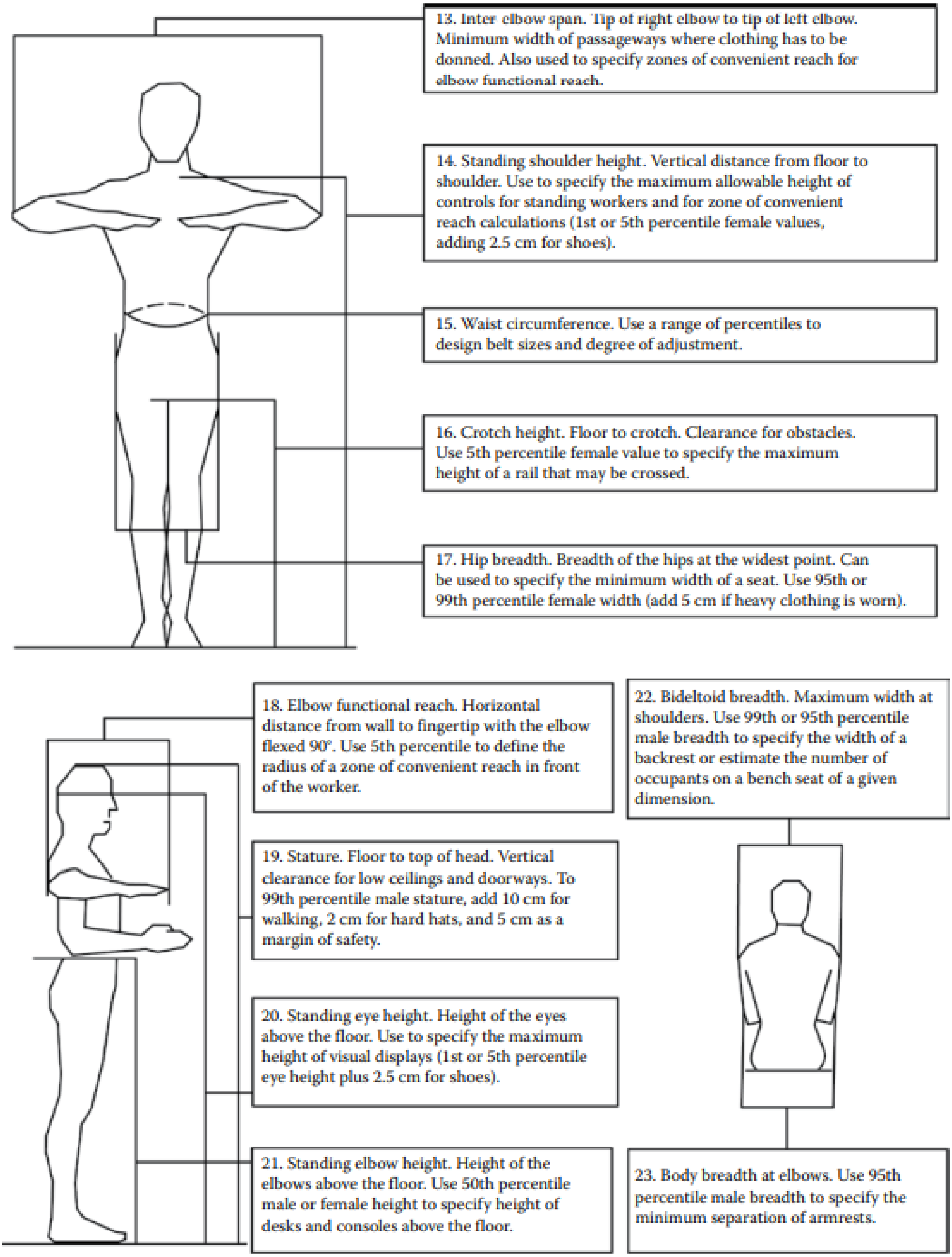


FIGURE 3.2. (Continued) Static anthropometric measurements commonly used in ergonomics. (Refer to Table 3.1 for mean and standard deviations of these in a variety of populations.)

TABLE 3.1. Selected Anthropometric Data: Means and Standard Deviations

No.	Males				
	United States	United Kingdom	China	Brazil	India[a]
1	923(37)	920(36)	906(36)	880(35)	840(25)
2	806(38)	803(37)	785(37)	775(34)	740(26)
3	637(30)	635(30)	624(33)	n/a	555(21)
4	245(28)	244(27)	236(22)	230(28)	205(20)
5	171(24)	169(19)	138(15)	150(16)	135(13)
6	450(28)	449(27)	410(23)	425(24)	415(21)
7	909(40)	811(40)	820(38)	n/a	725(24)
8	1322(54)	1318(53)	n/a	1220(56)	1190(44)
9	287(49)	280(39)	206(24)	245(33)	185(33)
10	546(29)	544(28)	502(28)	530(27)	510(30)
11	524(40)	517(35)	452(29)	480(29)	465(18)
12	620(41)	613(37)	556(31)	595(30)	555(21)
13	949(45)	946(44)	890(51)	925(44)	880(33)
14	1460(64)	1455(63)	1389(53)	1410(60)	1345(49)
15	1011(83)	985(66)	750(67)	n/a	n/a
16	819(49)	816(48)	780(45)	n/a	n/a
17	420(39)	393(31)	336(20)	340(25)	310(16)
18	479(22)	477(21)	450(21)	475(22)	460(20)
19	1755(71)	1755(70)	1691(62)	1700(66)	1620(50)
20	1643(70)	1638(69)	1573(59)	1595(66)	1510(52)
21	1099(51)	1096(50)	1021(42)	1045(49)	1025(40)
22	584(44)	570(35)	442(31)	n/a	410(19)
23	450(40)	449(39)	n/a	n/a	n/a
24[b]	82.1(17)	80(13)	60(8)	66(11)	49(6)

No.	Females			
	United States	United Kingdom	China	Sri Lanka[c]
1	861(36)	858(33)	840(35)	775(32)
2	745(36)	742(33)	720(33)	675(30)
3	583(31)	580(29)	573(28)	525(29)
4	233(27)	232(25)	223(19)	185(20)
5	160(39)	154(23)	133(14)	85(9)
6	400(28)	399(26)	378(23)	335(27)
7	811(40)	808(36)	753(35)	670(30)
8	1221(53)	1216(49)	n/a	1090(5)
9	280(80)	270(47)	208(24)	175(28)
10	496(29)	494(27)	456(25)	420(27)
11	503(50)	495(37)	438(28)	445(35)
12	599(56)	589(41)	531(29)	535(29)
13	860(48)	856(44)	775(49)	795(46)
14	1336(67)	1331(61)	1265(49)	1270(60)
15	874(122)	840(71)	692(64)	n/a
16	742(46)	739(43)	717(39)	n/a
17	426(70)	412(41)	351(25)	245(22)
18	433(23)	431(21)	411(20)	410(29)
19	1625(64)	1620(64)	1554(57)	1525(59)

3.2. Sources of anthropometric variability in body shapes and size

Anthropometric variables in the healthy population usually follow a normal distribution, as depicted in Figure 3.4. The Normal Distribution The two key parameters of the normal distribution are the mean and the standard deviation. The mean is the sum of all the individual measurements divided by the number of measurements. It is a

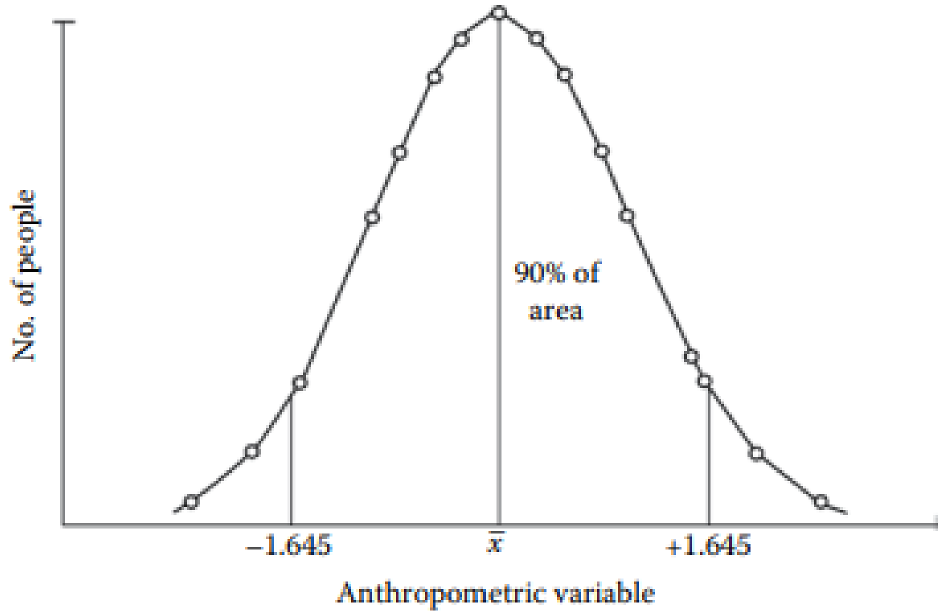


FIGURE 3.3 The normal distribution. Ninety percent of the measurements made on different people will fall in a range whose width is 1.645 standard deviations above and below the average.

(a) $$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}$$

(b) $$S = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1}}$$

FIGURE 3.4 Equations used to calculate (a) the mean and (b) standard deviation from measurements sampled from a population, where x is the individual measurement and n is the number of measurements. The mean is the sum of all the measurements divided by the number of measurements. The standard deviation is the square root of the mean squared difference between each score and the mean.

The standard deviation is a measure of dispersion. It is calculated from the sum of the differences between all of the individual measurements and the mean—the larger these differences, the more «spread-out» is the distribution and the larger the value of the standard deviation.

Thus, the value of the mean determines the position of the normal distribution along the x (horizontal) axis in Figure 3.3. The value of the standard deviation determines the shape of the normal distribution. In a normal distribution with a small standard deviation, most of the measurements are close to the mean value (the distribution has a high peak that tails off rapidly at both sides). A large value of the standard deviation means that the measurements tend to be scattered more distantly from the mean. The distribution has a flatter shape.

To find the measured value of a given percentile, use

(3.1) $$x = \bar{x} + (z \times \text{sd})$$

If Karen were 25th percentile stature and the mean and standard deviation female stature were 1650 and 100 mm, respectively, how tall would she be? First, we look up the value of z in Annex A. The value of z corresponding to the 25th percentile is z = −0.68 (the actual area in the table is 0.2483, rounded up to 0.25). This means that Karen is 0.68 of a standard deviation shorter than the mean. Therefore, Karen's stature, x, is

(3.2) $$x = 1650 + (-0.68 \times 100) = 1650 - 68 = 1582\,\text{mm}$$

Table 3.2 contains z-values and their corresponding areas under the normal curve. Crosscheck these values with the table in Annex A to confirm that you can find z-values for different areas under the normal curve, and vice versa

Required Percentile	Area to Left of *z*	*z*-Value (No. of Standard Deviations to be Subtracted from the Mean)
0.5	0.0049	−2.58
1	0.0102	−2.32
2.5	0.0250	−1.96
3	0.0301	−1.88
5	0.0505	−1.64
10	0.1003	−1.28
15	0.1492	−1.04
20	0.2005	−0.84
25	0.2414	−0.67
75	0.7486	+0.67
80	0.7995	+0.84
85	0.8508	+1.04
90	0.8997	+1.28
95	0.9495	+1.64
97	0.9699	+1.88
97.5	0.9750	+1.96
99	0.9898	+2.32
99.5	0.9951	+2.58

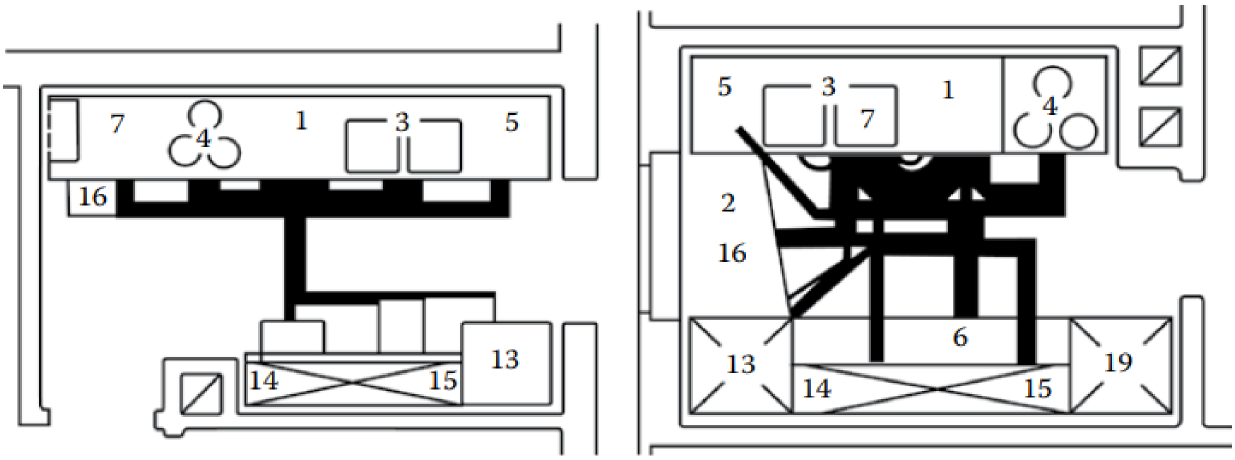
Note: The total area under the normal curve is taken to be 1 (Appendix A).

3.3. Anthropometric database

In the light of the increasingly international nature of business and trade, an urgent area of research is to fill-in the gaps in the world anthropometric database. Data are lacking on the anthropometry of many populations. Another challenge is to develop inexpensive automated methods of capturing data —traditional methods requiring the use of manual instruments are prohibitively expensive. Also of interest is the increase in body size of populations that occurs as countries develop industrially. This is known to have happened in Western Industrial Countries and Japan and more recently in Southern Europe and parts of South America. In developing countries, there may be differences in the anthropometry of urban versus rural people. In developed countries, there is a severe obesity crisis with over half the population overweight or obese. Many existing databases, based on old survey data corrected for the secular increase in stature, will underestimate all measures that depend on body composition. Available data are being incorporated into computer-based design aids. Several packages have been developed and they all assist in integrating data with 3D representations of the human form to improve the visualization and solution of problems of anthropometric fit. Further development of these aids will no doubt take place.

3.4. The use of anthropometry in shaping the spatial structure of workplaces designing methods

Anthropometric data help designers to optimize the dimensions of workspaces and furniture but are of limited use in optimizing the final design. Some kind of task analysis is always needed so that the anthropometric recommendations can be considered in relation to the task demands. Figure 3.16 presents the results of a very simple observational task analysis known as «link analysis» used to investigate alternative layouts for domestic kitchens. Two plan views are presented and the black lines show the movements of the user when working in the kitchen. The thicker the lines, the more frequently the user moves between linked objects (e.g., there is much movement between the work surfaces and the sink and less between the refrigerator and the stove). The U-shaped kitchen layout requires less walking but more twisting and turning. In general, objects that are used in succession are positioned close together and vice versa.



Two-sided kitchen, 7 m^2
1, 5, 7 = places where things are put down, or work is carried on
4 = cooker, 3 = Sink
14, 15, 16 = crockery cupboard and refrigerator

U-shaped kitchen, 6.2 m^2
1, 2, 5, 6 = places where things are put down, or work is carried on
4 = cooker, 3 = sink
13, 14, 15, 19 = cupboards and refrigerator

FIGURE 3.5. Link analysis of a user's movements when working in two alternative kitchen layouts. (Redrawn from Grandjean, E. 1973. Ergonomics of the Home. Taylor & Francis, London.)

Space Planning for Offices

Margaritis and Marmaras (2007) proved guidance for optimizing the use of space in offices for more than one person:

Step 1: Determine the number of people who will work permanently in the office. Step 2: Determine the organizational structure.

Step 3: Describe the main activities, the need for interaction between different employees, the need for privacy, reception of visitors, etc.

Step 4: Determine the equipment needed for each activity (e.g., VDT, printer, storage requirements, etc.).

Step 5: Detailed layout:

- Allow 50 cm free space in front of windows.
- Allow 3 m to the front and 1 m either side of the main entrance.
- Allow 1.5 m in front of and 0.5 m to the side of all other doors.
- Allow 0.5 m in front of heating units. Free space around desks:
- Allow 55 cm along front of desks for passage
- Allow 50 cm along the sides of workstations for ingress and egress Allow 75 cm at the back of desks for seating space
- Allow 100 cm at the back of desks if there are cabinets behind the desk.

Step 6: Determine requirements for proximity: physical separations should be compatible with task separations (the more two workstations collaborate, the closer they should be). Place the units that interact most with other units toward the center of the space.

Step 7: Arrange individual workstations in accordance with local health and safety regulations for office work.

4. THE CHARACTERISTIC OF THE OPERATOR'S WORK

4.1. The optimization of operator's work: receiving information, making decision, operational activities

Operator's work consists of: receiving information, making decision, operational activities.

Factors optimizing the operator's work:

- Receiving information (characteristics of signals, the amount of information)
- Making decision (situations which make it difficult to take a decision, i.e. the choice, complex, preferences, probabilistic)
- Operational activities (spatial structure, characteristics, arrangement and visibility of the controls and displays, working methods)
- Most of the information is transmitted via the signals received by the eyes and ears.
- This is due to the key role of these senses relative to the other.
- The use of a specific signaling information in specific systems depends on the situation.
- Conditions for the use of visual or auditory signal (by C. Morgan)

The information that a person receives in a given time be integrated into the information obtained in the past and fixed in memory.

There are two types of memory:

- Operational (short-term) — it is used in the making decision on the basis of signals received immediately prior to that decision
- Long-term — manifests itself in knowledge and human skills. This is the main store of human knowledge. Information taken from the current signals are processed according to the messages already held. The memory capacity is unlimited.

Basic operational activities:

- positional movements
- repetitive movements
- continuous movements
- serial movements
- static position

The structure of the movements:

<u>All working movements consist of two main phases:</u>

- target (dynamic, stabilizing)
- manipulation (pulling, pushing, pressing,
- gripping, twisting)

<u>Characteristics of movements:</u>

- Speed
- Accuracy
- Force

4.2. Human performance (psychophysical state)

Human performance psychology had its roots in the practical problem of how to reduce the time taken to train a worker to carry out a task. Taylor and the Gilbreths had gone some way to the solution of this problem by simplifying tasks. However, the emergence of new, more complex machines and manufacturing processes created new jobs whose skill requirements could not be met from the existing labor pool. Traditional methods of training (such as apprenticeship to a skilled craftsman and «sitting by Nellie») were not always appropriate to the industrial system with its fundamental requirement to standardize all aspects of the production process. Psychologists began investigating the variables influencing the learning of work skills, for example, whether tasks should be broken down into elements to be learnt separately and then bought together, the advantages and disadvantages of «massed» versus «spaced» practice, and the duration of rest periods. After World War II, interest in training continued. The cybernetic approach investigated the use of feedback (knowledge of results) and its effects on learning. The theoretical ideas of Skinner and the behaviorist school of psychology were implemented in the form of «programmed learning.» Behaviorism saw learning as the chaining together of stimulus–response pairs under the control of reinforcing, or rewarding stimuli from the environment. In programmed learning, the material to be learnt was presented in a stepwise fashion and the order of presentation of information to be learned was determined by whether the trainees' previous responses were correct or incorrect. The pressure for the productive and efficient use of machines was amplified by the demands of World War II and brought psychologists into direct contact with the problems of human–machine interaction. The famous Cambridge psychologist Sir Frederick Bartlett built a simulator of the Spitfire aircraft and investigated the effects of stress and fatigue on pilot behavior. This led to an increased understanding of individual differences in response to stress and enabled the breakdown of skilled performance to be described in psychological, rather than machine-based terms. Perceptual narrowing, which occurs as a result of fatigue or as a maladaptive response to severe stress, is an example. Craik studied a class of tasks known as «tracking tasks» (which involve following a target as in gunnery or steering a vehicle). The beginnings of user-interface (display and control) design emerged from this in the form of recommendations for gear ratios and lever sizes. This became an important area of ergonomics, particularly in postwar military applications and also in civilian vehicle design and the aerospace industry.

4.3. Mental workload (overload, underload)

ISO 10075 (2000) Parts 1 and 2 deal with ergonomics and mental workload. The mental workload of a task is nothing more than the sum of the mental demands placed upon the operator, in a manner analogous to physical workload or stress. However, the effort required to meet the demands and carry out the task effectively will depend on many factors—including operator training and skill, the duration of task performance, and the strategies used by the operator to cope with the demands. If the effort is too great or cannot be sustained, mental strain may result. The role of ergonomics is twofold—to modify the demands in accordance with the characteristics and limitations of human information processing and to schedule the task such that human performance can be sustained in accordance with system requirements. According to ISO 10075, mental stress is defined as «any external influence impinging on human beings and affecting them mentally.» Mental strain is defined as the immediate reaction to the stress and its consequences may be facilitatory and induce learning or they may result in fatigue and human error.

Factors Affecting Mental Workload

Many of the factors that affect mental workload are under the control of designers and ergonomists. Gives examples (ISO 10075) Boredom and monotony can be caused by: social isolation; absence of rest pauses; lack of physical activity; lack of task variety; unvarying climate; and unvarying acoustical stimulation. The kinds of coping strategies adopted by operators can also affect the mental workload. Many of these, such as work scheduling and error recovery, have to be taught. In general terms, avoidance coping consists of doing something else when the workload becomes high (e.g., carrying out a secondary or less demanding task) or ignoring the problem. Avoidance coping strategies may work as a last resort (e.g., fleeing the scene before the reactor melts down) but are not generally problem focused enough to maintain system performance. In the short term, they may reduce the mental workload but at the cost of the system's operation and increased workload in the future.

Approach coping strategies consist of finding out more about the problem, speaking to others about it, trying to «see the bigger picture,» etc. and are more likely to lead to solutions, even though the mental workload may increase in the short term. Broadbent (1979) argued that fatigue, both after sustained performance and after exposure to abnormal environments (such as physical stressors), caused a breakdown in the organization of the performance of complex tasks characterized by

- Forgetting to carry out critical subtasks on time
- Mistiming the execution of one task in relation to others
- Attentional «stickiness» (inability to shift attention from one subtask to the next)
- Lack of persistence

5. TASK ANALYSIS AND DIFFERENT ROLES OF HUMAN FACTOR IN TRANSPORT SYSTEMS

5.1. Operator/driver — task analysis,

Interactive tasks in cars can be divided into three classes:

1. Primary,
2. Secondary
3. Tertiary

Primary tasks describe how to maneuver the vehicle itself. The driver controls headings and speed of the car, as well as the distance to other cars and objects.

Secondary tasks are mandatory functions such as setting turning signals and activating the windshield wiper. The increase safety for the driver, the car and the environment.

Tertiary tasks cover entertainment and information functionality. These do not have any direct relationship to the driving task. Rather, they provide luxury services which are in high demand from today's car buyers, and thus a mandatory asset in modern cars

5.2. Delegating control between the driver / operator and the vehicle

Many examinations of automobile accidents have marked «distraction» as the principal villain. In almost the same breath «situational awareness» is also marked as a necessary component of skilled driving. How can we have the latter without some acceptance of the former? Which is more important; the improvement of situational awareness or the reduction of distraction? Is either of them important? What is the case is that the driver of an automobile must deal correctly and in a timely fashion with a number of different kinds of demand that correctly and in a timely fashion with a number of different kinds of demand that arise from a number of sources. Their nature can be somewhat clarified by an examination of a few limiting conditions.

Demand number 1

Consider first: driving an automobile on a billiard-ball planet with a completely smooth surface and totally uninhabited by any form of life. There is no wind, no hill, no animal or human to cross in front of the car. There is no weather, no rain or fog, no sun to dazzle the driver. There is even no «place». The driver is free to drive in any direction, especially since all directions are identical. Despite these extraordinary conditions there may be limits to what the driver is free to do. The car may be dynamically unstable. If no control is exercised, the car, with some degree of divergent instability, might at some speed swerve in its path and overturn. Therefore the driver must exercise speed control and/or steering control, to prevent extreme directional divergence. The timing and duration of such control will depend on the directional stability of the car, on the speed at which it is driven, and on the thresholds and reaction times of the driver. Thus, even in the absence of both spatial constraints and competitors for space — pedestrians, animals, bicycles and other cars — there is an intermittent attentional demand placed on the driver to exercise closed loop control over directional divergence that may occur. Crossman and Szostak (1968, p. 192) discussed it thus: A three-level information-processing model for driver steering control is developed. A key question appears to be what are the actual and feasible minimum repetition rates (or sampling frequencies) at each level. While this certainly depends on the exact forcing function applied at a particular time and on the various thresholds, it seems that level 1 and level 2 could operate withabout a 1–1 ratio and a scan rate around 1 per second while level 3 would require perhaps 1/5 the scan rate. Data of Senders *et al.* are relevant here.

Demand number 2

On the same uninteresting planet, let us put a pair of lines with constant separation (a «1-lane road») and demand that the driver stays between the lines. There is a long history of well-founded theoretical solutions to the lane-keeping task — the first and simplest component of the driver's problem. Rashevsky (1959) calculated a model of driver behaviour that would prevent Rashevsky (1959) calculated a model of driver behaviour that would prevent a car from «jumping off the road». This, his first discussion of the driving problem, presents an elegant analysis, largely ignored by modern writers, of the elementary driving situation. In the second paper (Rashevsky 1960) he extended the earlier deterministic model to a statistical model. The problem dealt with the nature of the path of the car (in the first paper) and the probability that the boundary of the road would be crossed (in the second paper). In the second paper (Rashesky 1960, p. 257) he said:

In a previous paper we outlined an approach to the theory of automobile driving for the ideal case of a single car on an empty road. The basic idea of the previous paper is that the driver makes ... an angular error ... from the exact direction of the road ... as, due to that error, the car approaches sufficiently close to the edge of the road, the driver corrects the direction making now the same average error in the opposite sense. Thus the car follows not a straight line but approximately a zigzag line with a very small angle.

Continuing, he assumes that the angular error is a variable with some distribution. This leads not to a zigzag with some specified angle but rather to a wandering path so that the car approaches the edge of the road, after some time at some speed, with a calculable probability distribution. He then asserts: «it is conceivable that through an erroneous act the driver, when for example approaching too closely the right edge, turns the wheel not to the left but to the right, enhancing the error and actually jumping off the road.» One may easily draw from his analysis the conclusion that if a «distracted» driver failed to note the position of the car at some instance, the car might, through the driver's failure to act, «jump» off the road. There is a purely perceptual «demand» on the driver to note his lateral position on the road and respond appropriately often enough to prevent that event. Rashevsky (1960) went on to comment on the possible effect of distracting stimuli on the reaction time of the driver (i.e., to the approach to the edge of the road) and therefore on the safety of driving. My own early experiments (e.g., Senders 1965) demonstrated and measured the intervals between voluntary observations of the road for a variety of speeds made by a small number of subjects (the «occlusion technique»). That work, predicated on an earlier work on the information-processing load placed on an observer and controller of multiple sources of information (Senders 1955), was a combination of control-theoretic analysis of the car and an information theoretic analysis of the driving situation. The data showed, as one might expect, that the greater the speed the more often the driver *would* take a look at the road. On most of these occasions, a small correction would be made in steering so as to reduce the rate of departure from the lane direction and the driver would then continue driving without further looks until some interval had passed that was ended with another voluntary look. The data obtained were assumed to be a function of a particular driver, driving a particular car, on a particular road. We assumed that if the car were more stable or the steering better adapted to human use, etc., the driver would have to look less often. In other words, our theoretical position was that the demand was a function of the vehicle, the road (with its traffic and obstacles and defects) and the perceptual speed and acuity, the motor skill and the psycho physiological state of the driver. Demands numbers 1 and 2 do not arise from anything external to the driving task itself. One comes from inherent instabilities of the driver–car system, and the other from perceptual and mechanical thresholds (and possibly nonlinearities such as mechanical dead spaces that limit the precision of steering) so that inevitable, even though very small, errors integrate over time and distance into significant deviations from the desired path. Both demands necessitate the same kind of closed-loop perceptual-motor activity. These two demands can be eliminated by the addition of full directional control, independent of the driver, as suggested in the following scenario of demand number 3.

Demand number 3

If we add to the «billiard ball world» two parallel rails and place the car on them, we relieve the driver of all directional control. The demands for stability and lateral position control disappear and the driver may fall asleep with no risk. An attentional demand arises only if there are intruders, actual or potential, into the swept space of the «car». It is, therefore, important to assess the *probabilities of intrusion* as well as the actual intrusion. If there is an intrusion, the driver must assess the speed of his car and the distance of the intruder and make an appropriate response to change speed. When there is a *probability of intrusion* attributable to a particular location along the track, the driver must attend in a suitable way, even if no intruder is visible, looking more often in areas of higher probability and less often, if at all, when the probability of intrusion is low.

Demand number 4

If there is a speed limit the driver must observe and control speed and/or scan for possible traffic police while exceeding the limit. When driving through an intersection there is a probability that an approaching car will violate the red light and cross into one's path. The glance up the road to the right may inform light and cross into one's path. The glance up the road to the right may inform one that the approaching car is not slowing, but is made with the risk that a nearby pedestrian may choose that moment to cross the road in front of the car. In the vicinity of a playground there is a probability that a ball may bounce into the street and be followed by a child or a dog. I commented on this in 1968 thus: If the vehicle is very stable it does not need to be attended to as often as if it were very unstable; and if the uncertainty of steering is small, the driver does not have to look as often as he would if it were large. Similarly, objects at a distance produce less uncertainty than objects close at hand. One would expect that as opposing traffic approaches, the driver must attend more often ... If there are many side streets, driveways, and the like, the probability of cross traffic is high and the driver has to pay more attention ... For example, if one were traversing a road at a constant speed and entered a populated area so that the probability of animal or human entry was high, then the frequency with which one looked at the road would go up (Senders and Ward 1968, p. 4).

Demand number 5

The introduction of technological aids and devices (e.g., IVIS, cell phones) into the automobile creates another set of demands, some of which are initiated by outside events (the cell phone incoming call) and some by events within the driver. The latter, like initiating a cell phone conversation or texting into a cell phone, have their precursors in map-reading, eating and drinking — and talking — by drivers while moving, since the beginning of driving. Since much of driving is uneventful, a driver's mind will address a wide variety of topics not involving the driving task: e.g., concern about the route, about the fuel remaining, about dinner tonight *etc.* These various demands are relatively simple to analyze. Combining them into a single model is somewhat more speculative. The demands are neither periodic nor predictable; they are almost surely uncorrelated. Each of them is a random, or quasi-random, process with its own parameters. The load on the driver is therefore not a simple linear summation of the components. It is not unreasonable to assume that both the durations of attentional acts and the intervals between attentional demands will have exponential distributions, each with its own parameters.

5.3. Driver assistance systems

We have come a long way in the development of vehicle technology since the humble horseless carriage of the late 19th century. The first decade of the 21st century has seen particular advancement in active safety systems — those which are designed to prevent, or mitigate the consequences of collisions by taking automatic control of the vehicle in some way (as opposed to passive safety, such as seatbelts and airbags, which prevent or mitigate the consequences of injuries resulting from a collision). Such advanced driver assistance systems (ADAS) purport to improve aspects of safety, comfort and convenience (e.g., Richardson et al., 1997) by either supporting the driver or taking over certain driving tasks.

5.4. Cognitive Aspects of Supervisory Control

In routine driving situations, the schema selection mechanism described above runs more or less automatically, based on reflexive (bottom-up) or habitual (topdown) selection. Thus, the strongest schemata, and/or the schemata most strongly associated with value, will always win the competition. This will lead to stereotyped behaviour which is effective in routine situations but insufficient to deal with novel or inherently difficult situations where the relevant schemata may be too weak and/or the task requires a flexible switching between schemata. This implies the need for a top-down «force» that can bias the schema selection in a certain direction when required by task goals and demands (deliberation in terms of Trick and Enns' 2009 framework). Moreover, a more general boost of schema activation and/or sensitivity might be needed to facilitate bottom-up selection of weaker stimuli (exploration). 5. This is the key role of *cognitive control*, a brain function mainly subserved by the prefrontal cortex (Miller and Cohen 2001). The deployment of cognitive control generally requires effort and is accessible to conscious awareness. Thus, actions driven by cognitive control may be viewed as «willed», as opposed to those triggered by the schema system alone (Norman and Shallice 1986). As mentioned above, strong schemata are more easily activated and may run automatically, without conscious effort, while weak schemata require cognitive control to become activated at all or to override stronger competing schemata. More generally, cognitive control is needed whenever there is a conflict in schema selection that cannot be resolved by routine, automatic scheduling alone. Such conflicts include the following in particular.

• *The lack of a sufficiently strong habitual schema to match the current situation:* this may generally be the case for novice drivers or for experienced drivers that enter into novel or inherently difficult traffic situations or when the driver is motivated to optimise driving performance. For example, if the driver needs to maintain a tight time schedule and thus reduces safety margins from what is normally accepted (van der Hulst *et al.* 1998), cognitive control can be deployed to boost the relevant vehicle control schemata.

• *A mismatch between habitually selected schemata and the current situation:* an example of this is when a person used to right-hand traffic should cross a street in the UK. In this situation, the strongly automatised «look left» schema is in conflict with the actual task demands (as potential traffic approaches from the right) and needs to be overridden with effort. A similar example, already mentioned above, is the need to override the habitual tendency to look left in our example T-junction scenario in order to look for cyclists to the right. Based on Botvinick *et al.* (2001) and Botvinick (2007), it may be suggested that cognitive control is *recruited* in a self-regulating fashion based on monitoring of conflicts between schemata and/or evaluation of the performance of selected schemata by their outcome. In the present model, this monitoring function is performed by the value system. Thus, if the value system detects that the current performance is insufficient to obtain task goals and/or to maintain accepted safety margins, cognitive control is recruited to enhance performance. Similarly, if a task-relevant schema is interfered with by a stronger schema, the conflict is detected by the value system, which, in turn, recruits cognitive control to resolve the conflict and protect the weaker schema from interference. However, since cognitive control is effortful, and effort is associated with a cost (discomfort) the deployment of cognitive control always requires motivation, which also derives from the value system. If motivation is lacking, drivers normally accept a lower level of performance (e.g., by slowing down instead of mobilizing cognitive control). *Working memory* is closely related to cognitive control. More specifically, cognitive control is needed to maintain activation of task-or goal-relevant representations in the absence of stimulus input (Miller and Cohen 2001). In terms of the present model, working memory corresponds to controlled topdown biasing (deliberation by means of cognitive control) with the purpose being to sustain activation of a schema or a schema coalition during a task. The link between attention and effort is a key feature of many classical models of attention, most notably Kahneman (1973). This energetic aspect of attention selection is traditionally closely linked to the concept of *arousal* (which, like attention, is a rather heterogeneous concept with no commonly accepted definition). It is generally believed that arousal involves a global modulation of schema sensitivity that occurs during the deployment of cognitive control (e.g., Aston-Jones and Cohen 2005). However, the mechanisms behind this modulation is only partly known and thus arousal mechanisms are not explicitly represented in the present model.

Schema learning

A key remaining issue concerns how schemata are learned. A general theory of learning in driving is obviously outside the scope of the present chapter. Here, we will merely sketch some key principles for how schemata and schema coalitions in the model may become established and tuned through driving experience. Learning may take place at different time scales. When we first learn to drive, no driving-specific schemata exist and thus have to be established. Once established, the schemata may have to be adjusted due to changing contingencies in the driving environment. For example, the introduction of novel infrastructure elements such as the two-way bicycle lane in our T-junction example requires learning of new proactive attention allocation strategies. Finally, schemata may also have to be fine-tuned on a trip-by-trip basis, for example when renting a car with different braking dynamics from the car one is used to driving. Aside from driving lessons, driving schemata generally have to be learned through driving experience in an unsupervised way. In driving, the most basic ability to be learned is to avoid collisions. Collision avoidance is naturally most efficient if potential collisions can be anticipated. A conceptual model of how anticipatory avoidance behaviour in driving is learned is offered by Fuller (1984), who suggests that avoidance actions become *conditioned* on predictive cues through continuous feedback on the outcome of actions. Thus, if a certain driving situation repeatedly results in a non-successful outcome (e.g., a violation of the driver's minimum accepted safety margins), and this situation is consistently associated with some discriminative stimulus or more general contextual cues, the driver will eventually learn to allocate attention and initiate anticipatory avoidance actions, based on the perception of the predictive stimulus or context, rather than the specific hazard per se. This is, again, closely related to the contextual cueing phenomenon mentioned previously (Chun and Jiang 1998, 1999). The general idea is also supported by recent work in neurobiology and computational modelling (see, e.g., Schultz *et al.* 1997, Sporns *et al.* 2000), which suggests specific mechanisms for how this type of conditioning is implemented in the brain. A reinforcement learning algorithm based on these principles was used by Sprague and Ballard (2003) to implement value-driven action selection and gaze arbitration. It may be further proposed that conditioning in naturalistic tasks such as driving relies on the presence of *consistent mappings* (Schneider and Shiffrin 1977, Shiffrin and Schneider 1977, Schneider *et al.* 1984) in the environment. If the driver is consistently exposed to certain stimulus contingencies and/or stimulus-action mappings, and these are associated with significant value (behavioural relevance), they will be gradually learned and the anticipatory behaviour becomes more and more automatic (and hence less dependent on cognitive control). In terms of the present model, it may be suggested, mainly based on Sporns *et al.* (2000), that the value system continuously modulates the strength of schemata representing consistent mappings, and the links between them, so that schemata and schema coalitions that consistently lead to successful outcomes (high value) are strengthened while schemata/coalitions that lead to unsuccessful outcomes are weakened. Moreover, cognitive control may serve to deliberately *establish* desired consistent mappings in the early learning phase when no strong schemata exist. For example, when first learning to keep the vehicle in the lane, cognitive control may be deployed to maintain gaze on the road in order to establish a consistent mapping between visual input and steering output. Once the basic schema for lane keeping has been learned, the need for cognitive control is reduced until the point where the lane keeping task is almost completely automatized.

Summary

At this point, it may be useful to summarise the main proposed features of the model. In everyday driving, drivers proactively select information and actions in anticipation of how situations will develop, but also need to be able to react to non-anticipated events. In the model, *attention selection* refers specifically to the selection of schemata which may proceed automatically (habitually or reflexively) for strong schemata or rely on cognitive control (i.e. deliberate or exploratory) for weaker schemata. Two general schema levels are proposed (although more fine-grained hierarchies may be defined based on the modelling purpose): (1) basic schemata (which may be further divided into sensory-motor and semantic schemata) and (2) task context schema. Schemata are selected by virtue of their level of activation and the activation of a schema is modulated by four main types of biases:

1. *Bias from sensory input activation*, which is determined by physical stimulus properties, such as brightness, background contrast and size;
2. *Value bias*, which drives selection towards schemata associated with positive value and away from schemata associated with negative value — this enhances value-associated input activation (bottom-up) and selectively biases schemata associated with expected value (top-down);
3. *Contextual bias*, which implements habitual top-down selection driven by task context schemata initially activated automatically (bottom-up) by the «gist» of the present context; and
4. *Cognitive control*, which implements deliberate top-down selection of nonroutine actions or action patterns. It also serves to maintain activation of task goals in the absence of stimulus input, thus implementing the basis for working memory. Cognitive control requires effort and is associated with arousal. Cognitive control is recruited in a self-regulatory way based on monitoring of value outcome and/or potential conflicts between schemata.

6. A NEW APPROACH TO TRANSPORT SYSTEMS DESIGN

6.1. Five fundamental fallacies of design,

N1: This design is satisfactory for me — it will, therefore, be satisfactory for everybody else.

N2: This design is satisfactory for the average person — it will, therefore, be satisfactory for everybody else.

N3: The variability of human beings is so great that it cannot possibly be catered for in any design — but since people are wonderfully adaptable, it doesn't matter anyway.

N4: Ergonomics is expensive, and since products are actually purchased on appearance and styling, ergonomic considerations my conveniently be ignored.

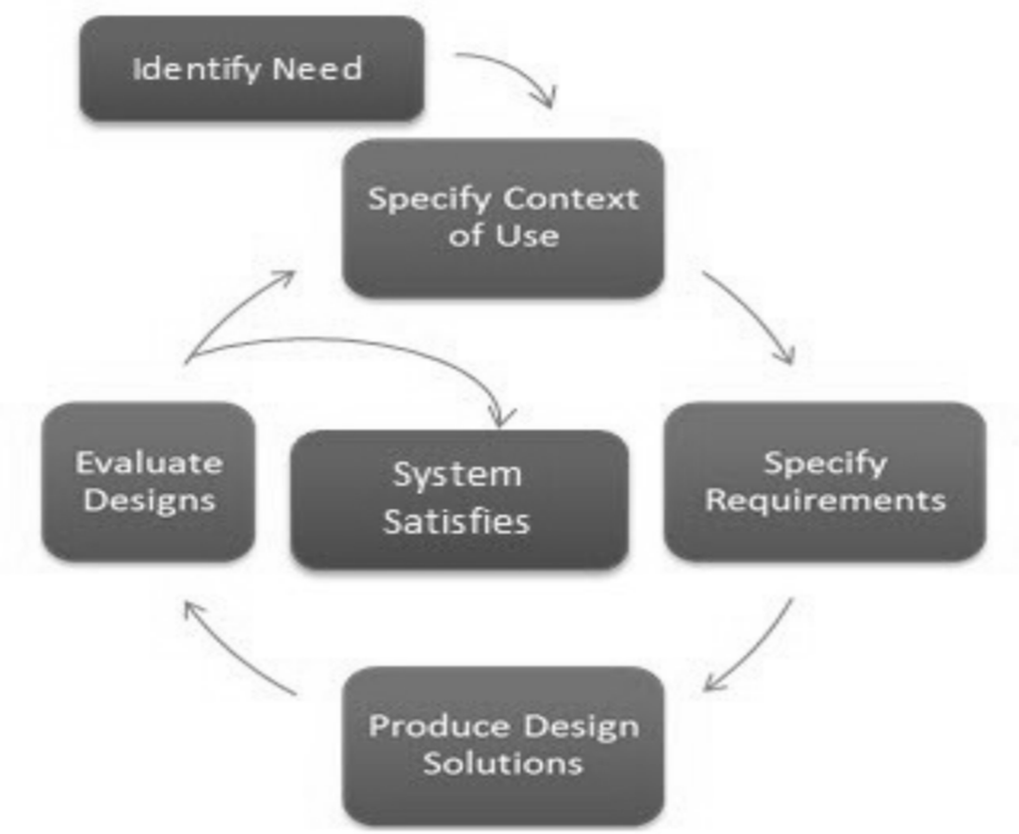
N5: Ergonomics is an excellent idea. I always design things with ergonomics in mind — but I do it intuitively and rely on my common sense so I don't need tables of data or empirical studies.

6.2. Ergonomic design

Designing an automotive product such as a car or truck involves the integration of inputs from many disciplines (e.g., designers, body engineers, chassis engineers, powertrain engineers, manufacturing engineers, product planners, market researchers, ergonomics engineers, electronics engineers). The design activities are driven by the intricate coordination and simultaneous consideration of many requirements (e.g., customer requirements, engineering functional requirements, business requirements, government regulatory requirements, manufacturing requirements) and trade-offs between the requirements of different systems in the vehicle. The systems should not only function well, but they must also satisfy the customers who purchase and use the products. The field of ergonomics or human factors engineering in the automotive product development involves working with many different vehicle design teams (e.g., management teams, exterior design teams, interior design teams, package engineering teams, instrument panel teams, seat design teams) to assure that all important ergonomic requirements and issues are considered at the earliest time and resolved to accommodate the needs of the users (i.e., the drivers, passengers, personnel involved in assembly, maintenance, service) while using (or working on) the vehicle.

6.3. User-centred design

User-Centered Design(UCD)is a methodology that involves users in the entire process of creating a system from the beginning(planning) to the subsequent (following) implementation of the system



The following are the general phase soft he UCD process:

– **Specify the context of use:** Identify the people who will use the product, what they will use for it, and under what conditions they will use it.

– **Specify requirements:** Identify any business requirement for user goals that must be me forth e-product to be successful.

– **Created sign solutions:** This part of the process may be done in stages, building from a rough concept to a complete design.

– **Evaluate designs:** Evaluation-ideally through usability testing with actual users-is as integral as quality testing is to good software development.

User-centred design is empirical.
User-centred design is iterative.
User-centred design is participative.
User-centred design is non-Procrustean.
User-centred design takes due account of human diversity.
User-centred design takes due account of the user's task.
User-centred design is system-oriented.
User-centred design is pragmatic.

6.4. Universal design

DEFINITION OF UNIVERSAL DESIGN

The general acceptance of the term *universal design* was itself a big step forward and is exemplified in the following definition from a resolution adopted by the Committee of Ministers of the

Council of Europe at their February 2001 meeting:

Universal design is a strategy that aims to make the design and composition of different environments and products useable for everyone. It attempts to do this in the most independent and natural manner possible, without the need for adaptation or specialized design solutions. The intent of the universal design concept is to simplify life for everyone by making the built environment, products, and communications equally accessible, useable, and understandable at little or no extra cost.

The universal design concept emphasizes user-centered design by following a holistic approach to accommodate the needs of people of all ages, sizes, and abilities. It provides for the changes that all people experience throughout their lives. Consequently, universal design is becoming an integral part of the architecture, design, and planning of the built environment.

Principles of Universal Design/Creating Accessible, Equitable Kitchens

Kitchen & Bath Business (KBB) and Residential Design/Build

Universal design concepts need to be applied to kitchen planning so the kitchen will function for, and benefit, all residents and visitors.

The term *universal design* is sometimes inaccurately used as the politically correct description of compliance with the Americans with Disabilities Act (ADA) and other access codes or guidelines. Universal design is a broader approach that incorporates the needs of all users, not one specific group. Universal design is an ideal whereas code compliance is simply following a dictate.

Understanding the principles of universal design is fundamental to creating environments that ensure the end user's well-being. Universal design is inclusive and equitable, meeting the needs of a variety of people. It is much more than the misconception that it is design limited to medical solutions or access challenges.

Because it is typically used by all occupants of the house, the kitchen is the primary focus of universal design applications.

Following is the Center for Universal Design's Seven Principles of Universal Design with applications that apply to kitchens and the Life Span Design features for the entire house. These principles could be used as a checklist of additional criteria during the design process. The checklist follows:

1. EQUITABLE USE

Design is useful and marketable to people with diverse abilities.

• Provide the same means of use for all users: identical whenever possible; equivalent when not.

• Avoid segregating or stigmatizing any users.

• Provisions for privacy, security, and safety should be equally available to all users.

• Make the design appealing to all users.

Design applications

• Rocker light switch

• Motion sensor lighting, ventilation, or faucets

• Side-by-side refrigerator

Life span design features for equitable use

• A 4-foot-wide walkway from sidewalk or driveway

• No step entries

• Americans with Disabilities Act Accessibility Guidelines (ADAAG)–compliant thresholds

• Thirty-six-inch-wide doors throughout

• Minimum 44-inch-wide hallways

• Electrical outlets and telephone jack 18 inches from the floor

• Switches 42 inches from the floor

• Environmental controls 48 inches from the floor

• Access to the circuit breaker panel; topmost breaker at maximum reach of 48 inches.

2. FLEXIBILITY IN USE

Design accommodates a wide range of individual preferences and abilities.

• Provide choice in methods of use.

• Accommodate right — or left-handed access and use.

• Facilitate the user's accuracy and precision.

• Provide adaptability to the user's pace.

Design applications

• Knee spaces with door and storage options, allowing for seated or standing use

• Forty-eight-inch work aisles, ensuring either a perpendicular or parallel approach to appliances

• Multiple counter heights

• Movable (portable) storage

• Deep drawers with or without divider pegs

• Storage for an optional stool Life span design features for flexibility use

• Blocking for grab bars and shower-seat installations

• Roll-in showers offering adequate maneuvering room for wheelchairs

• Shower system including temperature set/pressure balance single-handle control, diverter valve, and handheld shower

• Side or front transfer access space to commodes

• Single-lever kitchen and bathroom faucets

3. SIMPLE, INTUITIVE

Design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.

• Eliminate unnecessary complexity.

• Be consistent with user expectations and intuition.

Accommodate a wide range of literacy and language skills.

• Arrange information consistent with its importance.

• Provide effective prompting and feedback during and after task completion.

Design applications

• Operation of single-lever faucet that moves left for hot and right for cold

• Use of red to indicate hot and blue to indicate cold

• One-step controls on a microwave for preprogrammed recipes

Life span design features for simple and intuitive use

• Thermostats with intuitive features and directive notations or symbols large enough to read and with sufficient color contrast

4. PERCEPTIBLE INFORMATION

Design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.

• Use different modes (pictorial, verbal, tactile) for redundant presentation of essential information.

• Provide adequate contrast between essential information and its surroundings.

• Maximize «legibility» of essential information.

• Differentiate elements in ways that can be described (i.e., make it easy to give instructions or directions).

• Provide compatibility with a variety of techniques or devices used by people with sensory limitations.

Design applications

• Digital temperature control on faucets or ovens that sound and blink when limits are reached

• Lighting controls that light up in the off position and go dark when on

• Smoke detectors with sound and light alarms

• Cooking controls that use numbers and pictures to indicate cooking mode/process

• Use of color contrast

Life span design features for perceptible information

• Contrasting colors of floor materials delineating traffic passages

• Energy-saving illumination

• Various floor materials, all of which comply with the Federal Housing Accessibility Design Guidelines, and colors to different areas

5. ERROR TOLERANCE

Design minimizes hazards and the adverse consequences of accidental or unintended actions.

• Arrange elements to minimize hazards and errors. Most-used elements, most-accessible; hazardous elements eliminated, isolated, or shielded.

• Provide warnings of hazards and errors.

• Provide failsafe features.

• Discourage unconscious action in tasks that require vigilance.

Design applications

• GFCI outlets that reduce risk of shock

• Temperature-limiting faucets that prevent accidental scalding

• Timed automatic shutoff on faucets or ventilation

• Induction cooktops

14 *Universal Design*

Life span design features for error tolerance

• Low volatile organic compound materials and finishes

• Fire extinguisher mounted on base cabinet next to the range/cooktop

6. PHYSICAL EFFORT

Design can be used efficiently, comfortably, and with minimum fatigue.

• Allow user to maintain a neutral body position.

• Reasonable operating forces used.

• Minimize repetitive actions.

• Minimize sustained physical effort.

Design applications

• Lever handles

• Remote window controls

• Remote controls for cooktop ventilation

• Motion-activated appliances and controls

• D-pulls on cabinetry

• Conveniently located storage and appliances (raised dishwashers, counter height microwaves and ovens)

Life span design features for low physical effort

• Lever handles on all swinging doors

• Handles that accommodate grasp on all sliding or folding doors

• Kitchen, bathrooms, and other cabinet doors fitted with D-shaped or other styles of handle that facilitate grasp and are ergonomic

• Garage door opener

7. SIZE AND SPACE

Appropriate size and space are provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.

• Provide a clear line of sight to important elements for any seated or standing user.

• Make the reach to all components comfortable for any seated or standing user.

• Accommodate variations in hand and grip size.

• Provide adequate space for the use of assistive devices or personal assistance.

Design applications

• Split double ovens at comfort height

• Storage accessories installed within the universal reach range (15 to 48 inches above finished floor)

• Movable (portable) storage

• The 30-inch × 48-inch clear floor space in front of all appliances

• Knee space at a sink, cooktop, work counters or adjacent to tall appliances

Life span design features for size and space

• Sixty-inch turning radius in bathrooms and kitchen

• Lazy Susan cabinets in kitchen where indicated

• Pull-out shelves in kitchen base cabinets

• Front controls on the range or cooktop

• Switches for garbage disposal installed in the front apron of the sink's base and range/cooktop exhaust fan/light switch installed in the base cabinet next to the range

7. HUMAN ERRORS

7.1. Definition of human reliability.

Human error

This is the failure to carry out a specified task (or the performance of a forbidden action) that could lead to disruption of scheduled operations or result in damage to property and equipment.

Human error consequence

This is an undesired consequence of human failure.

Human reliability

This is the probability of accomplishing a task successfully by humans at any required stage in system operation within a given minimum time limit (if the time requirement is specified).

Human performance reliability

This is the probability that a human will perform all stated human functions subject to specified conditions.

The purpose of this book is to cover the topic of human reliability assessment (HRA) in some depth from the viewpoint of a practitioner. There have been a lot of changes in the topic over the last number of years. Because HRA is still developing, it has elements of controversy in terms of the appropriate methods for the representation of human failure probability. Even the term human error causes problems for certain individuals. The idea that human error is a random event is not acceptable, and the concept that humans can be set up to fail due to the context or situation under which they are operating is gaining credibility. This concept means that one can do something to avoid human errors, and it is not a case of firing «error-prone» individuals.İn the study of human error, simulators are now seen as a valuable resource, and their use in this field has gone through a change in attitude. This book will cover aspects associated with data and data sources, choice of methods, training of individuals,use of simulators for HRA purposes, and relationships between psychology, human factors, accident analyses, and human reliability.

In writing a book about this topic, what to include and what to leave out is an issue. Some of the topics covered here in a few paragraphs are covered by many books. For example, there are many models attempting to cover only the prediction of human error probability. In one research document, Lyons et al. (2005) documented some 35 methods and techniques, and I would guess that this number is an underestimate. I do not intend to cover each method and technique. A number of HRA methods have been selected to discuss which are currently in use in the nuclear industry in the United States and elsewhere. Many of the approaches discussed here lean heavily on nuclear energy applications, but they are adaptable for use in other industries. The nuclear energy field is the wellspring for the development of ideas in both probabilistic risk assessment (PRA) and HRA.

The idea of human reliability has grown out of the development of equipment reliability as a science and the evaluation of systems. The concept of risk has played a major role in its development. Once one starts to consider the risk of an accident to an operating plant leading to both economic loss and loss of life, eventually one is forced to consider the role of organizations, decisions made by both managers and staff, and, of course, a risk–benefit relationship of design and operational decisions.

7.2. Psychological mechanisms of errors in human work

The systematic human error reduction and prediction approach (SHERPA) was developed by Embrey (1986) as a human-error prediction technique that also analyzes tasks and identifies potential solutions to errors in a structured manner. The technique is based upon a taxonomy of human error, and in its original form it specified the psychological mechanism implicated in the error. The method is subject to ongoing development, which includes the removal of this reference to the underlying psychological mechanism.

In general, most of the existing human-error prediction techniques have two key problems (Stanton,2002). The first of these problems relates to the lack of representation of the external environment or objects. Typically, human-error analysis techniques treat the activity of the device and the material with which the human interacts in only a passing manner. Hollnagel (1993) emphasizes that human reliability analysis (HRA) often fails to take adequate account of the context in which performance occurs. Second, there tends to be a good deal of dependence made upon the judgment of the analyst.Different analysts, with different experience, may make different predictions regarding the same problem (called interanalyst reliability). Similarly, the same analyst may make different judgments on different occasions (intraanalyst reliability). This subjectivity of analysis can weaken the confidence that can be placed in any predictions made. The analyst is required to be an expert in the technique as well as the operation of the device being analyzed if the analysis has a hope of being realistic.

7.3. Different category and typology of errors

1. Human errors in different modes of transport
2. Some of these reasons are follows

Poor training or s	Poorly written equipment operating and maintenance procedures
Poor equipment design	Improper work tools
Complex task	Poor verbal communication
Poor work layout	Poor motivation
High temperature or noise level in the work area	Crowded work space
Distraction in the work area	Poor management
Poor lighting in the work area	Poorly written equipment operating and maintenance procedures

The one of Human Error Classifications:

1. Design Errors,
2. Maintenance Errors,
3. Operator errors,
4. Inspection errors,
5. Fabrication Errors,
6. Handling errors,
7. Contributory errors.

Methods for Performing Human Reliability and Error Analysis in Transportation Systems

There are many methods developed in reliability, safety, and other fields for conducting various types of analysis. Some of these methods can also be used to conduct human error analysis in road transportation systems. These methods include:

- fault tree analysis,
- Markov method,
- failure modes and effect analysis, and
- cause and effect diagram.

This section covers the four main human error categories along with some discussion of dependence between human activities. Human errors are sometimes thought of as spontaneous errors made by individuals and crews; however, most errors are induced by the situation under which persons operate. They may be caused by technical or human factors in procedures, by misinterpretation of statements within the procedures, by failures in training, and by instructions generated by management.

7.4. Occupational Stressors and Human Performance Effectiveness

There are basically the following four types of occupational stressors:

- Occupational change-related stressors
- Occupational frustration-related stressors
- Workload-related stressors
- Miscellaneous stressors

The occupational change-related stressors are concerned with the occupational change that disrupts an individual's cognitive, behavioral, and physiological patterns of functioning.

The occupational frustration–related stressors are concerned with problems of occupational frustration. This frustration is generated in situations where the job inhibits the meeting of stated goals or objectives. Some of the factors that form elements of occupational frustration are lack of effective communication, role ambiguity, ineffective career development guidance, and bureaucracy difficulties.

The workload-related stressors are concerned with the problems of work overload or work under-load. In the case of work overload, the job/task requirements exceed the ability of the concerned individual to satisfy them effectively. Similarly, in the case of work-under load the work activities being performed by the individual fail to provide sufficient stimulation.

The miscellaneous stressors are all those stressors that are not included in the above three categories. Three examples of these stressors are noise, poor interpersonal relationships, and too much or too little lighting.

8. EFFECTS OF THE PHYSICAL ENVIRONMENT ON HUMANS

8.1. Definition and category of work environment factors

Several different factors can cause mental, psychological and physical loading on the body.

Five main areas are:

- thermal climate,

• air quality,
• lighting,
• sound,
• vibration and radiation.

The discipline of occupational hygiene addresses these and many other work environmental factors but includes a wider scope of topics (e.g. chemical exposure, air quality etc.)

The basic division of factors according to harmfulness:
• nuisance factor
• harmful factor
• risk factor

NDS — the highest acceptable concentration,
NDN — the highest acceptable intensity.

8.2. A brief introduction to the occupational hygiene discipline

Evaluation of the occupational environment is one major focus of occupational health or industrial hygiene. Applicability of industrial hygiene theories, principles, and practices often extends beyond the occupational and manufacturing settings. Accordingly, many of the topics presented in this book are applicable to both occupational and nonoccupational and manufacturing and nonmanufacturing environments.

Numerous methods are used to evaluate the occupational environment and other applicable settings for physical, chemical, and biological agents and ergonomic factors that pose potential hazards and risks to the health of workers and others. This book is intended to summarize numerous industrial hygiene instruments and methods for evaluating occupational and some nonoccupational environments. It is divided into relatively short units and appendices that provide concise overviews and description of basic concepts, followed by technical exercises. Several units have example problems and some have short case studies.

The step-by-step exercises can be conducted in a setting where the applicable agents are detectable and measurable and other factors are observable. As an alternative, simulated evaluation exercises can be conducted in the classroom or laboratory. In either case, the learner will gain the knowledge, comprehension, and skill of basic industrial hygiene principles and practices for collection, detection, identification, calculation, and interpretation of qualitative and quantitative data.

The training exercises are intended only for demonstration purposes. Although based on and very representative of accepted industrial hygiene practices, the methods outlined here are not intended to be used as substitutes for those already established by various agencies and organizations. For two examples, learners are strongly encouraged to be familiar with practical information and methods summarized in publications such as the NIOSH Manual of Analytical Methods and

the OSHA Technical Manual. In addition, for more expansive coverage of the related theoretical aspects, learners using this book should be or become familiar with several of the excellent recommended references listed in the bibliography. This book is an excellent adjunct to books addressing comprehensive practice, such as The

Occupational Environment — Its Evaluation and Control and the Fundamentals of Industrial Hygiene. Finally, training exercises should be conducted under the supervision of an experienced industrial hygienist while ensuring that personal health and safety precautions are implemented.

This book is an introductory, condensed learning reference intended for novice environmental and occupational health and safety undergraduate and graduate students and practitioners. It also will serve as a useful book for the nonacademic continuing education and professional development of individuals who need an understanding or review of evaluation methods fundamental to industrial hygiene practice. The first edition was well received as a succinct review for even experienced practitioners. This second edition is expanded and improved and will certainly serve and accomplish the same, if not more.

8.3. The influence of work environment factors on human performance and health

The alerting quality of noise makes it an ideal warning signal. However, noise can distract workers and is a major source of dissatisfaction with the environment. Individuals differ widely in their attitudes to and tolerance of noise. Many factors need to be considered if an optimal auditory environment is to be designed. Woodson (1981) has compiled the findings of many studies of the effects of noise on human performance.

The effects of factors in the material working environment on people and indirectly on their work depend on:

- the type of working medium used (e.g. noise, lighting, etc.),
- the timing and duration of these factors,
- intensity (concentration, intensity),
- nuisance of work,
- individual immunity and sensitivity of a person to a given factor, as well as the state of health and current condition of the person.

8.4. The measure and evaluation methods of work environment factors

Measurements with the purpose of investigating the presence of agents and the patterns of exposure parameters in the work environment can be extremely useful for the planning and design of control measures and work practices. The objectives of such measurements include:

- source identification and characterization
- spotting of critical points in closed systems or enclosures (e.g., leaks)
- determination of propagation paths in the work environment
- comparison of different control interventions

9. EVALUATION METHODS OF THE HUMAN FACTOR PERFORMANCE IN TRANSPORT SYSTEMS

9.1. What are human factors methods ?

HF methods are designed to improve product design by understanding or predicting human interaction with those devices. Different methods tap into different aspects of this interaction.

9.2. Challenges for Human Factors and Ergonomics Methods

Ergonomics science abounds with methods and models for analyzing tasks, designing work, predictingperformance, collecting data on human performance and interaction with artifacts and the environmentin which this interaction takes place. Despite the plethora of methods, there are several significant challenges faced by the developers and users of ergonomics methods. These challenges include:

- Developing methods that integrate with other methods
- Linking methods with ergonomics theory
- Making methods easy to use
- Providing evidence of reliability and validity
- Showing that the methods lead to cost-effective interventions
- Encouraging ethical application of methods

Annett (2002) questions the relative merits for construct and criterion-referenced validity in the development of ergonomics theory. He distinguishes between construct validity (how acceptable the underlying theory is), predictive validity (the usefulness and efficiency of the approach in predicting the behavior of an existing or future system), and reliability (the repeatability of the results). Investigating the matter further, Annett identifies a dichotomy of ergonomics methods: analytical methods and evaluative methods. Annett argues that analytical methods (i.e., those methods that help the analyst gain an understanding of the mechanisms underlying the interaction between human and machines) require construct validity, whereas evaluative methods (i.e., those methods that estimate parameters of selected interactions between human and machines) require predictive validity.

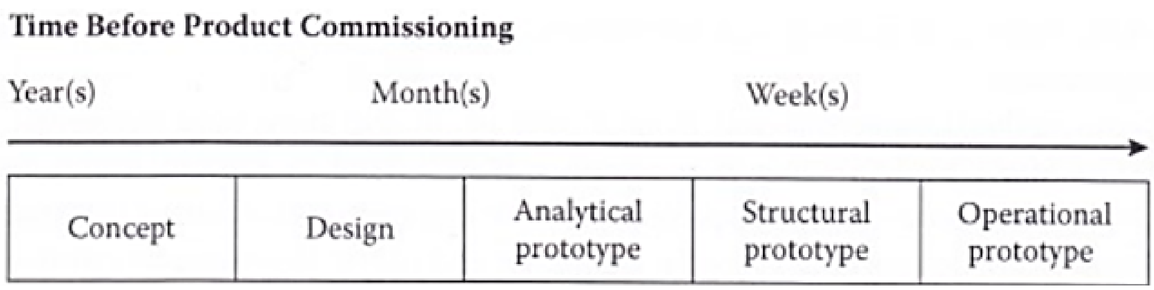
9.3. How do we choose which method to use?

Some methods are only appropriate to use at certain points in the design cycle, some take longer than others, some depend on two people being available, and all provide different forms of output.

The following tables summarize the criteria for using all of the methods, and working through them should help us to decide.

The first question to ask yourself is: At which stage of the design cycle are you?

In ergonomics the design process is divided into five principal stages at which different methods may be applied.



The methods may be broadly classified as quantitative or qualitative approaches.

All of them make predictions about either the user, or the device, or the user and the device.

The quantitative methods predict speed of performance (e.g. critical path analysis [CPA]), errors (e.g. systematic human error reduction and prediction approach [SHERPA] and task analysis for error identification [TAFEI], and speed and errors (e.g. observation).

The qualitative methods predict user satisfaction (e.g., questionnaires and repertory grids), device optimization (e.g., checklists, link analysis, and layout analysis) or user and device interaction (e.g. heuristics, hierarchical task analysis [HTA], and interviews).

9.4. What do we want to evaluate? (errors, performance times, usability, or design)

We should choose our method according to the output we require: errors, performance times, usability, or design.

Errors	Times	Usability	Design
SHERPA	CPA	Checklists	Link analysis
Observation	Observation	Questionnaires	Checklists
TAFEI		HTA	SHERPA
		Repertory grids	Rep grids
		Interviews	TAFEI
		Heuristics	Layout analysis
			Heuristics

9.5. Classification of human factor methods

I. Physical Methods
II. Psychophysiological Methods
III. Behavioral — Cognitive Methods
IV. Team methods
V. Environmental Methods
VI. Macroergonomics Methods

Physical Methods — this section deals with the analysis and evaluation of musculoskeletal factors. The topics include: measurement of iscomfort,observation of posture, analysis of workplace risks, measurement of work effort and fatigue, assessing lower back disorder, and predicting upper-extremity injury risk.

Psychophysiological Methods — this section deals with the analysis and evaluation of human psychophysiology. The topics include: heart rate and heart rate variability, event-related potentials, galvanic skin response, blood pressure, respiration rate, eyelid movements, and muscle activity.

Behavioral — Cognitive Methods — this section deals with the analysis and evaluation of people, events, artifacts, and tasks. The topics include:observation and interviews, cognitive task analysis methods, human error prediction, work analyses and prediction, and situational awareness.

Team methods **—** this section deals with the analysis and evaluation of teams. The topics include: team training and assessment requirements, team building, team assessment, team communication, team cognition, team decision making, and team task analysis.

Environmental Methods **—** this section deals with the analysis and evaluation of environmental factors. The topics include: thermal conditions, indoor air quality, indoor lighting, noise and acoustic measures, vibration exposure, and habitability.

Macroergonomics Methods **—** this section deals with the analysis and evaluation of work system. The topics include: organizational and behavioral research methods, manufacturing work systems, anthropotechnology, evaluations of work system intervention, and analysis of the structure and processes of work system.

10. ADAPTATION OF TRANSPORT SYSTEMS TO USERS WITH SPECIAL NEEDS

10.1. Basic definitions — disability, accessibility, discrimination

• Universal Declaration of Human Rights 1948

• The International Covenants on Human Rights

• The European Convention for the Protection of Human Rights and Fundamental Freedoms

• The European Social Charter,

• Charter of Fundamental Rights of the European Union

Discrimination occurs where without justification, and for a reason which relates to the disabled person's disability, a disabled person is treated less favourably than others to whom the reason does not or would not apply.

Person with disabilities and person with reduced mobility' means any person who has a permanent or temporary physical, mental, intellectual or sensory impairment which, in interaction with various barriers, may hinder their full and effective use of transport on an equal basis with other passengers or whose mobility when using transport is reduced due to age.

Accessibility is one of the most important outcomes of the transportation system.

Public transport can be more attractive by providing «Door to door mobility» and development of transportation services is an important factor of social quality. Public transport accessibility has gained vital importance in designing and evaluating the transit system in terms of mobility and sustainability.

• Accessibility is the possibility of all people to maneuver readily within and make use of the built environment

• Accessibility for people with disabilities is generally not given enough focus in transport planning, design, construction

• Exclusion increases the costs associated with disability

•**Accessibility**: Guiding principle of the Convention (article 4) and relevant for all areas of implementation

• **Physical environment:** Measures should be undertaken to eliminate obstacles and barriers to indoor and outdoor facilities, including schools, medical facilities and workplaces

• **Public facilities & buildings:** Governments should set an example in ensuring full participation in society for persons with disabilities by developing guidelines to make public facilities and services accessible.

10.2. Documents determining the accessibility of transport for people with special needs,

EU The 1993 Community Action Program for Accessible Transport is adopted, with measures to improve accessibility of transportation: vehicles, buses and coaches (Directive 85/EC, 2001); maritime transport (for example, Directive 99/35/EC195), lifts and parking cards for people with disabilities

10.3. User restrictions taking into consideration during design of transport systems

Cities and urban areas offer a range of both positive and negative aspects that impact quality of life for older people. On the positive side, there is greater access to cultural and educational events and a wider array of transportation options, including taxis and «ride-hailing» services, such as Uber and Lyft, as well as public transportation options. On the negative side, there tends to be more crime, overcrowding, pollution, and traffic congestion. Quality of life in cities depends on a balance between the good and bad aspects associated with urban life.

In towns and cities there is greater access to delivery services for a wide variety of goods, such as groceries and freshly prepared meals. This can decrease the need to travel outside the home but does little to maintain opportunities for socialization. Mobility in cities can be enhanced by welldesigned transport systems, enhanced measures to maintain safety and security, and urban planning. Urban planning is particularly important. In the Netherlands where there are many protected bicycle lanes, 17% of people over 65 years of age bicycle every day, in comparison to 27% of people under 50. Bicycling in older people not only facilitates mobility, it can also facilitate social connectedness. It should be noted that use of public transportation among older adults in the United States does lag behind many other developed countries. This is likely due, at least in part, to the lack of alternatives to the personal automobile in many rural areas throughout the United States. In cities, well-designed urban areas can provide spaces for recreation and socialization and therefore have the potential to offset some of the decreases in quality-of-life factors associated with driving cessation. In rural areas, older people who cease driving are more vulnerable to social isolation, which carries negative health consequences.

10.4. Types of barriers preventing access by persons with special needs to transport systems

• Barriers to accessibility in transport

• Lack of regulatory frameworks and inadequate monitoring and enforcement of access legislation

• Lack of resources and perception of high cost for implementation; knowledge gaps

• Barriers in — Physical infrastructure — Vehicle design — Information — Social acceptance

References

1. Gkikas N., (2013), Automotive Ergonomics. Driver-Vehicle Interaction., CRC Press, Taylor & Francis Group,

2. Regan M.A., Lee J.D., Victor T.W. (2013), Driver Distraction and Inattention — Advances in Research and Countermeasures, ASHGATE

3. ErikssonA., Neville A. Stanton N.A., (2018), Driver Reactions to Automated Vehicles: A Practical Guide for Design and Evaluation, CRC Press

1. Null R., (2017), Universal Design: Principles and Models., CRC Press,

2. Baldwin C.L, Lewis B.A., Greenwood P.M., (2019), Designing Transportation Systems for Older Adults., CRC Press,

3. Bridger R., Introduction to ergonomics., (2017), CRC Press Taylor & Francis Group,

4. Vivek D. Bhise, Ergonomics in the Automotive Design Process., CRC Press Taylor & Francis Group

CHAPTER 5
HUMANITARIAN LOGISTICS AND TRANSPORT SERVICES IN DISASTERS CONDITIONS

Valiyeva SAPARGUL
Hudaygulyyev NURALY

Objectives

The objective is to give to the candidate the basis of logistics and transport service first. These bases will be extended to the context of disasters and emergency context.

Outlines

– Introduction to global logistics and transport problems
– Logistic network design and location problem
– Distance — Short path selection
– Distribution resources planning
– Vehicle routing problem

- Humanitarian logistics process
- Transportation aid process flow
- Warehousing
- Containerized cargo
- Freight forwarder
- Freight consolidation
- Minimum evacuation time
- Facility location optimization model for emergency humanitarian logistics.

Introduction to global logistics and transport problems

– Logistic network design and location problem
– Distance — Short path selection
– Distribution resources planning
– Vehicle routing problem

Global logistics — is an interrelated set of functions of material management in international trade. Global logistics involves strategy and tactics development for creating sustainable micro-logistics systems, which connecting business structures all over the world based on labor division, partnership and cooperation in form of contracts and agreements, master plans supported at the intergovernmental level. The emergence of this term «global logistics» in itself is reflecting growing tendency in global economy, which characterized by the development of business activity from specialization in local regions and countries to multi-organized world markets. Formation, management and optimization of material flows on the level of macro-regional economic institutions, are the main objects of global logistics.

In the field of logistics management main driving forces to its globalization are the following:

– Continuing world economic growth;

– Exploring further growth potentials by entering new markets, finding cheap sources of raw materials and labor forces outside national borders (outsourcing);

– Establishing a large number of companies with wide international division of labor and modern information technologies which form the basis of integration in global logistics systems, also formation of third party logistics service providers (freight forwarding companies, expert operation managing companies, international trade companies) with developed global infrastructure;

– Implementing of deregulation procedure, in order to eliminate trade, custom, transport and financial barriers in development trade and economical relations. It facilitates the movement of capitals, goods and information through national borders.

At the same time, there are a lot of barriers for development of global logistics resulting from different causes, such as different political systems, unequal levels of social and economic developments of countries. Also trade, tax and custom policy of countries can create different financial barriers.

Recession in many markets, combined with new sources of competition, has raised the consciousness of customers towards value. 'Value' in today's context does not just mean value for money — although that is certainly a critical determinant of the purchase decision for many buyers — but it also means perceived benefits. Customers increasingly are demanding products with added value, but at lower cost, and hence the new competitive imperative is to seek out ways to achieve precisely that.

It is now being recognized that, for the real benefits of the logistics concept to be realized, there is a need to extend the logic of logistics upstream to suppliers and downstream to final customers. This is the concept of supply chain management.

Transport Management

Transport management is critically important for enhancing overall supply chain performance and facilitating socioeconomic development (Susniene and Jurkauskas, 2008). The two main objectives are to improve commercial performance and provide sustainable distribution solutions. Transport plays a vital role in closely integrated, customized, time- sensitive and vulnerable supply chains and networks. The improvement in the use of time is a major issue in the literature on SCM (Ptak and Noel, 1998; Svensson, 2002; Mason and Lalwani, 2006). Morash and Clinton (1997, p. 5) explained that «to minimize total costs and maximize customer value, transport integration is essential within the supply chain.» Also, the 14th World Conference on Transport Research (WCTR) reinforced the observation that sound transport infrastructure with different transport modalities creates comprehensive distribution channels (Woxenius et al., 2017). Since the early 1990s, the field of transport management has applied the concept of technological advancement. Circumstantial evidence has suggested that technological development encourages transport integration and maintains a smooth physical distribution through reasonable scheduling over time (Geerlings et al., 2009; Liu et al., 2014). The concepts of «nodes» and «links» become especially important for transport management.

One of the main problem of transportation services — development of merchant shipping, port facilities in conjunction with railway networks. In Russia and CIS, for example, in maritime transport as total amount of transported cargo falls, amount of exports in international traffics rising since 1999 (Transportation Logistics: modern problems and ways of development.V.N.Filina.). Also growth rate of freight turnover reached 126%. International practice is developing to simplify and expedite customs procedures and guarantee security of goods.

Interaction with customs fulfilled in two stages:

1. Preparation of all papers necessary during border crossing, implemented by provider or freight forwarder;

2. Full customs clearance of freight is implemented by freight owner.

Logistic network design and location problem

The Logistics Network consists of:

– Facilities:

– Plants/Vendors Ports

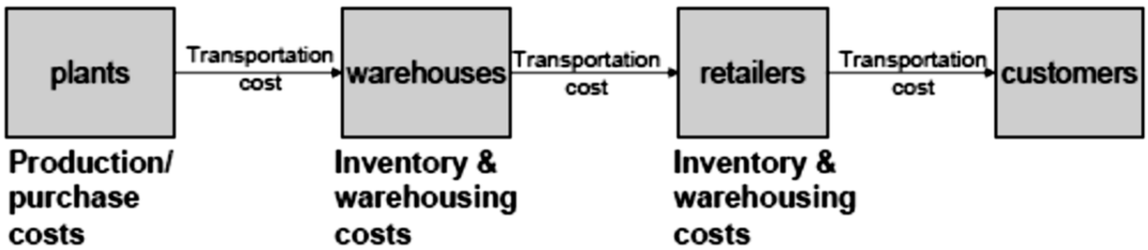
– Warehouse

– Retailers/Distribution Centers

– Customers

– Raw materials and finished products that flow between the facilities.

Typical Logistics Configuration



Key Strategic Decisions in the Logistics Network

Assuming that plants and retailer locations are fixed, it is better to concentrate on the following strategic decisions in terms of warehouses.

– Pick the optimal number, location, and size of warehouses

– Determine optimal sourcing strategy

– Which plant/vendor should produce which product

– Determine best distribution channels

– Which warehouses should service which retailers

– The objective is to design or reconfigure the logistics network so as to minimize annual system-wide costs, including:

– Production/ purchasing costs

– Inventory carrying costs, and facility costs (handling and fixed costs)

– Transportation costs.

Main purpose is to find a minimal-annual-cost configuration of the distribution network that satisfies product demands at specified customer service levels.

The trade-off in this problem I

Increasing the number of warehouses yields:

– An improvement in service level due to the reduction in average travel time to the customers.

– An increase in inventory costs due to increased safety stocks required to protect each warehouse against uncertainties in customer demands.

– An increase in overhead and setup costs.

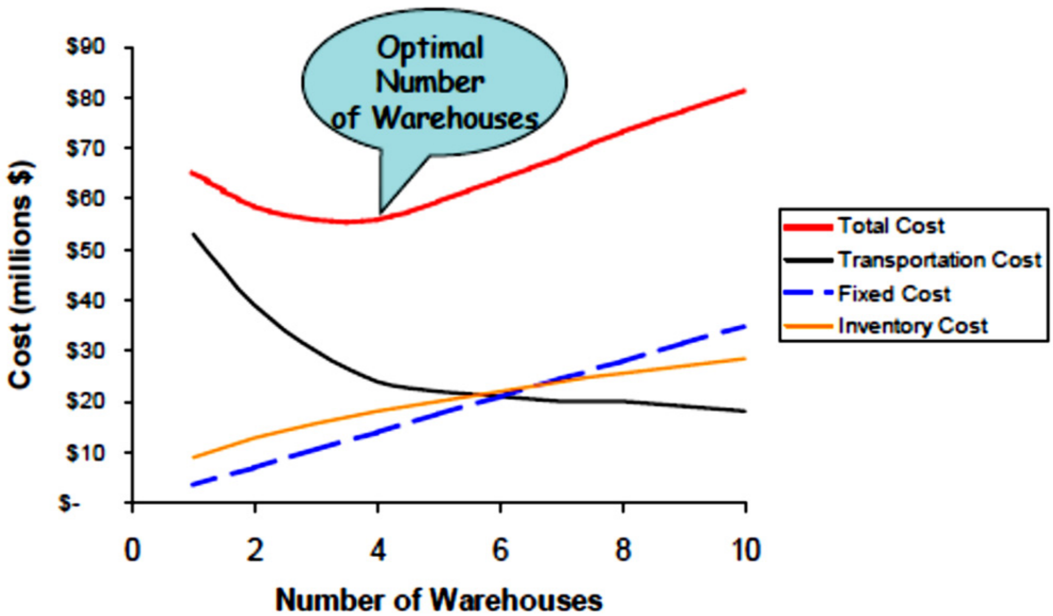
– A reduction in outbound transportation costs: transportation costs from the warehouse to the customers.

– An increase in inbound transportation costs: transportation costs from the suppliers and/or manufacturers to the warehouse.

In essence, the firm must balance the costs of opening new warehouses with the advantages of being close to the customer.

The trade-off in this problem II

Thus warehouse location decisions are crucial determinants of whether the supply chain is an efficient channel for the distribution of products.



Major Steps in Network Design

Step 1. Data Collection

Step 2. Data Aggregation

Step 3. Data Validation and Model

Step 4. Optimization

Data Collection

A typical network configuration problem involves large amount of data, including information on:

1. Location of customers, stocking points and sources — location theory
2. A listing of all products
3. Demand for each product by customer location — forecast technique
4. Transportation rates by mode-information system, like rating engine

5. Mileage estimation — GIS
6. Warehousing costs (handling and fixed) — inventory management
7. Service level requirement — probabilistic technique
8. Shipment sizes by product
9. Order patterns by frequency, size, season, content
10. Order processing cost
11. Customer service goals

Transportation costs = Transportation rate × Distance

Transportation rate: the cost per mile per SKU. An important characteristic of a class of rates for truck, rail, UPS and other trucking companies is that the rates are quite linear with the distance but not with volume. Usually there are two kinds of transportation rates:

– Internal fleet (company-owned): It can be easily calculated from information like annual costs per truck, annual mileage per truck, annual amount delivered, and truck's effective capacity.

– External feet (third-part): More complex calculation is needed: There are rating engines available, such as the SMC.

– Rate Ware — www.smc3.com.

Mileage estimation: Once we know the transportation rates, which usually depend on the distance, we need to estimate the mileage between any two locations. Depending on situation, it can be:

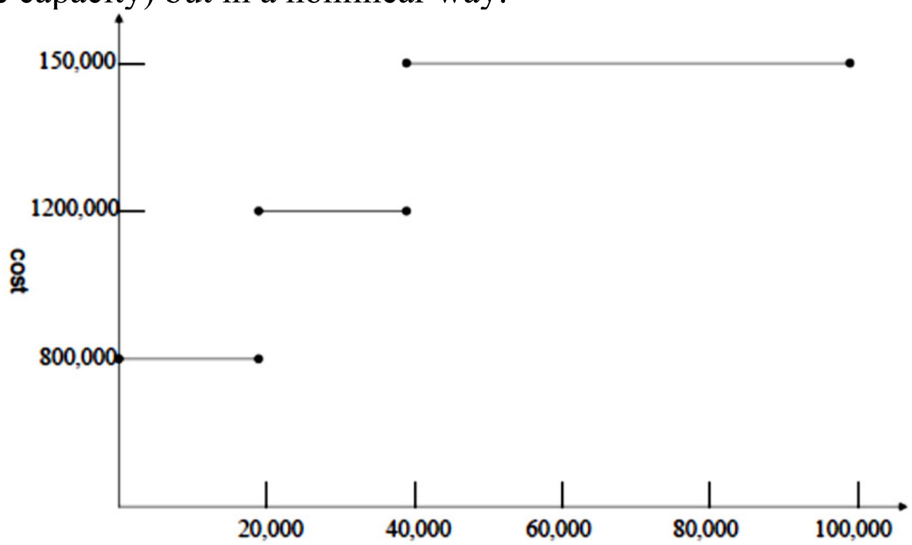
– Exact estimation: this usually can be obtained using GIS system, but the drawback is cost and speed — it may be need to install GIS receiver and slow down the operation of a Decision-Support System.

– Approximate estimation: For most of the applications, this will be sufficient.

Warehousing costs (handling, and fixed costs).

– Handling cost: proportional to the amount of material that flows through the warehouse.

– Fixed Cost: All costs that are not proportional to the amount of material the flows through the warehouse. It is typically proportional to warehouse space size (or warehouse capacity) but in a nonlinear way.



1. Warehouse capacity is proportional to the peak inventory, not the average inventory or annual flow.

2. Inventory turnover ratio = $\frac{annual\ flow}{average\ inventory\ level}$

3. The warehouse capacity is given by

$$\text{Warehouse Capacity} = 3\times(2 \times \text{average inventory level}) = 6\frac{annual\ flow}{inventory\ turnover\ ratio}$$

Data Aggregation

Aggregate and clean the data because:

1. the data collected is usually overwhelming,
2. the cost of obtaining and processing the real data is huge,
3. the form in which data is available must be streamlined,
4. the size of the resulting location model is huge, and
5. the accuracy of forecast demand is improved.
6. Of course, data aggregation only approximates the real data, so the impact on model's effectiveness must be addressed.

A heuristic to aggregate data I

– Customer-based Clustering: Customers located in close proximity are aggregated using a grid network or clustering techniques. All customers within a single cell or a single cluster are replaced by a single customer located at the centroid of the cell or cluster. We refer to a cell or a cluster as a customer zone.

– Product type-based clustering: Place all SKU's into a source-group. A source group is a group of SKU's all sourced from the same place(s). Within each of the source-groups, aggregate the SKU's by similar logistics characteristics (Weight, Volume, Holding Cost).

– A rule of thumb for aggregate customers and product types is give by

o Aggregate 150-200 customers or 20-50 product types points for each zone.

– Make sure each zone has an approximate equal amount of total demand

– Place the aggregated point at the center of the zone.

– In this case, the error is typically no more than 1%

Data Validation and Model

– Once the data are collected and cleaned, we need to ensure that the data and model accurately reect the network design problem.

– This is typically done by reconstructing the existing network configuration using the model and collected data, and comparing the output of the model to existing data. The purpose is to answer the following questions:

o Does the model make sense?

o Are the data consistent?

o Can the model results be fully explained?

o Did you perform sensitivity analysis?

Distance — Short path selection

Evaluating the Route Selection Process

The choice of linking a location to another, and more importantly, the path selected is part of a route selection process which respects a set of constraints.

Although route selection varies by mode, the underlying principles remain similar; in its most simple form, a route selection process (R) tries to respect these general constraints:

$$R = f\,(\min C : \max E)$$

Route selection tries to find or use a path minimizing costs (C) and maximizing efficiency (E). There are obviously two major dimensions in this function:

Cost minimization. A good route selection should minimize the overall costs of the transport system. This implies construction as well as operating costs. The most direct route is not necessarily the least expensive, notably if rugged terrain is concerned, but most of the time a direct route gets selected. It also implies that route selection must be the least damageable to the environment, if environmental consequences are considered.

Efficiency maximization. A route must support economic activities by providing a level of accessibility, thus fulfilling the needs of regional development. Even if a route is longer and thus more expensive to build and operate, it might provide better services for an area. Its efficiency is thus increased at the expense of higher costs. In numerous instances, roads were constructed more for political reasons then for meeting economic considerations.

Route selection is consequently a compromise between the cost of a transport service and its efficiency. Sometimes, there are no compromises as the most direct route is the most efficient one. At other times, a compromise is very difficult to establish as cost and efficiency are inversely proportional.

Distribution resources planning

Distribution resource planning (DRP) is the process of determining the right quality of finished goods to be sent to each distribution center or warehouse in order to meet customer demand within a supply chain. DRP enables the user to set certain inventory control parameters (like a safety stock) and calculate the time-phased inventory requirements. This process is also commonly referred to as distribution requirements planning.

DRP uses several variables:

- the required quantity of product needed at the beginning of a period
- the constrained quantity of product available at the beginning of a period
- the recommended order quantity at the beginning of a period
- the backordered demand at the end of a period
- the on-hand inventory at the end of a period

During DRP, customer and forecasted demand are translated into purchase orders. This process depends on actual demand signals such as customer orders as those orders are used to plan the gross requirements of the supply source.

DRP needs the following data:

- the future demand;
- the planned receipts at the beginning of a period;
- the available inventory at the beginning of a period;
- the safety stock requirement for a period.

Supply chain management is a combined process that involves coordinating the purchasing of materials, time planning of operations, logistics, and planning of resource capacities. With the many aspects involved in supply chain planning, the distribution of materials is considered a vital component of production.

There are many questions that supply chain and project managers must ask themselves when it comes to optimizing flow, minimizing shortages, reducing transportation costs, reducing orders, and timing delivery.

The outputs of DRP can help supply chain managers answer questions such as:

– Which products will we need?
– What quantity of each product will we need?
– Where are those finished goods needed?
– What quantity do we have on-hand and how much do we need to produce?

The goal of DRP is to ensure that the right quantity of goods are produced in the manufacturing facilities and sent to various warehouses to fulfill customer orders.

Push or Pull method in DRP

The DRP process can either use a push or pull method. First, the pull method involves demands for finished goods shifting upward throughout the system to fulfill customer orders. Although management controls the amount of goods available, the distribution inventory management is challenging because all orders are considered new to the supplying location as the demand is flowing upward, which is otherwise known as the «Bullwhip Effect». This effect reflects the increasing demand forecast inaccuracies as orders move up the supply chain.

The push method is the opposite of the pull method — instead, goods are sent downward through the system. The advantage of this method is that it allows lower costs, but can be disadvantageous when the central planning and demand are not on the same page at all times.

Vehicle routing problem

Vehicle routing problem first appeared in an article, in 1959, where mathematical statement and its solution for supplies of petrol to fuel stations were presented. Nowadays it is one of the well-known statements in the field of combinatorial optimizations. General meaning of vehicle routing problem is as follows: m vehicles in depot have to deliver goods to n customers with minimal expenses for goods delivery. The solution is to create several closed circuits in depot, on the condition that all customers were visited only one time. Expenses for goods delivery are optimized by reducing the number of vehicles or optimization of routing.

The vehicle routing problem (VRP) is a generic name given to a whole class of problems involving the visiting of «customers» by «vehicles». These problems derive their name from the basic practical problem of supplying geographically dispersed customers with goods using a number of vehicles operating from a common goods depot. The problem is one of routing the vehicles so that the total distance travelled (or time taken, cost incurred, etc.), is minimal. The VRP appears very frequently in practical situations not directly related to the delivery of goods. For example, the collection of mail from mail-boxes, the pickup of children by school buses, house-call tours by a doctor, preventive maintenance inspection tours, the delivery of laundry, etc. are ail VRP's in which the «delivery» operation may be a collection, collection and/or delivery, or neither; and in which the «goods» and «vehicles» can take a variety of forms some of which may not even be of a physical nature. In view of the enormous number of practical situations which give rise to VRP's it is not surprising to find that an equally large number of constraints and/or objectives appear in such problems. However, the basic VRP can be characterized as follows.

The VRP defined above is by necessity a gross simplification of problems found in practice. The most important omissions in VRP are:

1. Multiple trips operated by vehicles in a single work period.
2. Multiple periods (e. g. many days with intermediate overnight stops) needed for certain vehicle trips.
3. The VRP is most often encountered not as a single period (day) problem, but as a problem over many periods (e. g. a week) with some customers requiring delivery once a week others twice of three times a week, etc. In such multiperiod VRP's the days on which a certain customer requires delivery may be completely unspecified or a combination of days is to be chosen from a number of acceptable ones. Thus, for any one day, the set X of customers to be delivered to must be decided from the total set of customers that must be supplied during the whole period.
4. Capacitated vehicle routing problems. All vehicles have fixed capacity.
5. Vehicle routing problems with time windows. For each customer settled certain time interval (window), during which goods have to be delivered to customer.
6. Multiple depot vehicle routing problems. In this case there is more than one depot that can be used for customer services.
7. Periodic vehicle routing problem. Goods can be delivered in a prolonged time period. Total transportation period is prolonging for several days, during that period each customer must be visited at least one time. Also vehicles can return to the depot on the next day of departure.
8. Stochastic vehicle routing problem. In this case, random variables can be used in order to show the number of customers, their requests or length of the path. During the decision making this data can be changed.

Humanitarian logistics process

The purpose of emergency aid or disaster relief is to mitigate the effects of disasters and reduce the suffering of the affected people (Kelly, 1995). It is therefore important to rapidly provide appropriate emergency supplies to the people affected so that human suffering can be minimized (Balcik, Beamon, & Smilowitz, 2008). Designing an efficient and effective humanitarian supply chain is a key challenge for humanitarian organizations. Humanitarian supply chains differ from regular supply chains because they focus at minimizing loss of life and suffering, whereas commercial supply chains are mainly concerned with quality and profitability (Campbell, Vandenbussche, & Hermann, 2008). In fact, a humanitarian supply chain is one of the most dynamic supply chains in the world (Hoffman, 2005). Every disaster is different and it is hard to tell what the impact will be on an area or country. The management of these humanitarian supply chains is complicated because the amount of experienced logistics experts available is limited and coordination between the involved parties is often minimal (Nahleh, Kumar, & Daver, 2013). Timely distribution may be complicated because the infrastructure in the affected area is often damaged or difficult to reach (Balcik et al., 2008). Furthermore, special care in transportation is needed since strict attention must be paid to food safety (e.g. storage of perishable food and temperature) as well as hygiene (Gaboury, 2005). Several medicines and/or vaccines need to be transported in a refrigerated box because they must be kept at the right temperature (UNICEF, 2012). Humanitarian supplies can be categorized to *urgent/immediate distribution, low priority distribution and non-priority items*. For each supply priority and each agency, corresponding response strategies is needed. These issues require humanitarian organizations to engage in preparatory activities such as inventory prepositioning in warehouses. Ukkusuri and Yushimito (2008) define prepositioning as: 'the storage of inventory at or near the disaster location for seamless delivery of critical goods'. Prepositioning will reduce the lead-times for reaching places that are affected by a disaster. Time is an important factor in the provision of relief ; this is especially critical in the first 72 hours (Nahleh et al., 2013). The survival rate in affected areas is enhanced by the quick availability of critical supplies such as blood and water as well as other resources. Critical supplies and relief personnel must therefore be transported quickly and efficiently to minimize the cost of the operations and maximize the survival rate of the affected people (Nahleh et al., 2013). All these aspects lead to supply chain challenges when disaster strikes.

Though helicopters are used for transporting a fraction of the daily requirements, the capacity of small aircrafts limits the throughput of this mode. Ground transportation modes are still playing a major role in the humanitarian logistics. Compared to traditional transportation problem, humanitarian response problem has its own features throughout the entire procedure. First, there is approximately no lead time in preparation stage. Second, the transportation on road is subject to high risk and low reliability due to sever climate or incomplete information of road condition. The impact of delivery is at high stakes, usually directly related to human lives and health. Selecting proper performance measures is another issue. As an example, when transporting medical supplies, the measures can be amount of delivery in a given time, reliability of the scheme, total cost of the transportation or the shortest time that the first batch is delivered. Selection of performance measures may depend on the applicable humanitarian principles and decision maker's preference.

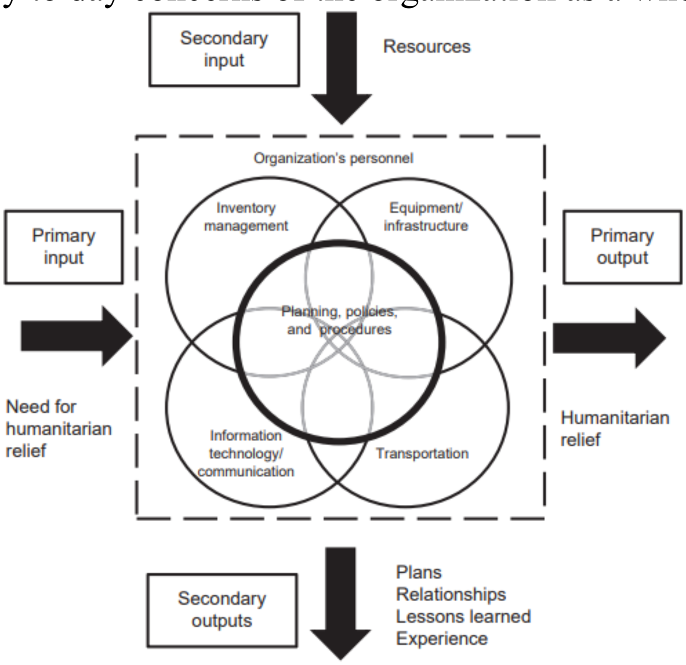
Transportation aid process flow

Transportation is the second largest overhead cost to humanitarian organizations after personnel. Academic knowledge about fleet management in humanitarian operations is scarce. Most information are available from widely known and largest International Humanitarian Organizations (IHO) such as: the International Committee of the Red Cross, the International Federation of Red Cross and Red Crescent Societies, the World Food Program and World Vision International. According to academic literature global operations, high uncertainty, urgency, lack of local infrastructure

(Tomasini and Van Wassenhove, 2009) and rigid funding structures (Edwards and Hulme, 1996) are some of the challenges faced by International Humanitarian Organizations (IHO) in charge of delivering relief to people in need of assistance. IHO relief (life saving) and development (improving quality of life) delivery is performed via in-country programs. Transportation is a key element of delivery and in many NGOs, UN agencies and other humanitarian organizations, vehicle fleets represent the second largest overhead cost after staff expenses (Disparte, 2007).

Most of the time IHO operate in not usual way. With the mission of responding to human suffering through relief and development programs, IHO do not follow to standard market rules that guide the activities of commercial firms. IHO are large, diversified multinational organizations (Prahalad and Doz, 1987). Typically, headquarters are located in developed countries while most of their operations are located in developing countries. This exposes IHO to unstable macroeconomic conditions, tumultuous political environments, distinctive socioeconomic conditions and cultural diversity (Austin, 1990). No perfect market exists in the humanitarian sector. In contrast to multinational commercial companies, at their core IHO are non-profit oriented, but they are held accountable to three distinct groups: donors who finance the operations, beneficiaries representing uncertain demand, and the international community through public reporting of their actions.

In-country operating conditions, particularly outside the urban centers, transportations are difficult in terms of infrastructure, facilities, local knowledge, and security. IHO also face the high rotation of expatriates, with high decision-making power, who frequently occupy the top management positions of national offices. Local staff usually has a lower rotation but little decision-making power creating high levels of organization specific uncertainty and market demand uncertainty (Beckman et al., 2004). As programs evolve from a context of relief to development, the objectives of the IHO also change (Jennings, 2002). IHO working in volatile and naturally unstable regions must constantly be prepared to respond to disasters, making contingency planning part of the day to day concerns of the organization as a whole.



Warehousing

To achieve efficient and effective humanitarian relief it is essential for humanitarian organizations to have their warehouses in appropriate locations. The locations of these warehouses have a direct influence on the response time of the humanitarian organizations (Balcik & Beamon, 2008). When a disaster strikes, basic items such as water and food need to be distributed as fast as possible to cover initial needs. In addition, hygiene kits and sanitary supplies as well as medication are important in the early response phase, because of the risk of the outbreak of various diseases (MSF, 2011). In order to fulfill these needs some humanitarian organizations locate their supplies in a place where they can serve a region, for example, per continent such as the IFRC [International Federation of Red Cross] (Gatignon, Van Wassenhove, & Charles, 2010). Another option is for humanitarian organizations to place their inventory in the country they want to assist (Richardson & Leeuw, 2012). Facility location models and the associated factors that are relevant in determining warehouse locations form a topic of frequent discussion in the commercial domain, see e.g. Farahani, Bajgan, Fahimnia, and Kaviani (2015), Melo, Nickel, and Saldanhada-Gama (2009) and MacCarthy and Atthirawong (2003). Many factors influence the selection of the location of a facility, though often the overriding concern is costs (MacCarthy and Atthirawong, 2003). The research carried out by MacCarthy and Atthirawong (2003) also showed that site selection factors are industry-specific because each industry has different characteristics and strategies. For example, in the case of humanitarian organizations, the delivery time can be expected to be important because people's lives are at stake. If the supplies are strategically placed, the delivery time of the goods to the affected area can be reduced (Duran, Guiterrez, & Keskinocak, 2007; Balcik & Beamon, 2008).

Facility location is a key problem that has a considerable effect on the success of relief operations (Nahleh et al., 2013). Facility location concerns the placement of facilities taking several characteristics into account such as demand size and location (Caunhye, Nie, & Pokharel, 2012). Simchi-Levi, Kaminsky, and Simchi-Levi (2008) state that business literature indicates that facility location decisions involve the number, location, size and capacity of each facility. These considerations also apply to the humanitarian sector (Richardson, Leeuw, & Vis, 2010). Facility location decisions have a direct impact on the operating cost and on the timeliness of response to the demand (Haghani, 1996). In order to respond quickly to the onset of a disaster, facility location and stock pre-positioning are therefore key decisions in humanitarian relief (Balcik & Beamon, 2008). Distributing relief supplies from strategically — located warehouses improves the efficiency of disaster relief in economic terms, but also in terms of transportation efficiency, speed and demand satisfaction (Döyen, Aras, & Barbarosoğlu, 2012). In humanitarian supply chains, this may translate into minimizing transportation cost (Drezner, 1995) and delivery time (Akkihal, 2006). In fact, within relief operations, a faster delivery time will often be chosen over lower costs (Akkihal, 2006). A popular modeling approach in facility location is the «covering problem». In covering problems, customers receive service by facilities depending on the distance between customers and facilities (Farahani, Asgari, Heidari, Hosseininia, & Goh, 2012). Customers receive service from a facility when the distance is equal to, or lower than, a predefined number — the so-called coverage distance or radius. In the case of disaster relief, it is difficult to set such a requirement. Disaster relief supply chains have to deal with high levels of demand uncertainty and large-scale demands at short notice, such as damaged roads, distraught victims, fragile communication lines, short lead times, and uncertainty about what relief supplies are actually needed (Nahleh et al., 2013). Balcik and Beamon (2008) indicate that the dominating characteristics that bring complexity into disaster relief chains are the unpredictability of the event (in terms of timing, location, type and size), the quantity of the needs arising and the short lead times required for many different supplies. Generally in these circumstances stakes are high, and there is a lack of appropriate resources (supply, people, technology, transportation capacity and money).

Factors influencing new warehouse locations MacCarthy & Atthirawong (2003) investigated relevant factors affecting location decisions. Although their research was mainly focused on manufacturing organizations, these factors can also be applied to humanitarian organizations (Richardson et al., 2016). MacCarthy & Atthirawong (2003) identified thirteen major factors. Each major factor also has specific sub-factors that include quantitative and qualitative aspects that are relevant to making location decisions. These include operational, strategic, economic, political, social and cultural dimensions. Richardson and Leeuw (2012) and Richardson et al. (2016) draw on the work of MacCarthy & Atthirawong (2003) to identify 10 main factors that have an influence on humanitarian inventory prepositioning locations. Their top five factors include: *the cost of operating a facility, the speed of humanitarian response, the availability and quality of labor, the availability and quality of business and support services (which consist of standard business services (e.g., warehousing and handling of goods) and specific business services (e.g., procurement), (cf. Richardson et al., 2016)) and the availability and quality of the infrastructure*. These factors fit in the framework of MacCarthy and Atthirawong (2003), though some factors are specific to humanitarian supply chains.

Recently, an increasing number of humanitarian relief organizations have begun to locate strategic pre-positioned warehouses around the world to save and assist disaster victims as soon as possible by delivering sufficient relief aid effectively within a short time. In the relief chain, decisions on facility location and stock pre-positioning are significant for a rapid disaster preparedness and response.

In order to understand more deeply the important weights of evaluation criteria of warehousing in humanitarian logistics it is more useful to apply Analytical Hierarchy Process. Since warehouse location is regarded as a Multi-Criteria Decision Making (MCDM) problem with uncertainty, individuality and ambiguity with a variety of criteria need to be considered.

From Wikipedia to establish a warehouse in humanitarian logistics is essential in disaster response planning. Warehouses should be constructed by taking into consideration for dangerous or waste of materials and organized in order to facilitate deliveries to the desired area at the desired time and quantities.

Humanitarian warehouses can be categorized into four main types, depending on their functions and locations.

• General Delivery Warehouses: where products are stored for a long time (e.g., months or quarters) or until they are sent to secondary warehouses or distributed in the field. General delivery warehouses are more common in the capital of beneficiary or donor countries or at strategic points of a given region (based on forecasts).

• Slow Rotation Warehouses: where non-urgent or reserve stockpiles are kept, including goods that are not in frequent demand such as spare parts, equipment, and tools.

• Quick Rotation Warehouses: where emergency supplies quickly move in and out, on a daily or at most weekly basis. Such warehouses are situated near the heart of affected zones and hold items that require prompt distribution among the affected population, including food, blankets, and hygiene items.

• Temporary Collection Sites: where incoming supplies are stored until a more appropriate space can be found. Temporary collection sites include yards, offices, meeting rooms, and garages of disaster relief organizations.

Depending on the magnitude of disasters and the urgency, a certain type of warehouses is needed. For example, for unexpected disasters, temporary warehouses are more common than others. In contrast, for planned disasters, general delivery warehouses are needed to store products in beneficiary countries.

When selecting an appropriate site to store goods, two considerations are important:

• Type of supplies: Pharmaceutical products and foods require a well-ventilated, cool, dry place. Some of these products may even need temperature control. Other items, such as clothing or equipment, have more flexible requirements.

• Size and access to warehouses: the size of the storage site is significantly important. One must take into account not just its current capacity but also the potential for expansion of the storage area. Accessibility is another key issue, particularly for large vehicles.

Containerized cargo

The advances in supply chain management have provided a new meaning to the concept of temporary storage in terminals. «Instead of using the stacking area as a facilitator for a smooth synchronization between transport modes, shippers and logistics service providers started to use terminals as places for the cheap storage of goods» (Notteboom and Rodrigue 2009). This change in the use of terminals has stimulated the idea of using containers as storage units to respond immediately to the victims of a disaster in a better way. Containers are utilized for mass fatality management (Morgan et al., 2006), as temporary housing (Peña and Schuzer 2012), and as medical units (Anonymous, 2014) in humanitarian logistics.

Most of the delivered items would originate from a known source (i.e., local government) and the prepositioned items (i.e., tents, blankets, beds, electric heaters, kitchen sets) would be requested in a post-earthquake environment. Thus, there would be minimal need for extra non-consumable supplies, decreasing the number of unsolicited items. The high-priority items would be dispatched immediately using already packed and loaded containers. If the type of relief items stored in container warehouses is publicized widely, only the type of relief items that are needed would be donated. For example, after the Van (Turkey) earthquake in 2011, national capacity was enough for the needs of search and rescue teams. The Turkish government appealed and accepted donations only for winter tents, prefabricated houses, and living containers (Özkapıcı et al., 2012).

Freight forwarder

A freight forwarder is a company that arranges commercial transportation for the cargo of other firms. The freight forwarder generally assumes responsibility for consignments until they reach their destinations, depending on the trade and transport terms agreed, such as the Incoterms from the International Chamber of Commerce. A very important role of a freight forwarder is to collect and consolidate consignments that are less than a truckload or a container load, and obtain common carrier transportation for the long-haul transport of the consolidation, thus making its transport more efficient and reducing transport costs. Freight forwarders often also act as custom broker and undertaken customs and other clearance formalities on behalf of the shipper.

Freight forwarding includes tasks such as:

- deciding on the best route and conditions for the physical transport,
- booking consignments with the carriers,
- handling the documentary requirements for goods in the various countries of the transport chain, and
- monitoring the movement of consignments, and obtaining and supplying tracing and tracking information for the client.

Main trade facilitation issues in shipping are:

- compliance with product-related regulations for the preparation of the consignment, its packaging and the transport equipment used,
- preparing proper documentation to accompany the goods or to pass to parties in the transport chain, such as waybills, certificates of country of origin, and certificates for agricultural goods,
- passing relevant detailed information about the consignment to the parties that organize and execute (part of) the transport so that they can comply with regulatory requirements and procedures,
- dealing with changes to the planned transport and hence changes in the required documents, for example when changing the mode of transport used,
- dealing with changes in ownership of and responsibilities for the goods and transport, and ensuring the security of the goods during transport.

Implementation solutions

Solutions to these trade facilitation issues are: implementing recommendations from International Transport Organizations; using harmonized and standardized documentary requirements; using the Incoterms from the International Chamber of Commerce; applying modern Information Technology through shipping portals; using modern information exchange throughout the transport chain; and using UNECE and UN/CEFACT Recommendations.

In international transport, separate freight forwarders are often used to organize the export of a consignment and to organize the import of the consignment in the country of destination. Freight forwarders often have arrangements between themselves to optimize the transport of several consignments through consolidation of consignments or by subcontracting the arrangements for a specific part of the transport leg. In freight forwarding, the international and national regulations on the goods, transport means and routes have to be taken into account. The required procedures and formalities for authorities have to be followed.

For a quick response the humanitarian organizations rely on the network of freight forwarders. The cooperation between the IFA member companies is a guarantee for a quick response for logistic services for the humanitarian organizations to the affected areas. The humanitarian logistics — not only a supply management, but also relationships between participants.

The humanitarian logistic is a mandatory part of the range of services of the European network for logistics services. Here the supply chain management once again is a guarantee for the timely delivery of humanitarian aid, but the importance of this management is critical for preventing massive crises and distress of the affected population. In this kind of logistic services the coordination and synchronization of the activities is in a very high level, not only between the member companies of the European Logistics Network, but also between them and the humanitarian organizations. In the participation of so many organizations in the collection and the delivery of the aids the integration and the relationships are coordinated continuously.

Freight consolidation

Minimum evacuation time

In disaster management cycle one of the main criteria in implementing any action regardless of which phase (mitigation, preparation, response, reconstruction) is a spent minimum time or in other words rapid response. According to academic literature (G. Kovács et al. (eds.) 2018) there is lack of general purpose decision support systems that can be used in practice. This has been recognized as a gap between academic work and practical requirements. The main reason behind this gap is the highly fragmented landscape of stakeholders and institutions that cope with disaster management in practice. G. Kovács et al. (eds.) has proposed a model that can be used in disaster management. Their approach is based on research projects that investigates the application of mathematical optimization methods to evacuation planning within an urban setting in Germany.

An urban evacuation scenario was defined as an organized relocation of humans, animals and material goods over a longer period — i.e. several days — from an endangered to a safe region. This includes the determination of respective regions, the notification of affected people as well as their transport, accommodation and lodging.

Organizational Structure

The political leader who is responsible for the affected region is entrusted with mandating an evacuation as a measure to fend of danger from people. In the case of a city, this is the mayor of this city; in case of several affected cities, it is the respective chief administrative officer of the federal state. The law equips this politician with the authority to delegate his power of decision to another person of his choice. Thus, the leaders of local authorities and organizations that are entrusted with security and emergency tasks are the end users of any decision support system in the field of urban evacuation logistics.

Official Guidelines for Evacuation Scenarios

Usually there are some official guidelines that should be followed in case of an urban evacuation. These guidelines have to provide a basic evacuation plan that has to be adapted by the individual communities by providing total numbers about their demography and task forces. The guidelines have to summarize empirical numbers and thoughts that have been gathered throughout exercises and real world scenarios that took place all over the country throughout the last decades. Since an evacuation is seen as a public duty, the responsible politicians have to prove their appropriate preparedness. Thus, the guidelines published by the state are widely adopted and followed by the responsible authorities.

Which Region Has to Be Evacuated?

First of all, in a simplest scenario a decision maker can be confronted with when he has to decide upon the region that has to be evacuated: An insecure explosive body in practice always leads to a radial region that is centred at the explosive body itself and whose radius is calculated by a simple rule of thumb that only considers the weight of the explosive body and neglects the details of the surrounding urban infrastructure.

There are other scenarios — as well as other models to determine the affected region in case of explosive bodies — that are more complex. An example is the spread of toxic gas which not only leads to regions that are hard to compute but also depend on and vary over time.

Therefore, the location of the inhabited buildings has to be included in the set of information that an evacuation process relies on. In a more complex scenario, one may also require information about the topography of the affected area.

Where to Establish Evacuation-Related Places?

Shelters. Those people who have no other place to go, must be provided with appropriate shelters by the public authorities. Thus, information about the demography of the affected region is crucial to retrieve any estimations on the required capacities of these shelters. Additionally, the set of possible shelters as well as information about their maximum capacities, preparation and maintenance costs have to be managed.

Gathering Points. People are meant to gather at the so-called gathering points to get picked up in groups. To keep both the evacuation plan itself as well as its communication simple, those places should be popular places like bus stops, pharmacies, popular buildings, big street crossings, etc. Thus, the set of such places needs to be available when coordinating an evacuation.

Force Accumulation Places. Large-scale evacuations sometimes require the operation controllers to mobilize external task forces. Those are usually gathered first at the so-called force accumulation places and from there on deployed in groups, instead of letting them reach the danger zone individually. Since a large gathering of emergency forces impose special demands on the technical infrastructure as well as on the traffic connections of the respective place, appropriate spots are usually chosen and listed upfront as possible force accumulation places by the persons in charge.

Sources of Support. Since the evacuation of people also includes their accommodation and lodging, those people who gather at the established shelters have to be served with food, information and basic health care. All the possible sources of support like canteens, drugstores or supermarkets have to be known to the decision-makers.

Which Routes Should Be Used by the Public Transportation?

When selecting the routes that should be used to transport the people from the gathering points to the shelters, the decision-makers not only have to know about the static structure of the street network but they also need to know about its behaviour under load. Thus, information about both the network and empirically gathered numbers concerning the traffic have to be accessible when planning an evacuation. Models that deliver estimations on traffic as it would result from the majority of people leaving the affected region by car additionally require demographic information about this region.

Which Forces have to be Mobilized?

To decide on which forces to mobilize, the operation controllers first of all have to know about the available forces and about the time it would take to mobilize them respectively. Which and how many task forces actually are required to allow the evacuation to happen as planned, depend on both the demographic characteristics of the affected region as well as on previously made decisions like which gathering points, shelters and other places have to be established and maintained or which routes to prepare for transportation.

Thus, not only information about the available task forces has to be managed but also do the information about gathering points, shelters, routes and the like has to be combined with information about the expected resulting personnel costs.

How to Inform the Affected People?

Since in emergency situations means of mass communication are severely damaged and not available at all or at best operating partly, to inform people is usually used every means possible. Most of the time the best approach is simply to drive by car through the streets and shout out the warning texts to the people. The main problem here is the determination of the vehicle routes as well as the scheduling of the single shouts. The target is to minimize the amount of time it takes to reach all the people, and to avoid a single household to be shouted at by two different speakers at the same time.

The Current «State of the Art»

The current decision-making process not only relies heavily on non-technical tools like paper maps and rulers but also lacks a unified protocol considering the access to the information that the operation managers depend on to find the right decisions in the course of an evacuation. This information is stored — if at all — in different formats and is communicated via network attached storage, email services and in some cases even via sheets of paper that are exchanged between the different actors using fax or the (non-electronic) mail service. This leads to severe delays of several hours or even days. Therefore, the overall evacuation process can already be considerably improved by gathering all the required information in a single place and providing the decision makers with appropriate technical tools to access it fast and in a unified way. Furthermore, practitioners often base their decisions solely on experiences derived from previous evacuation scenarios or exercises. Usually, they do not have any scientific models at hand that provide them with forecasts based on the current scenario, or allow them to adapt their experiences gathered so far to the current scenario in a rational — or even automated — way.

Retrieving Information About the Affected Population

The user should be provided with aggregated numbers of habitants that are affected by the current evacuation scenario. Besides categorizing people according to their medical requirements during the transportation, the HO usually distinguishes between children, teenagers, adults and seniors because those groups result in different numbers of required task forces to support them during the transportation and the number of seats and standings in busses. Therefore, any additional information about the population regarding their medical condition and their distribution over the aforementioned classes would be of great value.

Points of Interest Warnings

The user should be provided with a list of special places that lie within the region that has to be evacuated. A place is meant to be special, if it belongs to at least one of the following types:

- School
- Kindergarten
- Senior Residence
- Hospital
- Others (explicitly marked by the governmental organization)

If possible, the system should provide additional information like the number of pupils of a specific school or the capacity of a hospital. All of those features are acknowledged as necessary by different organizations that take part in emergency response.

Facility location optimization model for emergency humanitarian logistics.

Regardless of the moment of action, humanitarian logistics problems focus essentially on the response time and user accessibility under chaotic situations. As facility location problems look to improve timeliness of demand response and functional cost in the best way possible, they present themselves to be one of the most important and efficient areas of study in order achieve an adequate emergency plan, especially with the usage of optimization models.

Temporary Facility Location

Temporary facilities are located closer to affected areas to assist in the distribution of goods and the provision of shelter and medical attention for affectees. Ruan et al. (2014) discovered that greater numbers of temporary facilities often increase the efficiency and utility of medical supplies due to decreased distance between affected areas and temporary facilities. They also discovered that more vehicles are required to serve the increased number of temporary facilities.

One way of locating temporary facilities is seabasing. It originates from the military where a container ship forms a floating warehouse to deliver supplies where required. The application of seabasing provides flexibility in facility location to enable better response time. The floating warehouse can be anchored at a single point or move to other locations as required. Seabasing expands the horizon of multimodal logistics from transportation multimodality toward multimodality of warehouse facilities.Ozkapici et al. (2016) applied the seabasing concept for intermodal transportation in a disaster response scenario.

The already valuable work, optimization models could also be used for dynamic or robust emergency humanitarian logistics' facility location models, which would allow for the incorporation of uncertain time periods, uncertain environments, facility location risks, the possibility of facility locations, uncertain demand, disruption events, different fluctuation patterns, and facility expansion.

Disasters can be divided into the pre-disaster (mitigation and preparation) and post-disaster (response and recovery) stages. In the mitigation stage, future research could seek to treat hazards by relocating inhabitants farther from the risk area. As safety area planning is a long-term plan, dynamic and robust models could be adapted into mathematical models. In the preparation stage, research could investigate optimum planning and preparation for facility locations such as warehouses, shelters, permanent distribution centers, and permanent medical centers so as to increase the chances of survival and minimize financial and other losses.

Stochastic, dynamic, and robust facility planning models can be used to respond to real situations. For example, as distribution warehouses should be located near disaster sites but still place in safety area because they are the reception points for commodities and donations(domestic and international), suppliers, and NGOs, research could focus on when to transfer goods.

For the response stage, emergency decision makers will have to play a major role in this stage in managing the available resources while the disaster is still in progress. This phase is referred to as the «Disaster in progress» phase. At this time, emergency decision makers are involved but they merely make emergency decisions for unexpected events or for when emergency cases occur. In this stage, the most important considerations are shelters and medical centers that can respond to demand and ensure the wounded are transferred to medical centers. When permanent medical centers are located in the risk areas, the medical center needs to be able to evacuate patients to shelters as quickly as possible. Therefore, permanent medical centers should be located in safe areas, so further research could examine where to locate or relocate permanent medical centres. Immediately following the disaster, temporary shelters need to be rapidly identified, so emergency decision makers need to be able toidentify suitable evacuation shelters as quickly as possible. Finally, in the recovery stage, research could investigate optimum locations for temporary distribution centres (sub-distribution centres) to ensure efficient commodity distribution, and also to determine the optimum placement of temporary medical centers to ensure that the wounded are treated rapidly. Dynamic temporary distribution center and medical center selection methods have been proposed, but none have included robust models. In addition, obnoxious facility location problems have not been widely employed in DM research, so while optimum facility locations as close as possible to the disaster areas have been investigated, considerations regarding facilities far from potential epidemic zones, such as centers for disease control and prevention (an epidemic may occur following a disaster) and garbage dumps for debris removal have not been fully studied (arc (4)). The relationships in this stage need to be further investigated as warehouses send commodities (food, medicine, clothes, etc.) to shelters and medical centers (medicines, medical equipment). Likewise, when an epidemic breaks out, both permanent and temporary medical centers send patients with illnesses or infections to centers for disease control and prevention.

Facility location problems can be supported or developed to combine aspects such as routing problems, evacuation problems, relief distribution problems, casualty transportation problems, inventory problems, resource allocation problems, traffic control problems, debris management problems, and community flow. In some situations, two disasters may occur, such as an earthquake followed by a tsunami.

Research is needed that considers multi-disaster scenarios. Moreover, integrated disaster stage management is also important in the decision making process in emergency humanitarian logistics' facility location problems. Normally, researchers have always focused on each stage and a few research studies have concentrated on integration disaster stage management. Consequently, integrated disaster stage management is recognized as a major gap that should be considered going forward.

The objective function model could also be designed differently to create a single-objective or multi-objective model that could be single level or bilevel. Most objectives have focused on minimum time, minimum cost, minimum distance, minimum number of located facilities, and coverage by a maximum number of demand points. New objective functions could be developed by integrating the facility location problem with the other above-mentioned problems. Further, new objectives focused on environmental effect, reliability, risk, and ease of access could be developed. Constraints could also be added, such as an assessment of evacuee behavior (demand) and age of population (old age and childhood). For a more realistic approach, researchers should determine what the uncertain factors are such as demand, supply and time. Moreover, quantitative and qualitative measurements could be added to the parameters so as to include quality measurements in considering facility location problems such as availability, accessibility, functional ability and risk. According to the informed judgement of experts, this represents one element that we should emphasize and bring forward to be applied in the mathematical model. However, the key question is not only «How can we optimize the facility location in emergency humanitarian logistic problems» but also «How can we seek a suitable facility location in the emergency humanitarian logistic problems that we can commandeer and use» as well.

Current emergency humanitarian logistics' optimization models have some limitations due to the large-scale data, so it can be complex to calculate and finding the optimum can take an excessive amount of time and computing power. Therefore, the development of advanced algorithms that can be applied to emergency humanitarian logistics is necessary to add to the present stable of genetic algorithms, tabu searches, locate-allocate heuristics, Lagrangian relaxation heuristics, particle swarm optimization, ant colony optimization, biogeography based optimization, artificial immune systems, and hybrid algorithms.

Conclusions

This paper reviewed optimization models for emergency humanitarian logistics' facility location problems based on data modeling types and problem types and to examine the pre- and post-disaster situations with respect to facility location. Four main models were investigated: deterministic, stochastic, dynamic, and robust. The deterministic facility location problem addressed facility location problems for minimum problems, covering problems, minimax problems, and obnoxious problems. This review attempted to survey the objectives, conditions, case studies, applications, disaster types, facility location types, solution methods, and emergency humanitarian logistics' facility location problem categories. The literature's main objective was found to be focused on responsiveness, risk, and cost-efficiency. In emergency logistics problems, responsiveness and risk are the major criteria, with most models aiming to minimize response time, evacuation time and/or distance, transportation costs (distance and time), the number of open facilities, facility fixed costs or operating costs, uncovered demand, unsatisfied demand, and risk, along with maximizing the demand points covered. Depending on the problem type, the literature showed that the problem types could be merged with other problems and that the facility location problem could be applied along with other techniques such as decision theory, queuing theory, and fuzzy methods. Owing to the prevalence of earthquakes, hurricanes, floods, and epidemics in the world, these were the main focus of emergency humanitarian logistics research. An exact solution was found to be one efficiency technique, but advanced algorithms were found to be most effective for large-scale problems. Finally, research gaps and future research were identified as assisting in developing future disaster operations. This review has highlighted the extensive range of emergency humanitarian logistics' facility location optimization models that have been developed since the 1950s.

Humanitarian operations are uniquely challenged to serve uncertain yet urgent demand in highly dynamic environments, where success relies on coordination within supply chains otherwise heavily influenced by circumstance.

When a region is hit by a severe disaster, humanitarian supplies must be provided to victims/evacuees efficiently throughout the entire disaster and post-disaster periods. The emergency packages include but not limited to food, water, sanitation supplies, medicine, medical equipment, etc. Delivery of the humanitarian aids from suppliers to shelters must be done within certain time limits. Though helicopters are used for transporting a fraction of the daily requirements, the capacity of small aircrafts limits the throughput of this mode. Ground transportation modes are still playing a major role in the humanitarian logistics. Because of the severe weather during and after disaster, e.g. storm after hurricane or after-shock after an earthquake, it is common to have failures on the road and infrastructure, such as flooding, surface cave-in and sedimentation, which may delay the traffic or even make part of the network unusable. The expected reliability of a route is one of the main variables when planning a trip. The route choice coheres with the choice of the departure time to reach a destination in time with an acceptable probability. To increase the possibility of providing supply to evacuees under uncertainty without disruptions is a challenging problem. An efficient and reliable routing and scheduling model needs to be developed for both disaster and post disaster conditions.

In the wake of devastating events such as Hurricane Katrina in the United States (2005), Earthquake in Haiti (2010), earthquake and tsunami in Indian Ocean (2004) and Japan (2011), planning for humanitarian supplies and response operations have largely been the concern of emergency management agencies. Under these severe disaster situations, deficiency in the flow of supplies may have direct consequences. Humanitarian response is the procedure in which the relief aids is delivered by agencies according to preset humanitarian principles. These agencies include government agencies as well as local and international nongovernment organizations. Humanitarian supplies can be categorized to urgent/immediate distribution, low priority distribution and non-priority items. For each supply priority and each agency, corresponding response strategies have needed.

References:

1. RAIRO — Operations Research — Recherche Opérationnelle, Tome 10 (1976) no. V1, pp. 55-70.

2. The Asian Journal of Shipping and Logistics «Volume 29 Number 1 April 2013 pp. 103-120 • Warehouse Location Decision Factors in Humanitarian Relief Logistics Sae-yeonROH, Hyun-miJANG, Chul-hwanHAN.

3. Leeuw, S., Mok, W. Y.: An Empirical Analysis of Humanitarian Warehouse Locations 56 ISSN: 1984-3046 • Journal of Operations and Supply Chain Management Volume 9 Number 1 p. 55–76.

4. Transportation Logistics: modern problems and ways of development. V.N. Filina. (Транспортная Логистика: Современные Проблемы и Направления Развития. В.Н. Филина.)

5. Chuck Dipietro, director of procurement & planning, bema incorporated

6. A.J. Pedraza Martinez et al. / Journal of Operations Management 29 (2011) 404–421.

7. Wikipedia, the free encyclopedia.

8. Trade facilitation implementation guide. https://tfig.unece.org

9. International forwarding association. https://ifa-forwarding.net

10. G. Kovács et al. (eds.) 2018, The Palgrave Handbook of Humanitarian Logistics and Supply Chain Management, https://doi.org/10.1057/978-1-137-59099-2_1

11. Diogo Rafael dos Santos Forte; Location Models in Humanitarian Logistics.

CHAPTER 6
NEW CHALLENGES FOR RISK AND CRISIS MANAGEMENT OF TRANSPORT SYSTEMS

Yevhen DEMCHENKO
Andrii DOROSH

Starting from 2020 to the present, transport sector is adapting to the updated operating conditions and gradual resumption from the crisis associated with the global COVID-19 pandemic. However, there are still a number of risks and new challenges for the global transport system. The growing number of cases from the Delta strain of COVID-19 in some regions of the world, the partial resumption of previously lifted restrictions and other factors create further uncertainty about global transport and logistics systems. At the same time, uncertainty concerns not only the timing of the return to pre-crisis indicators, but also the future image of the transport sector in the post coronavirus world as a whole.

One should also mention that Ever Given container ship ran aground in the Suez Canal, which led to the blocking of the movement of almost 450 vessels in both directions on the Asia-Europe route in the spring of 2021. The consequence of this event for World Trade became a significant increase in transport costs and cargo delivery times, a potential shortage of raw materials in production, a rapid increase in freight rates for sea vessels, etc.

Thus, the presence of random factors and unpredictable risks, both natural and human, does not allow us to fully predict the functioning of transport systems. Therefore, ensuring sustainable functioning of the global supply chain requires the development of new procedures and improvement of existing ones for risk and crisis management of transport systems, taking into account modern conditions and challenges.

6.1. Modern challenges in ensuring sustainable functioning of railway transport in Ukraine

Railway transport is one of the main modes of transport, providing about 80% of freight and almost 50% of passenger traffic in the domestic traffic of Ukraine. At present, there is a great importance of improving the safety of railway transportation in the context of the military conflict in the eastern regions of Ukraine, which has led to an increase in the number of cases of unauthorized interference in the operation of railway infrastructure facilities. Solving this problem requires implementation of modern technical and organizational solutions that should take into account the world experience of managing risks and crises on railways.

Ukraine’s National Security Strategy [39] defines the main threats to the security of the functioning of transport infrastructure facilities as: critical depletion of fixed assets and insufficient level of their physical protection; insufficient level of infrastructure protection from terrorist acts and sabotage; inefficient security management. Indeed, the functioning of railway transport is provided by a significant number of critically worn-out technical means of various levels of complexity, which are located on an extensive railway network and, as a rule, do not have a high-quality protection system against unauthorized interference in their operation. At the same time, any unauthorized interference in the operation of railway transport infrastructure facilities can be classified as a socio-political emergency, the consequences of which can lead to man-made accidents or catastrophes. In this regard, the issue of identifying and analyzing threats to the normal operation of railway transport, forming a system for countering these threats and minimizing their consequences, as well as bringing Ukraine's transport security in line with the EU requirements and international standards is relevant.

6.1.1. Critical infrastructure protection (CIP)

It is known that the functioning of the state, the safety and quality of life of its population significantly depend on the continuous and coordinated operation of a complex of enterprises and structures, which, because of their importance, are usually introducing the term of critical infrastructure (CI) [13, 14]. Governments in developed countries have given considerable attention to developing preventive measures to reduce the risk of CI interruption as a result of wars, natural disasters, worker strikes, vandalism and terrorist acts.

In order to address this issue, the EU Council adopted directive 2008/114/EC [3], on the basis of which the European Programme for Critical Infrastructure Protection was developed. Within the framework of this program, a four-stage methodology for identifying critical infrastructure objects is proposed, while identification is performed according to a number of industry-specific and cross-cutting criteria [2]. At the same time, it should be emphasized that no risk assessment work is carried out when defining these criteria.

The CIP program in the United States is implemented in accordance with Homeland Security Presidential Directive (HSPD-7) [7]. This directive defines 17 sectors, for each of which a specialized agency — Sector-Specific Agency (SSA) has been created and an industry plan for the National Infrastructure Protection Program (NIPP) has been developed [11]. Thus, the American approach is industry-specific and similar to the approach implemented in EPCIP. However, the American CIP program tends to pay more attention to sustainability issues. In addition, as noted in [5], unlike EPCIP, NIPP does not have a formalized procedure for identifying critical infrastructures.

CIP activities in Canada are carried out in accordance with the National Strategy [12], which defines key areas for ensuring the sustainability of CI, and the action plan [10], which contains procedures in the field of partnership, risk management and information exchange in the implementation of CIP. The division of responsibilities adopted in Canada between CIP entities is of considerable interest: the task of the infrastructure operator is to manage and reduce risks, and the government is to ensure the sustainability of CI. It is clear that ensuring sustainability cannot be solved at the operator level, as it requires the cooperation of different actors, and in many cases — also attracting entities from different sectors.

The concept which defines the main directions, mechanisms and terms of comprehensive legal regulation of the protection of critical infrastructure and the creation of a public administration system in the field of its protection has been approved in Ukraine [33]. This document introduces a general categorization of objects into critical, vital, important and necessary objects; at the same time, one of the priority steps in implementing this concept is to develop a methodology for identifying infrastructure objects and procedures for interaction between CIP subjects. In addition, one should note that this concept assigns financial and resource support for the protection of critical infrastructure facilities to their owners.

6.1.2. Railway transport as an object of critical infrastructure

One of the key objects of the country's critical infrastructure is the railway, a leading enterprise in the transport communications system, which, along with meeting the needs of the economy and the population for transportation, plays an important role in the state's defense activities.

Railway transport of Ukraine is a developed technological complex, the infrastructure of which includes: 19790 km of main tracks, 1447 stations and 105 railway stations, 4198 railway crossings, rolling stock of 1936 diesel locomotives, 1628 electric locomotives, 65000 freight and 3100 passenger cars, artificial structures and devices of power supply, communication, signaling, centralization, blocking, information complexes and traffic control systems [36].

As you can see, the railway is an extensive network with a large number of elements that are characterized by multi-level interactions and complex relationships within the railway and with objects of related industries. Obviously, even with the existing staff of 2.7 million employees [36], it is physically impossible to ensure full protection of the entire railway network. To protect such network structures by the author [9] it is proposed to use the Pareto Principle (80/20) and implement priority measures at the main nodes of the system. On the railway, these nodes may include stations, train stations, depots, traction substations, freight terminals, large artificial structures (bridges, viaducts, overpasses), remote switches on the main tracks, rolling stock, etc.

6.1.3. Global practices for the protection of railway infrastructure

In the period from 2011 to 2013, the METRIP project was implemented in the EU within the framework of the EPCIP program [13], which aims to develop methodological tools aimed at improving the protection of railway infrastructure Security (Ris), with a particular focus on passenger rail transport. This methodology is based on the decision-making process, which includes:

data collection and analysis of the safety status of railway infrastructure;

analysis and modeling of the functioning of railway infrastructure to quantify its vulnerability in order to identify the most critical elements of the railway that need priority protection;

classification of threats and scenarios of unauthorized interference in the operation of railway transport;

time-space assessment of the system's behavior in possible scenarios of destabilization of its functioning and development of cross-tables for system elements and attack scenarios;

development of a system for identifying critical elements of the system and selecting effective ways to protect them.

At the international level, cooperation in the field of security is carried out by a number of organizations, among which the largest are COLPOFER and the UIC security platform [13]. Thus, in 1980, the main Western European railway companies founded the COLPOFER Association (Collaboration des Services de Polica Ferroviaire et de Sécurité), which currently unites the heads of security of railway companies, representatives of the authorities and police of 24 countries. The association has developed a common approach to solving security issues: anti-social behavior and crime in passenger transportation; stowaway travel and forgery of travel documents; cargo theft; vandalism and graffiti, cyber crime and terrorism.

Another international body is the UIC security platform, which operates within the Department of fundamental values of this organization. The platform's working groups work in three areas of UIC security policy: human factor, technology, strategy, and rules. At the same time, the emphasis is placed on the fact that an effective security policy begins with providing operational personnel (human factor) with the necessary information and decision support (technology) within the regulatory framework in partnership with the public and authorities (strategy and rules). In addition, the platform hosts the annual World Safety Congress, the last one was held in October 2018 and was dedicated to the topic of crisis management and ensuring the sustainability of railway systems.

In addition to international organizations, there are national transport safety authorities in the countries. Thus, France's railways (SNCF) are divided into 11 safety zones, which are monitored by a special SUGE service and security specialists working in the regional directorates and operational institutions of the SNCF. The SUGE service is a militarized force of authorized railway security services with 2800 agents with police powers in the field of crime prevention, ensuring the safety of railway personnel, customers and property; agents can make arrests in the event of a crime committed on the railway.

On the Railways of Spain, safety control is entrusted to the special service RENFE. The RENFE Security Department coordinates and organizes security activities. The Protection Department of this service deals with natural (snowstorms, floods), social (terrorism, strikes) and environmental risks (transportation of dangerous cargo).

In Switzerland, under the leadership of the Federal Department of transport, the Swiss railway company SBB CFF FFS operates a security service and Transport Police, which are granted the right to remove persons from transport facilities, and if necessary, to carry out arrest.

In Italy, there is a railway police that prevents and stops crimes, protects public order and ensures the safety of citizens at railway facilities and on trains.

In Ukraine, control over public order at railway transport facilities is entrusted to the structural bodies of the Ministry of internal affairs — linear police departments.

Important infrastructure facilities (railway bridges, tunnels) are protected by the Armed Forces and the National Guard.

6.1.4. Legal and regulatory framework in the field of countering interference in operation of transport in Ukraine

Activities in the field of preventing illegal interference in the operation of transport are regulated by a number of international and national regulatory legal acts. So, the concept [22] classifies an act of illegal interference of a terrorist nature in the operation of railways as an action (inaction) that threatens the safe functioning of railway complex and entails or creates a threat of causing harm to the life and health of people and causing material damage.

National legislation [21, 23] liability is provided for a number of illegal actions on transport that have signs of unauthorized interference in its operation, namely:

theft or seizure of railway rolling stock;

blocking of transport communications, as well as the seizure of a transport enterprise;

unauthorized unnecessary stopping of the train;

damage to railway tracks and other track objects, structures and alarm and communication devices;

placing objects on railway tracks that may cause train traffic disruption;

damage to the internal equipment of passenger cars.

At the same time, according to analysis [16], there are no regulatory documents regulating the procedure for conducting a survey of railway transport infrastructure facilities for protection from terrorist acts in Ukraine indicated. So, in [26, 38] criteria for analyzing terrorist activity as a whole as a social phenomenon, and at railway transport infrastructure facilities and rolling stock as a component of it are not defined. These documents are primarily aimed at preventing terrorist manifestations in transport, but do not disclose the methodology of these preventive activities.

6.1.5. Analysis of the main threats to the operation of railways

Authors [13] have identified the following main threats to the normal operation of railway transport:

disruption of train schedules, employee strikes;

robbery of passengers, stowaway travel and forgery of travel documents;

driving on unset or improperly set routes, collisions of rolling stock and derailment;

collisions with motor vehicles at railway crossings;

livestock accident with cattle or wild animals;

force majeure, emergencies, fires;

dangerous cargo accidents;

theft of railway property, cargo;

damage to railway infrastructure and rolling stock, vandalism in transport;

putting foreign objects on the rails, illegal stopping of trains;

unauthorized interference operation of railway equipment;

extremism and terrorism;

attacks on passengers and railway workers, seizure of transport facilities.

Most of these events can be classified according to their signs and consequences of occurrence (death or injury of people; damage to rolling stock of railway transport, technical means; violation of the train schedule; damage to the environment). [30] as transport events that threaten the sustainable and safe operation of the railway.

As research shows [4, 15], due to the large number of passengers in railway stations, stations and trains, the railway has recently become one of the main targets for committing acts of terrorism with a large number of victims and significant material damage. Since the beginning of the military conflict in the Donetsk and Luhansk regions of Ukraine, domestic railways have also been subjected to massive terrorist attacks. So, according to the resource data [6] between 2014 and 2016, there were 38 events on railway transport classified as terrorist acts (see table. 6.1).

Table 6.1. Cases of terrorist attacks and accidents on railway transport in Ukraine

№ s/n	Region	Date	Object					Nature of the event
			track	artificial structures	rolling stock	sta-tion	de-pot	
1	2	3	4	5	6	7	8	9
1	Donetsk region	22.06.14	X		X			explosion
2	Donetsk region	22.06.14	X					explosion
3	Donetsk region	24.06.14	X					explosion
4	Donetsk region	24.06.14	X					explosion
5	Donetsk region	07.07.14		X				explosion
6	Donetsk region	07.07.14	X					explosion
7	Kharkiv region	07.07.14			X			grenade explosion
8	Donetsk region	21.07.14					X	shelling
9	Luhansk region	22.07.14		X				explosion
10	Donetsk region	28.07.14	X					explosion
11	Kharkiv region	23.08.14	X					explosion
12	Luhansk region	10.08.14	X					explosion
13	Donetsk region	10.08.14				X		explosion
14	Donetsk region	27.10.14		X				shelling
15	Kharkiv region	11.09.14			X			explosion
16	Donetsk region	23.12.14		X				explosion
17	Odesa region	24.12.14			X			explosion
18	Zaporizhzhia region	20.01.15			X			explosion
19	Odesa region	02.06.15		X				explosion attempt
20	Luhansk region	12.02.15		X				explosion
21	Luhansk region	09.03.15	X					explosion
22	Luhansk region	17.03.15		X				explosion
23	Luhansk region	19.03.15		X				explosion
24	Kharkiv region	30.03.15			X			explosion
25	Kharkiv region	31.03.15			X			explosion
26	Dnipropetrovsk region	31.03.15	X					explosion attempt
27	Kharkiv region	04.07.15			X			explosion
28	Donetsk region	10.04.15	X					explosion
29	Donetsk region	23.04.15			X			explosion

1	2	3	4	5	6	7	8	9
30	Odesa region	28.04.15	X					explosion
31	Donetsk region	29.04.15	X					explosion
32	Odesa region	13.05.15	X					explosion
33	Odesa region	06.04.15			X			explosion
34	Kharkiv region	15.07.15				X		explosion attempt
35	Kharkiv region	08.12.15				X		explosion attempt
36	Donetsk region	16.02.16			X			explosion
37	Kharkiv region	25.02.16		X				explosion attempt
38	Luhansk region	26.08.16	X					explosion attempt

Author's development based on data [6]

As can be seen from the table and analysis [1], the most common method of committing a terrorist act on transport is an explosion; at the same time, as studies have shown [19], in the world, terrorists mainly use 2 schemes:

a car bomb explosion near crowded places of passengers or railway infrastructure;

placing an explosive device inside buildings or transport rolling stock.

At the same time, the analysis of terrorist acts on the Railways of Ukraine shows that in most cases the explosive device was placed directly on the railway tracks; in that connection, in 35% of cases, the explosion occurred during the passage of rolling stock. According to the data [6, 1] the authors analyzed the distribution of terrorist acts at the place of their committing on the Railways of the EU and Ukraine (fig. 6.1).

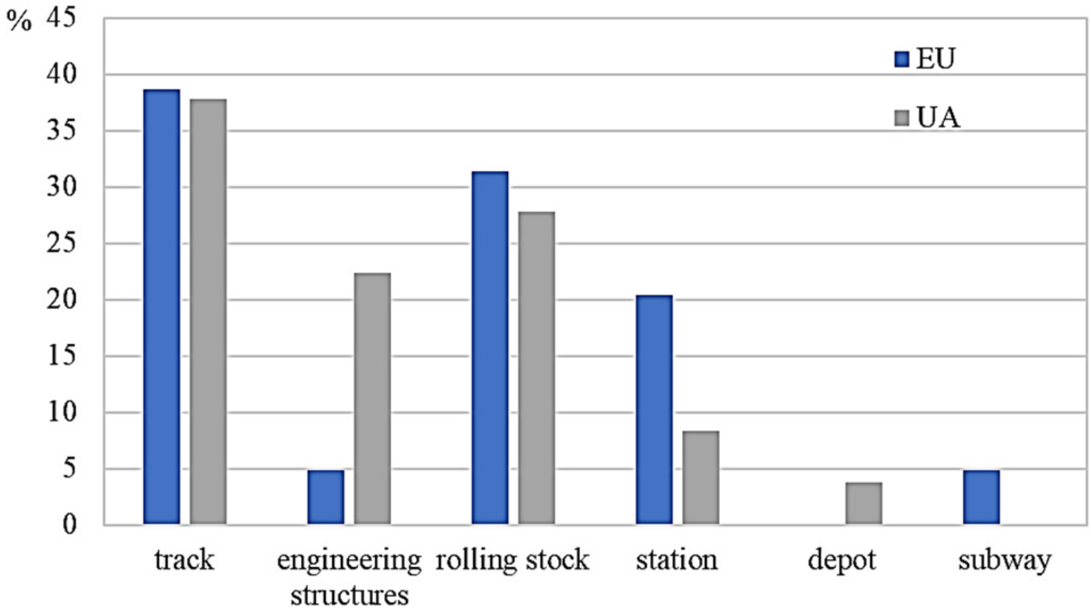


Figure 6.1. A percentage of distribution of the number of terrorist acts on the railway by place of their committing

Author's development based on data [1, 6]

As can be seen from fig. 6.1, the largest number of incidents occurred on railway tracks and in rolling stock. Separately, one should note that terrorist acts in the EU were mainly directed against civilians and passengers, as evidenced by a significant proportion of incidents at passenger stations and in the Metro. At the same time, according to statistics, a large number of attacks on Ukrainian Railways were directed at artificial structures (bridges, overpasses). Obviously, these attacks were aimed at stopping railway communication and logistics support of the Armed Forces of Ukraine in the zone of military conflict in the eastern regions of the country. Such specifics of attacks should be taken into account by risk management, in particular the risks of unauthorized interference in the operation of railway transport.

6.1.6. Railway risk management

Risk is an integral part of the production process, in particular the process of transporting passengers and goods by rail, and is a combination of the probability of damage and its severity. A set of measures aimed at minimizing possible losses that an enterprise may incur in connection with the occurrence of negative events is usually called risk management [8].

There are a significant number of risk assessment methodologies for critical infrastructures. The most common approach is linear approach [9], consisting of some basic elements: threat identification and classification, vulnerability detection, and impact assessment. In accordance with this scheme, we may formulate a general approach to risk management on the railway.

The first stage of risk management consists in identifying risks by determining the external (socio-cultural environment, political situation) and internal (organizational structure, available resources) contexts of the system's functioning. At this stage, it is determined which elements of the transportation process require risk analysis, which types of risks should be considered and risk management performers.

At the next stage, the risk value is assessed by determining the probability of occurrence of security breach incidents and the severity of their consequences. This assessment is the basis for prioritizing risk management measures.

Next, we develop risk management measures based on the following strategies [8]:

risk exclusion — completely eliminates the occurrence of risk. For example, the ban on passenger traffic on railway sections in the zone of military conflict completely eliminates the risk of injury and death of passengers from military operations.;

risk transfer — the risk is transferred to another party on the basis of an insurance contract. For example, mandatory passenger life insurance against accidents;

minimizing consequences — is aimed at reducing the damage caused by an incident, but does not reduce the possibility of this event. For example, restricting the transportation of certain types of cargo by railway sections in a military conflict zone reduces the consequences in cases of accidents on freight trains;

reducing the possibility of an incident occurring; in that connection the consequences are not minimized. For example, the organization of transportation of certain types of cargo by safer sections of Railways in the zone of military conflict reduces the possibility of accidents with them.

After developing management measures, it is necessary to determine their effectiveness by comparing the values of inherent (before management) and residual (after management) risks. As a general indicator of infrastructure protection from attacks, there is a probability of preventing a terrorist attack, which can be defined as [27]:

$$P = \frac{\sum P_1 P_2}{n}, \qquad (6.1)$$

where P_1 — probability of timely detection of danger;

P_2 — probability of successful prevention of danger;

n — number of hazards.

To determine probabilities P_1 and P_2 it is necessary to determine the most likely location and method of conducting a terrorist attack and the parameters of the attacker (number, armament, level of training). To solve this problem one can use the pairwise comparison method [27].

At the last stage, a risk management plan is developed, including monitoring mechanisms, distribution of responsibility for implementing measures and evaluating their effectiveness.

This approach to risk management, unlike in Ukraine, is used on most railways in the EU, the USA, Canada, and in recent years has been introduced on the railway transport of the Russian Federation [24].

Thus, the railway transport of Ukraine is an object of critical infrastructure that performs not only passenger and cargo transportation, but also plays a significant role in ensuring the country's defense capability. In that connection, a railway is a complex technological set with a network structure that is poorly protected from unauthorized interference in its operation.

As the analysis showed, with the beginning of military aggression in the eastern regions of the country, Ukrainian Railways were subjected to mass terrorist attacks, the purpose of which was to stop railway communication and logistics support of the Armed Forces of Ukraine in the zone of military conflict. In addition, in order to destabilize the socio-political situation, terrorist acts on the railway occurred in other regions of the country (Kharkiv, Odessa, Dnipropetrovsk regions). At the same time, the most common way to commit a terrorist attack was to blow up tracks or artificial structures.

As world experience proves, an effective means of improving the safety of railway transport functioning in these conditions is the introduction of risk management methodologies and means of countering unauthorized interference in the work of its management system.

6.2. Modern challenges in the organization of international cargo transportation by road

Efficient operation of the transport industry is one of the main prerequisites for sustainable economic development of Ukraine. Domestic transport companies and logistics providers have become an integral part not only of domestic communication, but are increasingly involved in ensuring foreign trade.

Currently, the European Union is the main foreign economic partner of Ukraine. Therefore, according to the data [20] more than 42% of Ukraine's exports and 37% of imports come from trade with EU countries. In that connection, about 10% of goods by volume and 38% by cost are transported in the specified international traffic by road. As the analysis showed, there is a steady trend towards an increase in the number of truck crossings of the western part of the state border of Ukraine, especially the section adjacent to Poland (see fig. 6.2).

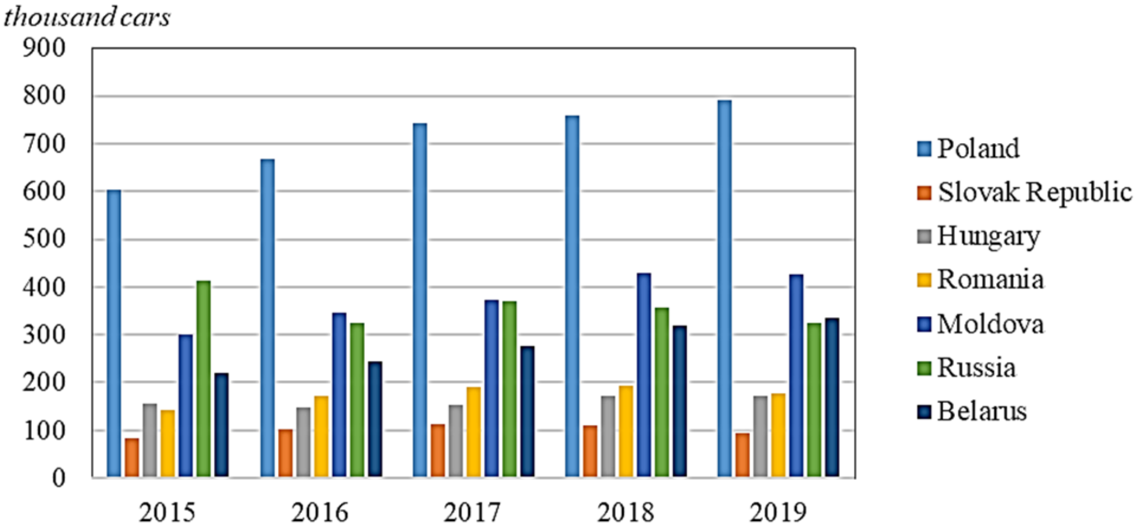


Figure 6.2. Road freight transport crossing over the state border of Ukraine

Author's development based on data [20]

In addition, activities in the field of providing transport services are one of the significant sources of filling the state budget of the country. Similar to international trade in goods, foreign economic activity includes the export-import of transport services — the performance of transportation on the territory of a foreign state, including the rental of vehicles and the provision of related and auxiliary services. The analysis showed that currently there is a gradual increase in the volume of international trade in transport services after a significant drop in 2014-2016, which was caused by the political and economic crisis in Ukraine (see fig. 6.3). It should be noted that a significant share in the total structure of foreign trade is accounted for by rail and air transport services [35].

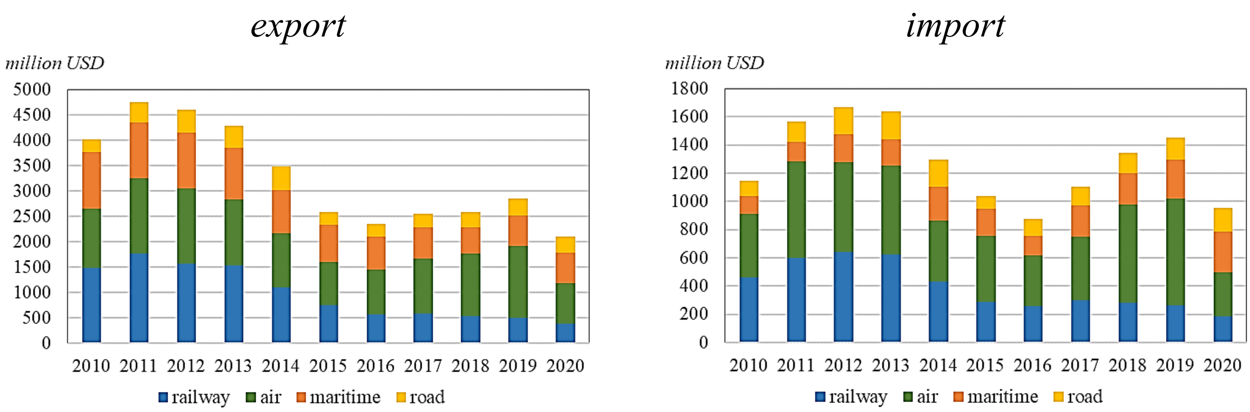


Figure 6.3. Dynamics of foreign trade in transport services

Author's development based on data [35]

At the same time, if we consider a similar distribution in trade with EU countries, the share of railway transport in the provision of these services is significantly reduced in favor of road transport (see fig. 6.4). This is due to significant technical differences between the railway systems of Ukraine and the EU countries, which considerably complicates the transportation process. In addition, road transport is more economically attractive over relatively short transport distances characterizing delivery to the EU.

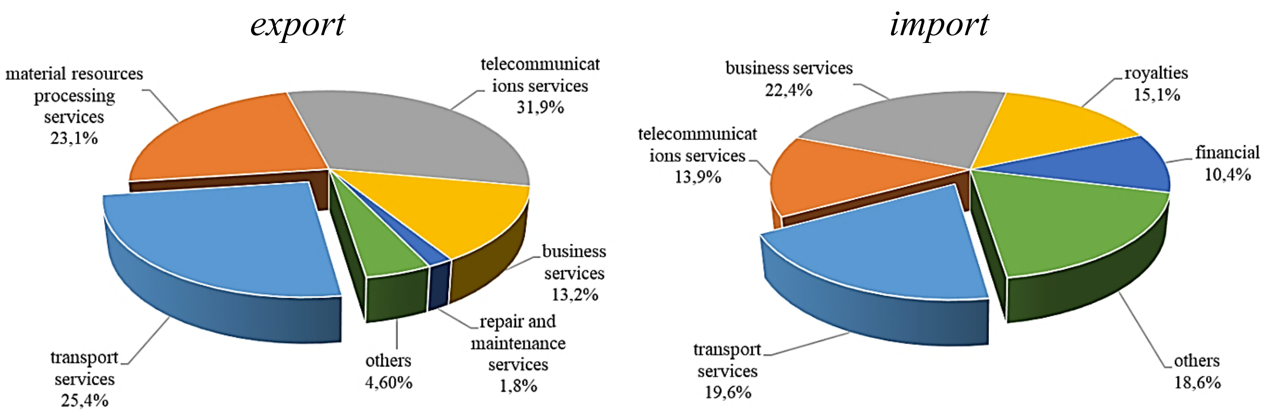


Figure 6.4. Structure of the foreign trade market in services with EU countries

Author's development based on data [35]

Transportation of goods by road in international traffic is a rather complex logistics process, which can be represented in the form of a multi-stage technological scheme. It is known that the implementation of each stage of this scheme is associated with a large number of unforeseen circumstances and random factors. Thus, in the process of international transportation, a number of risks arise that add uncertainty to the calculation of the standard duration and cost of cargo delivery [17]. At the same time, from the set of these risks at the level of persons organizing transportation, management is carried out mainly in relation to transport risks, the identification of which at different stages of international transportation is given in this article.

One of the methods of risk identification is SWOT analysis, which involves identifying strengths and weaknesses, threats and opportunities, as well as establishing links between them to form internal control and identify opportunities for developing the level of services provided. SWOT analysis of international cargo delivery services by road is given in Table. 6.2.

Table 6.2. SWOT analysis of international cargo delivery services by road

Strengths	Weakness
• Availability of the service for a wide range of consignors • Prompt execution of delivery • Possibility of organizing unimodal transportation and delivery «to the door» • Flexibility of the transportation route	• Technical condition of vehicles • Limited overall and weight parameters • Dependence on the requirements of the legislation of other countries • High level of competition • Insufficient capacity of border checkpoints

Opportunities	Threats
• Improving the safety of transportation process • Expanding the scope of additional related services • Creating a single customs zone and speeding up cargo delivery • Acceleration of customs and border control at international checkpoints	• Damage, loss or theft of cargo (road accidents, actions of third parties) • Violation of delivery terms • Lack of permits for transportation on the territory of foreign countries • A large number of participants in the transportation process and their possible incompetent actions • Political and economic risks

Author's development

Let's take a closer look at the threats and risks at the stages of transportation. The generalized scheme of cargo delivery by road in international traffic consists of the following stages:

preparation of cargo for transportation;

search and selection of a contractor for road transportation;

providing transport facility (TF) for loading;

preparation of shipping and transport documentation;

loading, placing and securing cargo in TF;

customs clearance of cargo in the country of departure (country of export);

transportation of cargo on the territory of the country of departure to the border crossing point;

passing customs and border control;

transportation of cargo through the territory of the destination country (transit countries) to the place of customs clearance;

transportation of cargo to its destination;

unloading TF.

One of the first stages where a transport risk may arise should be considered the preparatory phase of transportation, during which the cargo is packed and prepared for transportation. By Legislation of Ukraine [31] recommendations and requirements for packaging and labeling of goods in road transport have been established, so at this stage it is important to sort the cargo, as well as choose the appropriate container for its transportation. Risk factors at this stage may include the absence or choice of the wrong type of container for cargo, the use of damaged containers, careless attitude of personnel to the packaging or consolidation of cargo, etc. Therefore, research [37] has found that up to 40% of losses of perishable agricultural products are associated with the packaging of mature and diseased fruits in one container. Possible measures to reduce the amount of risks at this stage are the implementation of a system of preliminary control over the packaging and placement of goods in containers.

Direct transportation of cargo can be carried out by the shipper's own fleet (consignee) or with the involvement of third-party freight forwarding companies (outsourcing), which causes additional risk associated with the search and selection of a reliable and professional contractor. The involvement of an incompetent carrier can lead to a number of negative consequences: from non-fulfillment of obligations established by the contract to damage or loss of cargo. Economic activities related to the implementation of international road cargo transportation require mandatory licensing [32], which aims to make it impossible for unreliable carriers to enter the cargo transportation market. At the same time, as the study proved [29], the number of court cases in the field of freight forwarding activities has been steadily increasing over the past few years.

Today in Ukraine, one of the sources where you can find information about the rating and background of the transport company's activities is the All-Ukrainian online transport services exchanges: Lardi-trans, Della and others. In addition, there are now a significant number of open state registers that will additionally allow you to check the contractor's status, whether it has a tax debt, court cases, information about TF and drivers. Risk reduction at this stage is possible by implementing risk management procedures at an enterprise that attracts outsourcing companies to carry out cargo transportation.

Requirements regarding the terms and place of submission of the TF for loading, as a rule, are agreed in the application, which is an integral part of the freight forwarding contract, and their violation provides for penalties. As the analysis shows, at this stage, quite often there is a risk of late delivery of the car for loading or even refusal to load at all. The reasons for this risk may be delays of the car at the previous place of unloading, traffic jams or repairs on transport tracks at the entrance to the place of loading, irresponsibility of the driver, force majeure, etc. Obviously, the degree of risk at this stage largely depends on the level of reliability of the contractor chosen at the previous stage.

Road cargo transportation in international traffic involves the preparation of a package of shipping and transport documentation — CMR, Packing list, Invoice, Customs declaration, Certificate of Origin, Export declaration (EX-1), sanitary certificates, etc. The risk of errors, inaccuracies or lack of necessary data in the goods and transport documentation can cause significant delays in transportation, especially when crossing the state border, or even call into question its implementation.

After the vehicle is delivered to the loading point, it is received and inspected, checked for compliance with the customer's requirements and, if necessary, weighed. At this stage, there are risks associated with non-compliance of the transport facility with the customer's requirements, for example, insufficient internal dimensions of the semi-trailer, lack of a sealing cable, damage to the awning, technical malfunction of the refrigerated unit, etc.

Performing loading and unloading operations is regulated by Article 8 of the rules for the transportation of goods by road of Ukraine [31], and the requirements for placing and securing cargo in the transport facility — European standards EN 12195-1, EN 12195-2, EN 12195-3, EN 12195-4, EN 12195:2010, EN 12640. The main source of risks in cargo operations is the technical means and equipment for cargo operations, as well as the responsibility and vigilance of the personnel who carry them out. Separately, it should be noted the risks associated with the actions or omissions of the car driver. Analysis of existing practice has shown that quite often there are cases of shortage or damage to cargo due to drivers ' failure to perform their direct duties. Thus, the legislation of Ukraine establishes that the driver is responsible for placing and securing cargo within the TF, and is also obliged to control the process of loading and unloading the car.

A mandatory stage of international road transport is the implementation of customs clearance of goods. Cargo customs clearance procedures can be performed both on the territory of international automobile checkpoints and at customs terminals (posts) of regional customs offices. Depending on the cargo and the customs regime under which it is planned to be placed, a customs declaration and a package of documents for declaration established by national legislation are provided to customs in advance. When checking the documents submitted by the Declarant, the customs service applies a risk analysis method to determine the goods, including vehicles, to be checked, and the degree of such verification. It is at this stage that there are risks of car delay due to customs formalities. The increase in the duration of customs clearance may be due to incorrect processing of customs documents; incorrect calculation of customs duties and payments; lack of documents necessary for non-tariff regulation; inspection of a vehicle by a customs officer in order to compare the mass and number of cargo spaces declared in the documents with the actual one. The source of such risks is incompetent actions of the Declarant or broker when performing customs clearance of goods. Customs clearance is considered completed after the customs security (seal) is applied to the vehicle with the cargo and the mark «under customs control» is affixed in shipping and transport documents, after which international transportation begins.

The process of transportation carried out both on the territory of Ukraine and on the territory of the destination country or other third (transit) countries is the longest stage of international cargo delivery. Risks during transportation may occur for the following reasons: road accidents that may lead to damage, partial or complete loss of cargo; illegal actions of third parties that led to theft of cargo during transportation; failure to meet the delivery time of cargo due to force majeure or road conditions. Risk factors in this case may be unfavorable weather conditions; dangerous road conditions and unstable situation in the regions through which the route of transportation passes (transportation through the temporarily occupied territory of Ukraine); malfunction of individual technical systems and components of the transport facilities; lack or insignificant experience of the driver on a certain route or terrain of Transportation; insufficient awareness of the driver about the features of the cargo and the conditions of its transportation (compliance with the requirements of the temperature regime, the impossibility of delaying delivery).

In addition, during road transportation, there are stops related to food, satisfaction of the driver's natural needs, or regulated, in accordance with the requirements of the AETR [18], the driver's rest on the road. In accordance with international requirements and recommendations, long-term stopping or parking of TF with cargo should take place in certified Tir-parking facilities equipped with video surveillance equipment and an existing staff of security personnel.

Summing up this stage of transportation, it should be noted that according to international and national legislation, the responsibility for the safety of the cargo from the moment it is accepted for transportation and until it is issued to the recipient lies with the carrier, unless the latter proves that the loss, shortage, damage or damage to the cargo occurred due to circumstances that the carrier could not prevent and the elimination of which did not depend on it.

Export and import of goods by road across the customs border of Ukraine in accordance with [25] is carried out at the relevant checkpoints, the list of which is established by the Cabinet of Ministers of Ukraine. Currently, there are 100 international automobile border crossing points (IABCP) on the state border, but only 28 of them can serve cargo flow in connection with the following countries: Republic of Poland — 4, Hungary — 1, Slovak Republic — 1, Romania — 2, Republic of Moldova — 8, Russian Federation — 5, Republic of Belarus — 7. When crossing the state border, a number of checkpoints controls established by national legislation are met [28]:

control of the International Road Transportation Service (IRTS);

veterinary and sanitary, phytosanitary, environmental, radiological control;

customs control;

border control.

The total time spent by a car in the IABCP depends on the duration of the specified procedures, which is not regulated in any way, but it is established that the maximum period of stay of goods and vehicles at checkpoints can not exceed 5 days from the date of arrival at the checkpoint for customs procedures [28]. In addition, there are a number of other factors that may cause additional unpredictable downtime at the checkpoint. Thus, when exporting from Ukraine, there are cases of delay for the purpose of additional inspection of the vehicle by customs officers, due to the recommendations from automated risk analysis and management system (ARAMS) [40]. When importing goods, additional delays may occur due to the lack of prior notification of the cargo and TF in the customs information base of the point. The presence of these and other random factors gives reason to believe that the duration of stay at the checkpoint is a random value, and therefore there are risks of delay of the car with cargo at the state border of Ukraine.

The amount of risk in this case is characterized by a mathematical expectation and a standard deviation in the duration of delays. To determine these statistical characteristics, the paper analyzes the length of queues at Ukrainian border crossing points from Poland, Slovakia, Hungary and Romania by day in 2019. As the analysis showed, there are significant fluctuations in the length of the queue while waiting for the border to pass. Therefore, on the border crossing points Yahodyn-Dorohusk, the average number of cars in the queue was 178.35 cars; the standard deviation was 156.98 cars (±88%). The longest queue length at this border crossing was observed in December-January and reached 800 cars/day, and the waiting time in the queue exceeded 30 hours.

The final stage of the international transportation process is customs clearance, unloading of the transport facilities at the destination and acceptance of the cargo by the recipient. At this stage, customs formalities are performed similar to customs procedures in the country of departure, transfer of shipping and transport documents, check the number of cargo spaces and weight of cargo, inspect the cargo for signs of damage, and unload the vehicle. During these operations, there may be risks of detecting a shortage or damage to the cargo, due to inattention of the driver or unfair intentions of the recipient's personnel when unloading the cargo; technical malfunction of weighing and other equipment for unloading; unfair intentions of employees performing unloading the cargo.

Thus, as the analysis has shown, transport services in international traffic are one of the important components of economic development. The efficiency of the organization of international transportation depends not only on the economic result of the functioning of an individual transport company, but also on the indicators of foreign economic activity of industries and the country as a whole.

Research of statistical data has established that the main trading partner of Ukraine is currently the European Union. At the same time, a significant amount of cargo transportation between these parties is carried out by road, which provides attractive unimodal door-to-door delivery in a relatively short time. At the same time, the analysis showed that the organization of international transportation by road is associated with a large number of random factors and risks caused by this, which does not allow us to accurately estimate the cost and duration of such delivery. To solve this problem, the paper identifies risks at each stage of international transportation. The results obtained can be used in the risk management process to improve the efficiency of cargo transportation management by road in modern conditions.

BIBLIOGRAPHY

1. Analysis of Criminal and Terrorist Related Episodes in Railway Infrastructure Scenarios / De Cillis, F., De Maggio, M., Pragliola, C., et al. // Journal of Homeland Security and Emergency Management — 2013. — Vol. 10. — Issue 2. — pp. 447-476. doi:10.1515/jhsem-2013-0003

2. Bouchon S. Non-Binding Guidelines for the application of the Council Directive on the identification and designation of European Critical Infrastructure and the assessment of the need to improve their protection / S. Bouchon, C. Mauro, C. Logtmeijer, J. Nordvik, R. Pride, B. Schupp, M. Thornton. — Access mode: http://publications.jrc.ec.europa.eu/repository/handle/JRC48985

3. Council Directive 2008/114 / EC of 8 December 2008 on the identification and design of European critical infrastructure and the assessment of the need to improve their protection (Text with EEA relevance) — available at: http://data.europa.eu/eli/dir/2008/114/oj

4. De Cillis F. Analysis of criminal and terrorist related episodes in railway infrastructure scenarios / F. De Cillis, M. C. De Maggio, C. Pragliola, R. Setola // Journal of Homeland Security and Emergency Management. — 2013. — Vol. 10(2). — P. 447–476. doi: http://doi.org/10.1515/-jhsem-2013-0003.

5. Giannopoulos G. Risk assessment methodologies for Critical Infrastructure Protection. Part I: A state of the art / G. Giannopoulos, R. Filippini, M. Schimmer. — Joint Research Centre, 2012. — 70 p.

6. Global terrorism database: website-available mode: https://www.start.umd.edu/gtd

7. Homeland Security Presidential Directive 7: Critical Infrastructure Identification, Prioritization, and Protection. — Access mode: https://www.dhs.gov/homeland-security-presidential-directive-7

8. ISO 31000: 2018 Risk management-Guidelines: standard. — Access mode: https://www.iso.org/obp/ui/ru/#iso:std:iso:31000:ed-2:v1:en

9. Lewis T. G. Critical infrastructure protection in homeland security: defending a networked nation. New Jersey: John Wiley & Sons, 2006.474

10. National Cross Sector Forum 2018-2020 Action Plan for Critical Infrastructure. — Access mode: https://www.publicsafety.gc.ca/cnt/rsrcs / pblctns/pln-crtcl-nfrstrctr-2018-20/index-en.aspx

11. National Infrastructure Protection Plan. — Access mode: http://www.dhs.gov/xlibrary / assets / NIPP Plan.pdf

12. National Strategy for Critical Infrastructure. — Access mode: https://www.publicsafety.gc.ca / cnt/rsrcs/pblctns/srtg-crtcl-nfrstrctr / index-en.aspx

13. The Railway Security: Methodologies and Instruments for Protecting a Critical Infrastructure / R. Setola, A. Sforza, V. Vittorini, C. Pragliola // Topics in Safety, Risk, Reliability and Quality. Cham.: Springer, — 2015 — Vol. 27. — 255 p. DOI: http://doi.org/10.1007/978-3-319-04426-2_3.

14. Biryukov D. S. Protection of critical infrastructure: problems and prospects of implementation in Ukraine / D. S. Biryukov, S. I. Kondratov. — Kyiv: NISS, 2012. — 96 p.

15. Hlukhov N. I. Actual problems of vulnerability of transport infrastructure objects / N. I. Hlukhov, V. A. Protopopov // Bulletin of the Buryat State University. 2012, № 2, pp. 278-283.

16. Dityuk V. Z. Terrorist activity at transport infrastructure facilities in the context of events in the east of Ukraine: analysis of manifestations / V. Z. Dytiuk // Scientific notes of Lviv University of business and law. — 2014. — № 12. — pp. 265-268. — access mode: http://nbuv.gov.ua/UJRN/Nzlubp_2014_12_62.

17. Dorosh, A. S. A. S. Dorosh, E. B. Demchenko / Problems and prospects of railway transport development: Theses of the 79th international scientific and practical conference (Dnipro, May 16-17, 2019) — Dnipro : DNUZHT, 2019. — pp. 445-446.

18. European Agreement concerning the work of crews of vehicles engaged in international road transport (AETR). — Access mode: https://www.unece.org/fileadmin/DAM/trans/doc/-2010/sc1/ECE-TRANS-SC1-2010-AETR-ru.pdf.

19. Zelenkov M. Y. Modern terrorism and anti-terrorist activities on railway transport: a legal aspect. C. II. Characteristics of terrorism on railway transport and technologies of its warning / M. Y. Zelenkov. — M: MIIT Law Institute, 2005. — 132 p.

20. Foreign trade in services: express issue of the state statistics service of Ukraine. — Access mode: http://www.ukrstat.gov.ua/express/expr2020/02/16.pdf.

21. Code of Ukraine on administrative offenses (Articles 1 — 212-21) : Code of Ukraine; Law, Code of 07.12.1984 № 8073-X // database «Legislation of Ukraine» / Verkhovna Rada of Ukraine. — Access mode: https://zakon.rada.gov.ua/go/80731-10

22. Concept of anti-terrorist activity on railway transport of CIS member states / Anti-Terrorist center of states participating in the Commonwealth of Independent States. — Access mode: http://www.cisatc.org/1289/135/152/302

23. Criminal Code of Ukraine : Code of Ukraine; Code, Law № 2341-III of 05.04.2001 // database «legislation of Ukraine» / Verkhovna Rada of Ukraine. — Access mode: https://zakon.rada.gov.ua/go/2341-14

24. Methodology of implementation of the Russian Railways Service Station «Risk Management in the organization of Traffic Safety. — Access mode: http://oac.rgotups.ru/misc/files/39.4.4.pdf

25. Customs Code of Ukraine [electronic resource]: law of Ukraine [adopted by the Verkhovna Rada on 13.03.2012 № 4495-VI]. — Access mode: http://zakon1.rada.gov.ua/-laws/show/4495-17.

26. Order of the Ministry of internal affairs of Ukraine № 908 of 19.09.2013 «on the Action Plan of the Ministry of internal affairs of Ukraine for the implementation of the concept of combating terrorism».

27. Nefedyev S. A. Nefedyev S. A.: Modern instruments of management of the risk of unusual situations on transport // Fire and explosion safety. — 2016, pp. 60-69.

28. Issues of passage of persons, road, water, rail and air vehicles of carriers and goods moved by them across the state border: resolution of the Cabinet of Ministers of Ukraine № 451 of 21.05.2012. — Access mode: https://zakon.rada.gov.ua/laws/show/451-2012-%D0%BF#Text.

29. Pogribnyak, O. M. Modern conditions and features of legal regulation of cargo transportation by road transport of Ukraine / O. M. Pogrebnyak, A. S. Dorosh, E. B. Demchenko // Transport systems and technologies of transportation : Collection of Scientific Works. Dnipro

National University of Railway Transport named after Academician V. Lazaryan. — Dnipro, 2018. Issue 16. pp. 83-92. — DOI: 10.15802/tstt2018/164070.

30. On approval of the regulation on classification of Transport events in railway transport : Order of the Ministry of infrastructure of 03.07.2017 № 235 // Database «Legislation of Ukraine» / Verkhovna Rada of Ukraine. — Access mode: https://zakon.rada.gov.ua/go/z0904-17

31. On approval of the rules of cargo transportation by road in Ukraine: Order of the Ministry of transport of Ukraine № 363 dated 14.10.1997 — Access mode: https://zakon.rada.gov.ua/-laws/show/z0128-98

32. On licensing of types of economic activity: Law of Ukraine № 222-VIII of 02.03.2015 — Access mode: https://zakon.rada.gov.ua/laws/show/222-19#Text.

33. On approval of the concept of creating a state system for protecting critical infrastructure : decree of the Cabinet of Ministers of Ukraine; concept № 1009-р dated 06.12.2017 // database «Legislation of Ukraine» / Verkhovna Rada of Ukraine. Access mode: https://zakon.rada.gov.ua/-go/1009-2017-%D1%80

34. Decree of the Cabinet of Ministers of Ukraine № 547-р of 11.07.2013. «On approval of the action plan for the implementation of the concept of combating terrorism». — Access mode: http://zakon4.rada.gov.ua/laws/show/547-2013-р

35. Cooperation between Ukraine and the EU countries in 2019: a statistical collection. — State statistics service of Ukraine. — Kiev, 2020. — 60 p.

36. Statistical data on Ukrainian Railways: website. — Access mode: https://mtu.gov.ua/content/statistichni-dani-pro-ukrainski-zaliznici.html

37. Troitskaya, N. A. Transport and technological schemes of transportations of certain types of cargo : a textbook [text] / N. A. Troitskaya, M. V. Shilimov. Moscow: Kronus publ., 2010, 232 P.

38. Decree of the president of Ukraine № 230/2013 of 25.04.2013 «on the concept of combating terrorism». — Access mode: http://zakon4.rada.gov.ua/laws/show/230/2013

39. Decree of the president of Ukraine on the decision of the national security and Defense Council of Ukraine of May 6, 2015 «On the national security strategy of Ukraine». — Access mode: http://zakon2.rada.gov.ua/laws/show /287/2015/paran7 # n7

40. Risk management in customs: foreign experience and domestic practice: monograph; edited by I. G. Berezhnyuk. — Khmelnytskyi: PP. Melnik A. A., 2014, 288 p.

Chapter 7
SUPPLY CHAIN MANAGEMENT AND NETWORKS

Foreword
List of Abbreviations
1. Concept of Supply Chains
2. Structure of Supply Chains and Networks
3. Current Trends in the Development of Supply Chains
4. Logistic Approach to Supply Chain Management
5. Risks in Supply Chain Management
6. Organization of Logistics in Supply Chains
References
Subject Index

LIST OF ABBREVIATIONS

SMC — Service Metal Centers
4PL — Fourth-Party Logistics Provider
SAP — System Analysis and Program
SAP APO SNP — System Analysis and Program Advanced Planner and Optimizer Supply Network Planning
SCM — Supply Chain Management
SCRM — Supply Chain Risk Management
TQM — Total Quality Management
JIT — Just-in-Time

SUPPLY CHAIN MANAGEMENT AND NETWORKS

Maryna KHARA
Iryna NIKOLAIENKO
Andrii LYAMZIN

FOREWORD

The relevance of supply chain management issues, which are presented in this section, is associated with the versatility of supply chain management and with the modern realities of the information society, which contributes to the rapid development of modern logistics tools, which include: Big Data technology; GRID technology; Blockchain technology; sensory technologies; transport digitalization technologies.

The development of supply chain management began in the 90s. XX century. It was then that the tendencies emerged: the excess of supply over demand, the globalization of markets and the informatization of business. These trends have caused changes in the strategies of ensuring the competitiveness of enterprises, which were forced to take into account the needs of customers as much as possible and, therefore, individualize products (customization of production). At the same time, the markets of Southeast Asia, South America, and a little later, Eastern Europe and Ukraine began to actively develop.

Many developed countries, for reasons of ecology and economy on a relatively cheap labor force, moved their production capacities to these regions, as a result, the volume of traffic began to rapidly increase. All this together led to the fact that the optimization of the entire value chain, and not just individual functions of your own enterprise, became a decisive factor in ensuring the competitiveness and profitability of the business, which determined the development of science and practice of supply chain management [1].

According to most experts, the starting point for the emergence and development of the concept of supply chain management (Supply Chain Management or SCM) was also the desire to reduce risks and uncertainties based on models of cooperation and layered (i.e., at several enterprises at the same time) inventory management [2, 3]. In the 70-80s. In the twentieth century, the concept of synchronization of supply, production and distribution processes was also actively developed — the Just-in-Time (JIT) system.

Many experts associate the emergence and development of supply chain management with the need for rational use of production capacities. Unable to manage supply chains, businesses were forced to plan production with significant stocks of raw materials, materials and work in progress, since the supply processes were not synchronized with either suppliers or customers. Corporate information systems and Internet technologies have appeared, which have significantly improved the efficiency of coordination of processes in the supply chain. It is integration and coordination that significantly distinguish the ideology of supply chain management from traditional approaches to inter-firm cooperation.

The science and practice of real supply chain management has proven the effectiveness of building a business based on a holistic consideration of all elements of the process of creating the consumer value of a product, and not just the costs and revenues of your own enterprise, without taking into account the influence of interfirm relationships with suppliers and relations with customers.

In our country, people began to learn about supply chain management in the 90s. It was then that the first translated editions of famous foreign authors D. Bowersox and D. Clos, M. Christopher, and later K. Lambert and D. Stock appeared, which were mainly focused on strategic management of supply chains. Logistics issues explored in the scientific works of many Ukrainian scientists, in particular K.V. Zakharov A.G. Kalchenko, Y.V. Krykavskyy, V.K. Hubenko, M.Y. Grygorak, O.M. Sumets and many others.

Supply chain management is viewed from three main perspectives: business concept; independent scientific discipline; environment of information interaction of enterprises. Establishing relationships between these three areas is currently one of the most important tasks.

1. CONCEPT OF SUPPLY CHAINS

The concept of supply chain management is one of the most dynamically developing areas of scientific and practical activity over the past decades.

The blurring of geographic and organizational boundaries that is happening around the world thanks to e-business is shifting the focus of enterprise management from the internal business processes of enterprises to the integration of external relations with partners and customers.

Supply Chain Management (SCM) is one of the most powerful global integration concepts that make the most efficient use of existing production resources.

A logistics chain is a set of links linearly ordered according to the material (information, financial, service) flow and performing a certain set of logistics functions and operations.

The organizations that make up the supply chain are «connected» to each other through physical flows and information flows. Physical flows include the transformation, movement, and storage of goods and materials. Information flows allow different supply chain partners to coordinate their long-term plans and control the daily flow of goods and materials up and down the supply chain.

Supply Chain Management — is a complex concept that is considering the logistics industry not as a supply of ready-made materials, components, assembly units and units, as well as the active search on a competitive basis the best partners for placement based on the specialization of engineering, technology and production orders. As a result, not a static, but a constantly updated and modernized supply network of partner enterprises is created [4]. And the logistics concept allows you to move from discrete to end-to-end management along the entire logistics chain.

Today, suppliers of companies regularly move materials and goods around the world through dozens of trade routes, with each supplier maintaining its own supply chain. All of this leads to the fact that organizations are less and less seeing their full supply profile at a time when risks and their consequences are growing.

Analysis of the main trends in the economy that affect the modern logistics concept allows you to highlight such factors:

– deepening of specialization in industry;

– new relationships with trading partners, requiring new approaches to organizing cooperation and new forms of management;

– development of world integration processes;

– increased competition in all areas of business;

– transition from the introduction of new information and computer technologies to their more efficient use;

– introduction of flexible technological equipment, design automation systems, flexible automated and robotized production;

– widespread dissemination of the philosophy of TQM — Total Quality Management;

– enhanced implementation of logistics principles in the service industry.

Therefore, effective supply chain management in today's global economy requires an approach that includes more than just timely delivery and insurance against losses [5]. To meet the challenges of today's global operating environment, companies need to fundamentally rethink what poses a threat to their business and then align resources to make their supply chains more agile and resilient.

The types of disruption that manufacturers face today are broader and more unpredictable, partly as a result of expanding supply chains in search of savings and partly because in a dynamic global economy, change is the only constant.

According to McKinsey & Company Global Supply Chain Survey, 80% of goods will be produced in a country other than the one where they are consumed by 2022.

Expanding and developing a supply chain network is a complex operation and requires an incredible amount of careful planning and attention. The global environment, regulations, trade wars, politics and other risks must be taken into account before benefits such as faster lead times, enhanced capabilities and an expanded product range are recognized.

Supply Chain Management is the management of upward and downward relationships with suppliers and buyers in order to provide high value to the consumer at the lowest cost for the entire supply chain (*Christopher, 2011*).

The Supply Chain Management process ensures the movement of raw materials, components and finished products of an enterprise to communicate with each other the systems of procurement, production and sales (Figure 7.1).

By linking production and sales, the supply chain management system must flexibly adapt to the company's strategy and adapt to the existing economic model.

Moving materials into an organization from suppliers is called inbound or intralogistics; Moving materials out of the organization and to customers is called outbound or external logistics; movement of materials within an organization is usually described as material management (see figure 7.1).

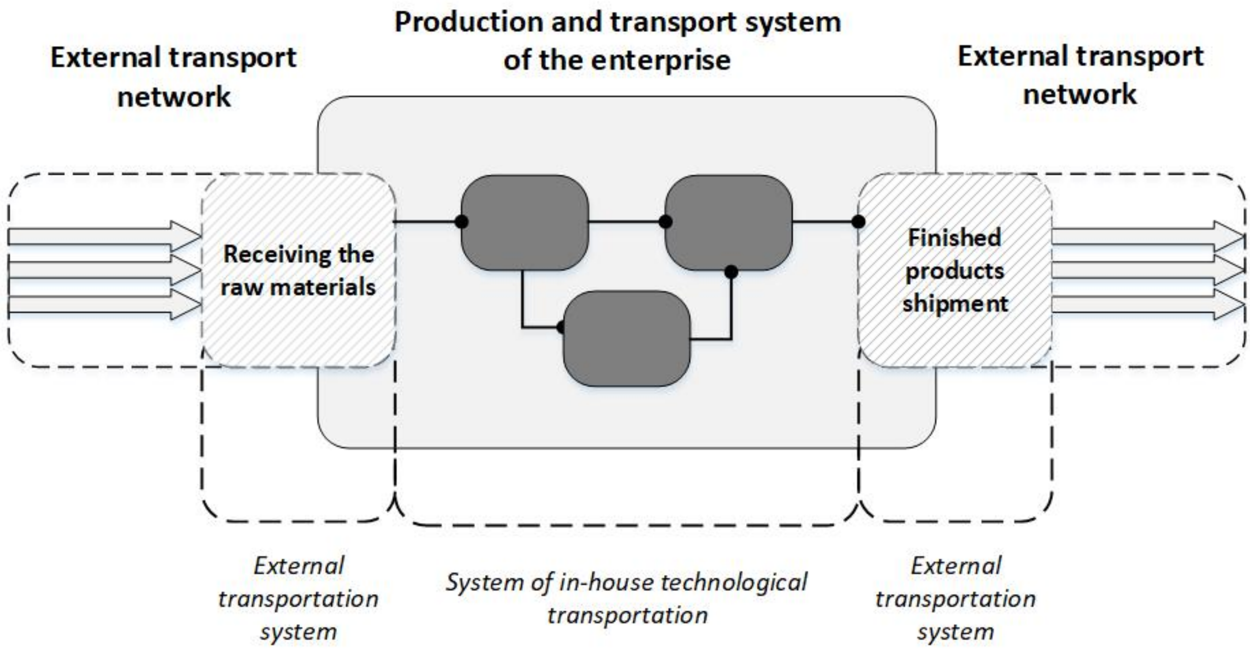


Figure 7.1. Moving Material Flows in the Supply Chain

The logistics concept of organizing production includes the following basic provisions:

– rejection of excess stocks;

– refusal of excessive time for performing auxiliary and transport and storage operations;

– refusal to manufacture series of parts for which there are no orders from buyers;

– elimination of equipment downtime;

– mandatory elimination of marriage;

– elimination of irrational intra-plant transportation, etc.

For example, the production logistics of a metallurgical plant is responsible for the design, formation and optimization of concentration and distribution systems within the enterprise and their effective use in managing the flows of raw materials (sinter, coke), iron and steel, and finished products (slabs, pipes, sheets, etc.) in the internal environment of an industrial enterprise.

The success of the supply chain is assessed according to three criteria: operability (ensuring work without disruptions), reducing costs and reducing the turnover time of a unit of production within the system.

This requires a deep analysis of: places of production, the number of production facilities, platforms and warehouses, which determine the physical flows between various participants in the supply chain and affect the optimal distribution of finished products in the right stocks for further delivery to the consumer.

All characteristics of supply chains are conceptualized and calculated (transport or production costs, production, operational or warehouse constraints).

On the basis of simulations, a model of an optimized logistics network is developed, including the economic justification of this model and its detailed overview (flows between production points, production capacities of enterprises, etc.).

A series of «What if?» simulations are created, such as «What if transportation costs increase by 2%? If a business can ship 10% more goods per day, how will this affect the rest of the chain?»

This analysis must be done prior to planning and executing operations, and updated at regular intervals.

Supply Chain Management extends from raw material suppliers through manufacturing, assembly, quality control, warehousing and onward through distribution channels, wholesalers and retailers to the final consumer of the product or service.

SCM is a management philosophy in which the delivery of products or services to the end user is viewed as a process. This process must be managed as a whole, regardless of the functions of an individual enterprise and the boundaries between enterprises, in order to ultimately increase the value of the business of all its participants.

Supply Chain Management focuses on supplying the end user with the product or service with the highest possible customer value at the lowest possible cost and in the shortest time on the market. This goal can only be achieved by an enterprise that works together with suppliers and customers to optimize the overall trade relationship, and not just its own parts of the process.

SCM emphasizes the fact that it is not enough to focus only on improving internal processes and functions, because the business activities of the enterprise also involve a network of relationships that extend far beyond the walls of the company. Therefore, the purpose and purpose of SCM is to manage and improve this complex web of relationships through the integration of connections, the provision and sharing of technologies, information and resources.

Timely and accurate supply chain information enables manufacturers to manufacture and ship as many products as can be sold. Efficient supply chain systems help both manufacturers and retailers reduce excess inventory.

2. STRUCTURE OF SUPPLY CHAINS AND NETWORKS

Logistics networks and chains link the functional areas of supply, production and sales in each of the organizations, connected to each other by cross-functional and inter-organizational business processes.

A logistics supply network connects all companies and enterprises that contribute to the product. At the same time, the network includes suppliers for its own suppliers, as well as customers for its own customers (Fig. 7.2).

Organizations do not operate in isolation, each one acts as a buyer when it purchases materials from its own suppliers, and then it acts as a supplier when it delivers materials to its own customers. Thus, a wholesale buyer is a buyer when buying goods from manufacturers and then a supplier when selling them to retail stores: a component manufacturer buys raw materials from its suppliers, assembles them into components, and transfers the results to other manufacturers. Products move through a number of organizations on the way from original suppliers of raw materials, through intermediate organizations and to end users.

When managing material flows in the process of selling finished products, the problems of distribution logistics are solved [6]. This is a wide range of tasks that are dealt with by enterprises engaged in trade and intermediary activities.

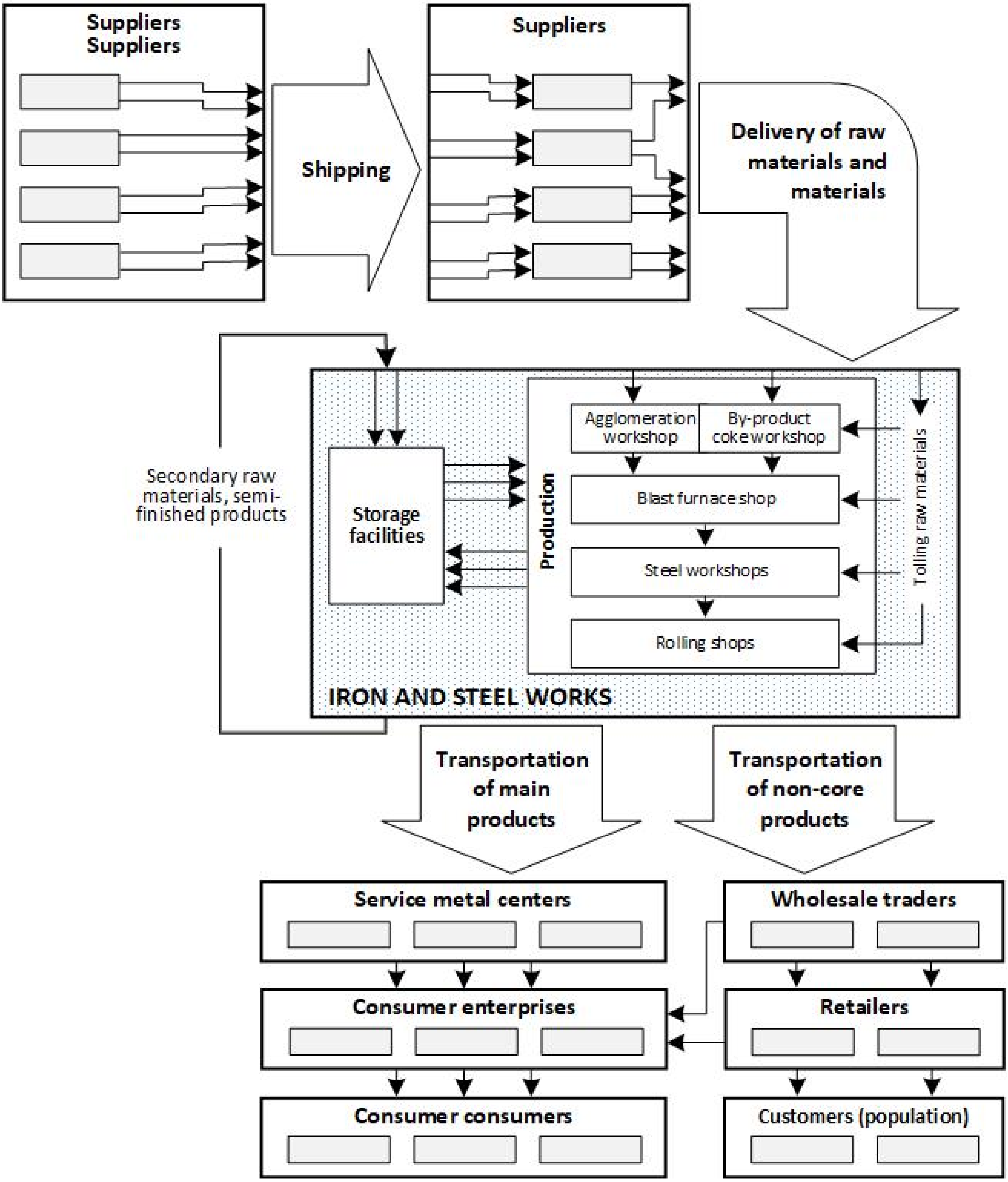


Figure 7.2. Logistic Supply Chain of Metal Products

The functioning of the supply chains of metal products is in a constantly changing high-tech environment, so solving big problems takes time, accuracy and perfection. Service Metal Center (SMC) is an important link in supply chains and chains, which provides material and informational communication between the stages of production and consumption. This is a specific industry that deals with metal processing and performs most of the blank production operations: cutting into strips and sheets, making profiles and structures of varying degrees of complexity.

SCM focuses on delivering the highest possible customer value to the end user at the lowest possible cost and in the shortest time on the market. This goal can only be achieved by businesses that work together with suppliers and customers to optimize the overall trading relationship, not just their own parts of the process. SCM emphasizes the fact that it is not enough to focus only on improving internal processes and functions, because the business activities of the enterprise also involve a network of relationships that extend far beyond the walls of the company. Therefore, the purpose and purpose of SCM is to manage and improve this complex web of relationships through the integration of connections, the provision and sharing of technologies, information and resources.

The criteria for the efficiency of supply chains are: the ratio of the net working time of the order (work) to the time of preparation, fulfillment and completion of the fulfillment of contractual obligations, the level of added value or margin minimization, as well as the quality of service of the production services provided.

Implementation of SCM and the implementation of appropriate systems are appropriate where the costs of working with suppliers, distributors and logistics make up a significant proportion of the cost of production. These enterprises primarily include diversified metallurgical holdings and chemical industry enterprises, manufacturers of consumer goods, large distributors and retailers.

3. CURRENT TRENDS IN THE DEVELOPMENT OF SUPPLY CHAINS

In the next decade, digital platforms will dominate the global steel industry by digitally connecting all market participants. The main goal of this process is to improve efficiency for all links, which will allow forecasting the demand for steel products and price trends with much greater accuracy.

In the world, at least one third of all manufactured metal products pass through service metal centers. Just-in-time delivery is one of the main objectives of the steel center, with 24/7 service to respond in a timely manner to unforeseen demand for steel products. At the same time, the organization of the effective work of the SMC should be ensured through the active use of modern digital methods of managing all operations, as well as the timely implementation of information technologies.

In the coming years, metal service centers will face quite serious changes in the organization of work. Digital platforms in the steel and metal market are changing traditional business models that rely on off-the-shelf inventory and arbitration agreements as key elements of the supplier-customer relationship. SMCs must find new ways to create value for buyers, manufacturers and other participants in the supply chain — otherwise they will disappear.

The main goal of a modern metal service center is to provide a comprehensive service for both metal buyers and manufacturers. In the short term, SMC customers will be able to use modern digital tools such as contract portals, online shops and order reviews. Customized solutions allow service centers to offer customers more specialized metal products and a variety of services.

Research and practical experience of competitive enterprises in the metals market show that a higher value-added business has great potential and prospects.

A good example of this is the investment in 3D lasers, which can be used to combine multiple customer tasks such as drilling, sawing and cutting at an attractive price, with a high level of accuracy and quality in order fulfillment.

The introduction of digital workplaces allows you to receive not only the advantage of an affordable solution for the modernization and integration of disparate operations, but also solutions that unite all participants in production and service centers, allowing them to communicate and collaborate with the production goal, meeting both their individual needs and preferences, as well as the general needs of the enterprise and the supply chain of metal products.

Along with the digitization of processes in the supply chain of metal products, the intelligent use of the data obtained is also becoming increasingly important. For example, one of the largest European distributors of steel and metal products Klöckner & Co cooperates with the leading supplier of artificial intelligence, the German company Arago GmbH. The use of artificial intelligence helps the service center to automate parts of the IT infrastructure through constant learning and self-improvement processes.

The development of metal service centers entails the expansion and improvement of sales channels for metal products, which in turn contributes to the development of the metallurgical industry and the country's economy.

One of the limiting factors for these innovations is the closedness of the databases of raw material suppliers and enterprises. Reducing the time of preparatory operations in the production cycle (switching to work on specific contracts) and the delivery time of raw materials is in direct proportion to the extent to which all participants in the supply chain will have limited access to their databases on planned volumes, assortment of finished products and data on raw material supply opportunities.

The COVID-19 crisis has accelerated the use of Industry 4.0 business models, i.e. introduction of automation technologies, autonomous systems and artificial intelligence. The more the supply chain depends on people, the greater the risks. At the same time, Industry 4.0 technologies do not depend on the human factor. Also, the use of automatic machines will significantly reduce transport costs, import duties and the risk of overproduction.

Technologies such as autonomous systems and additive manufacturing are deployed in a confusing, human-filled environment, with inevitable mistakes and consequences for corporate strategy, risks and damage to reputation.

Logistics experts believe more sustainable shorter and simpler supply chains are more likely to be used.

An idea that is gaining traction is bimodal supply chains:

1. «First mode» (traditional) — lean efficiency, low risks, high predictability.

2. «The second mode» — the need for flexibility (agility), speed and exploring new opportunities.

Most companies will have to become bimodal, and their priority will be the second mode — quick recognition of opportunities, adaptability, readiness to solve unexpected problems.

4. LOGISTIC APPROACH TO SUPPLY CHAIN MANAGEMENT

The application of elements of end-to-end management in relation to the foundation of the supply chain allows all participants to fully use the accumulated logistics potential.

Some of the most well-known international standards in the field of supply chain management are currently considered:

1. Supply Chain Operations Reference.
2. Global Supply Chain Forum.
3. Collaborative Planning, Forecasting, and Replenishment.
4. Supply Chain Consortium Best Practice Framework.
5. European standards ISO\PAS28000, ISO-9000.

On their basis, the development of standards for logistics service enterprises and complete supply chains can be carried out, but, without fail, taking into account national requirements and peculiarities.

An important direction for improving logistics processes is improving the inter-functional interaction of participants [7]. Mutual integration of supply chain partners into the business leads to an understanding of how suppliers work, in which direction to develop joint technical potential, how to build a control system and exchange information and, as a result, jointly improve activities.

No less important is the involvement of customers in the process of logistics services, a joint assessment of the true problems of customers and the formation for them not so much of specific types of services, but of integrated logistics proposals aimed at the final result and comprehensive development of the consumers' business.

Correct assessment and forecast of market development trends, timely proposal of management decisions aimed at consumers and profit, re-focusing and coordination of the activities of supply chain participants (bringing suppliers, distribution centers, trade enterprises closer to the places of production and sale of finished goods and services, involvement of suppliers and consumers into the design processes, development of services, etc.), all these measures allow service companies to reduce logistics costs without compromising the quality of service, staying in the profit zone for as long as possible.

Close cooperation with logistics operators provides enterprises with the ability to successfully manage global supply chains of raw materials and finished products, covering various countries.

Many larger companies are turning to third party logistics providers (3PLs) and fourth party logistics (4PL) providers because of the cost-efficiencies they can provide. This allows organizations to focus on their business priorities and core activities.

A 3PL does not take ownership of (or title to) the products being shipped. This third party comes into play as an intermediary or manager between the other two parties.

This includes facilitating the movement of parts and materials from suppliers to manufacturers, as well as finished products from manufacturers to distributors and retailers.

A 3PL may or may not have its own assets, such as trucks and warehouses. Most 3PLs offer a bundle of integrated supply chain services, including: Transportation, Warehousing, Cross-docking, Inventory management, Packaging, Freight forwarding.

Companies turn to 3PLs when their supply chain becomes too complex to manage internally.

A fourth-party logistics provider, or 4PL, represents a higher level of supply chain management for the customer. The 4PL gives its clients a «control tower» view of their supply chains, overseeing the mix of warehouses, shipping companies, freight forwarders and agents.

The Council of Supply Chain Management Professionals defines a Fourth-Party Logistics Provider as: «An integrator that assembles the resources, capabilities, and technology of its own organization and other organizations to design, build and run comprehensive supply chain solutions».

Typically, the 4PL does not own transportation or warehouse assets. Instead, it coordinates those aspects of the supply chain with vendors. The 4PL may coordinate activities of other 3PLs that handle various aspects of the supply chain.

The 4PL functions at the integration and optimization level, while a 3PL may be more focused on day-to-day operations. The 4PL has integrated technology offerings that deliver a high level of visibility into the supply chain for tactical and strategic analysis.

Key drivers of the continued growth in demand for logistics services include the globalization of the world economy, the use of just-in-time manufacturing (JIT) and the development of e-commerce. Globalization is driving the expansion and sophistication of distribution channels and supply chains.

5. RISKS IN SUPPLY CHAIN MANAGEMENT

In light of the growing complexity of the business and the growing general uncertainty, the creation of a systematic approach to risk management in the supply chain is becoming more and more urgent.

With regard to supply chain management, there is Supply Chain Risk Management (SCRM) — risk management in supply chains, in which three key elements are usually distinguished:

- Determination (identification) of risks;
- Risk analysis;
- Management of risks.

Supply chain risks are diverse and affect virtually all key business processes. Risk identification, analysis and management methods are highly dependent on their type and possible place of occurrence in the supply chain.

When managing risks in supply chains, it is advisable to apply simple rules: specificity in describing risks, quantifying specific risks, moving from studying risks to managing them, identifying the necessary resources for risk management, drawing up an acceptable schedule for risk management.

A systematic classification of risks and the development of an appropriate response strategy is essential to strategically increase the resilience of the supply chain while keeping costs to a minimum.

Common logistics risks in supply chains include:

a) risks associated directly with the transportation of goods on a specific vehicle, including breakdown of rolling stock, road accidents, theft or loss of a vehicle, explosions, damage during loading, stacking, unloading, damage to containers (packaging), loss or incorrect design documents, etc.;

b) risks of loss of quality or damage to cargo during storage, warehousing (cargo handling) and other operations in warehouses and in preparation for shipment;

c) risks associated with the delay of cargo during customs clearance of import-export, etc.

It is possible to identify potential risks in the supply chain before they arise with the involvement of experts or specialists in the field of risk forecasting. When identifying, it is important to highlight the factors influencing the magnitude of uncertainty and risk. In the logistics business processes of the supply chain, they include:

– characteristics of the product and its packaging;

– means of transportation, features of the logistics infrastructure (for example, types of warehouses, types of equipment for cargo handling, etc.);

– time of order fulfillment cycle, type of route upon delivery of cargo, etc.

The entire supply chain is influenced by the risks of the macro environment — economic crises, restrictions on the availability of raw materials, political instability, new legal requirements, natural disasters.

The risks of the extended supply chain, which include operational risks, i.e. risks in own supply chain and supply chain risks of suppliers and customers.

Operational risks include risks in planning, procurement, manufacturing, new product launches, and deliveries.

Supply chain risks for suppliers and customers include risks of suppliers and their contractors, risks of companies providing outsourcing services, risks of consumers.

In addition, there are functional risks, that is, the risks of «related» business processes, organization and infrastructure — the risks of incorrect legal, tax support, recruitment risks, IT support risks [8].

The more complex the supply chain, the more risks need to be considered when managing it. Integrated supply chains are subject to great risks: dependence on suppliers of raw materials and services (for example, logistics); dependence on infrastructure; less time to respond to disruptions in the extended supply chain; the greater the cost of any management error.

Risk identification allows you to subsequently obtain a quantitative and qualitative risk assessment — an assessment of the likelihood of a hazard, forecasting the probability of the level of losses in the supply chain and their value or actual value. The estimates obtained allow us to further develop solutions for the prevention (control) of risk — organizational, technological and economic measures taken in order to minimize the amount of damage and when regulating losses of counterparties in the supply chain.

In absolute terms, the risk can be determined by the amount of possible losses in material (physical) or monetary (monetary) terms, if the type of damage is measurable in this form. In relative terms, the risk is defined as the amount of possible losses attributed to any base: property of the enterprise; total resource costs; expected income (profit).

The most difficult to assess and prevent risks in supply chains arise as force majeure circumstances.

Natural disasters are a particularly vivid illustration of the difficulties faced by supply chain managers. So in 2019, global losses due to earthquakes, floods, fires and the like reached USD 150 billion.

When managing risks in supply chains, the integration of their links is important, since the risk can be realized in one organization, the consequences of this risk are automatically transferred to all enterprises. All participants in the supply chain need to work together for mutual benefit, thereby reducing overall vulnerability.

More advanced companies have permanent supply chain risk management teams and processes. This group typically includes the leading automotive, chemical and electronics manufacturers with highly complex global supply chains.

Risk management is about preventing adverse events, not just preserving tangible assets or avoiding risks.

The risk management process covers the entire supply chain with the ability to seamlessly incorporate new links. SCM leaders not only recognize the risks, but also try to minimize them. An adaptive supply chain looks like this: developing a multipurpose workforce, flexible rescheduling of goods flows, increasing the ability to maintain brand reputation, developing SRM and SCRM processes, developing the ability to quickly influence changes in demand, contingency plans, engaging in lobbying activities, hedging.

The following technologies are used to manage risks: modeling of financial risks, operational planning of the supply chain, strategic planning of the supply chain, risk management tools, predictive modeling, scenario modeling, process simulation.

By developing and evaluating scenarios with different probabilities for predetermined risks, the most advanced organizations can perform high-level impact calculations that allow for better prioritization. Accordingly, the choice of priority is based not only on financial factors, but also on business-specific factors such as regulatory and strategic considerations, as well as the company’s propensity for specific risks. Supply chain risk leaders develop a set of response and proactive response strategies and raise overall risk awareness among their workforce by creating openness to address potential gaps and disruptions.

6. ORGANIZATION OF LOGISTICS IN SUPPLY CHAINS

The active involvement of Ukrainian enterprises in global supply chains, the entry of domestic manufacturers to world markets, the consequences of hostilities, a pandemic, etc. led the management of industrial, agricultural, trade and service enterprises to the need to pay attention to the logistics of their business, to the organization of logistics processes (purchases, production, distribution). Ukrainian and international logistics companies are increasing the volume and range of services for the coordination of customer logistics processes and supply chain management. This is in line with global trends. The leaders of the world 3PL market are increasingly positioning themselves not as tellers who perform operations for the transportation and storage of goods for cargo owners, but as consultants who help the business in promoting goods to consumers. They offer clients not services, but solutions to logistical problems.

Supplies to enterprises, their impact on the performance of enterprises are important in supply chain management and interaction with suppliers. Supply chain management is an effective strategy for enterprises to gain a competitive advantage. One of the prospects is the integration of marketing and supply chain management, which provides opportunities for significant improvement in supply efficiency.

Supply chain planning is a form of regulation and control of the processes occurring within a separate supply chain, through the development of time parameters of these processes, showing how and when they should be performed. There are three levels of planning:

– strategic level — long-term planning (10-15 years);
– tactical level — mid-term five-year planning;
– operational level — current short-term planning (monthly, quarterly, annual).

These three levels of planning correspond to the objectives set within the supply chain: strategic objectives, tactical objectives, and operational objectives.

Supply chain planning begins with the adoption of strategic decisions at the highest level: the mission, corporate strategy and business strategy are developed [9]. Then functional and logistics strategies are formulated as part of strategic logistics decisions. At the level of making tactical decisions, plans for the use of capacities and generalized plans are developed, and the main schedule is built. The level of operational logistics solutions corresponds to the construction of short-term schedules.

One of the ways to involve Ukrainian business in global integration processes is the creation and development of Ukrainian companies' own supply chains and their inclusion, thus, into global supply chains. One of the striking examples is a large metallurgical company, which plans its work in the supply chain as an end-to-end production and logistics chain. To implement it, a business planning model was created in SAP APO SNP (Fig. 7.3).

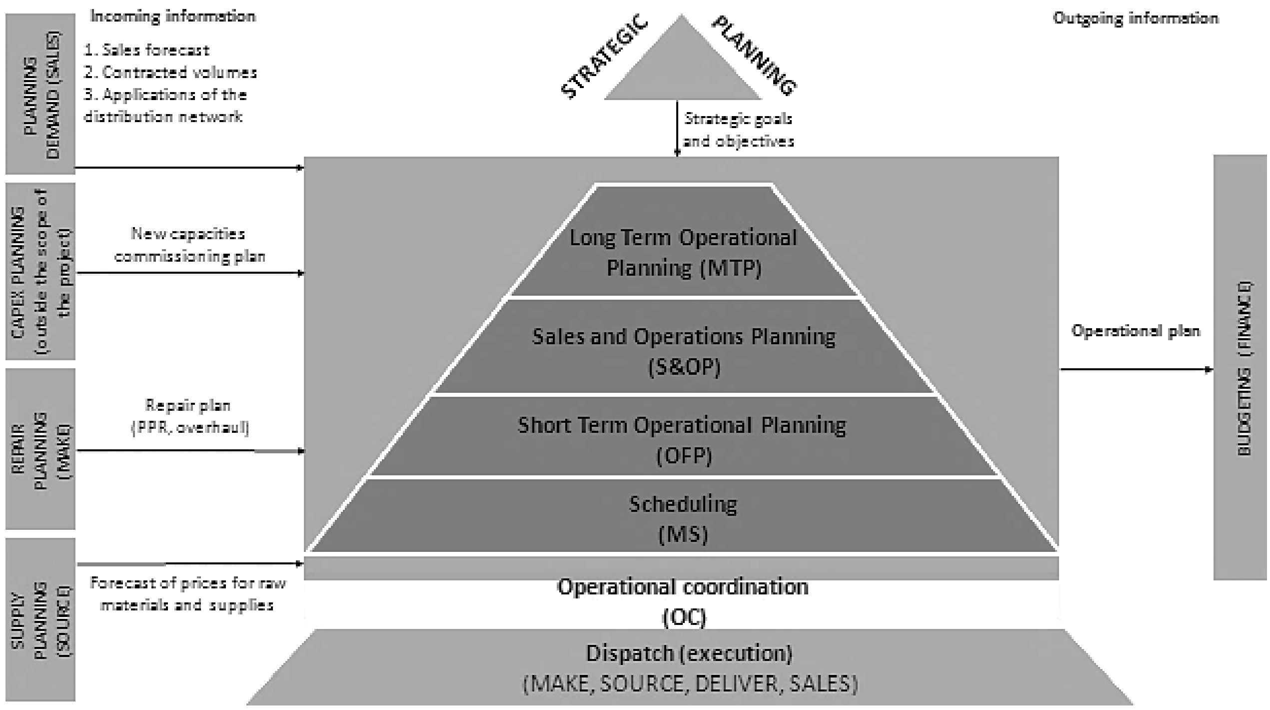


Figure 7.3. Business Model of Operational Planning

As part of long-term planning, the company formulates its own mission, vision and strategic goals. The overall mission sets medium-term goals for two years. The next level is the level of tasks, which can be divided into two parts: external and internal.

External tasks are aimed at the buyer: increasing customer service, developing distributor logistics, developing service providers, etc. Internal tasks are aimed at ensuring competitive advantages in steel production, achieving the level of best business practices. Figure 7.4 shows the elements of the operational planning business model.

Operational planning processes are cross-functional processes and involve tight interaction between the functions of Sales, Production, Purchasing, Logistics and Planning.

Target planning levels	Purpose	Horizon (target)	Horizon (transitional)	Periodicity	Detailing	Implementation status SAP
Long-term operational planning (MTP)	Translation of strategic goals and objectives to the level of operational planning	5 years	3 months	Annually	Food families, 1-2 years with a monthly breakdown, 3-5 years with a quarterly breakdown	Not implemented
Sales and Operations Planning (S&OP)	Monitoring the progress of the medium-term operational plan Supply chain optimization	15 months	3 months	Monthly / Quarterly (rolling plan)	Food families, broken down by month	Implemented
Short-term operational planning (OFP)	Optimization of detailed functional plans Preparation of data for calculating the projected cost price	3 months	1 months	Weekly	Product detailing at the GPM level with a monthly breakdown	Implemented
Scheduling (MS)	Optimizing performance and cost	2 months	1 months	Monthly	Product detailing at the GPM level with daily breakdown	Not implemented
Operational coordination (OC)	Placing an order in production and ensuring a given level of customer service Updating operational plans	2 months	1 months	Monthly	Detailing at the order level, with daily breakdown	implemented in terms of placing orders for production

Figure 7.4. Elements of the Business Model of Operational Planning

The diagram below shows the organization of the data flow in the operational planning processes (Fig. 7.5).

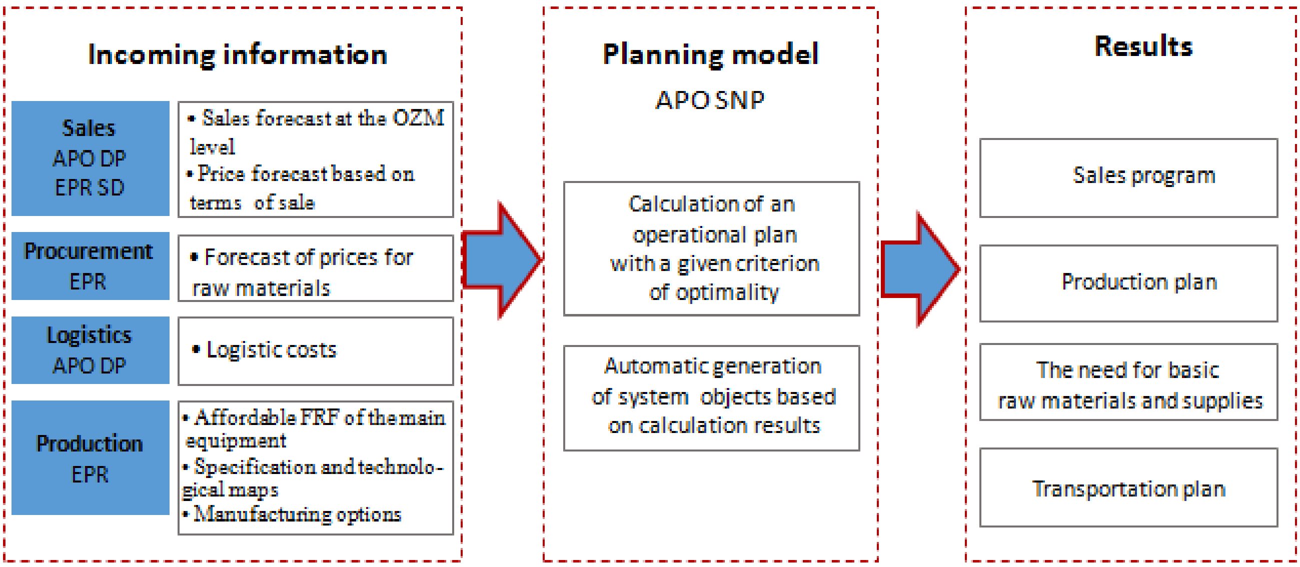


Figure 7.5. Data Flow in Operational Planning Processes

The implementation of operational planning processes for SAP software involves the integration of SAP modules into a single whole, allowing: to generate a sales forecast, update the logistics component, generate a forecast for raw materials prices, manage the maintenance of basic production data

These modules are: materials, sales forecast at the product group level, price forecast based on sales conditions, sales plan, production plan, transportation plan, demand for basic raw materials (Fig. 7.6).

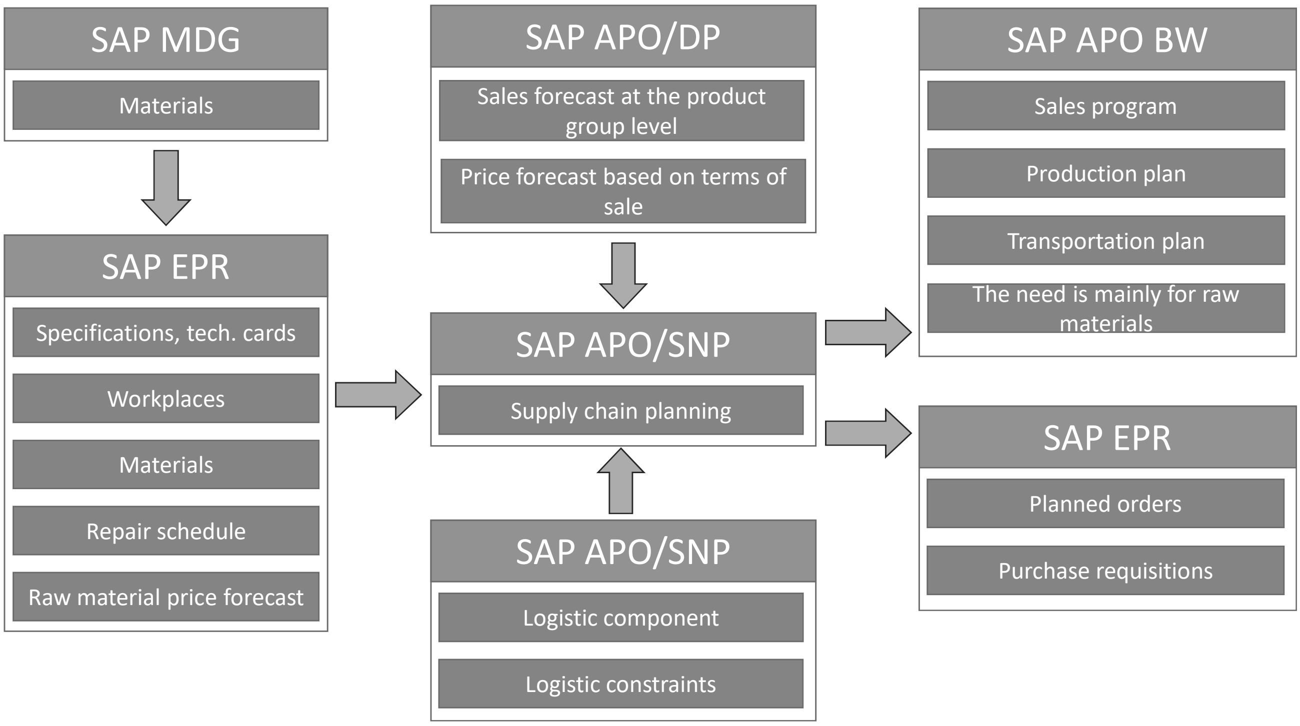


Figure 7.6. Technical Architecture of the Operational Planning Solution

The company is developing a supply management system: it provides production with raw materials, materials and equipment, and also supplies metal products to consumers.

For example, the company in question has its own freight forwarding company and shipping lines in its structure for the purpose of prompt supply of raw materials and products around the world.

To increase the efficiency of supply chains, top-level strategic solutions, strategic logistics solutions, tactical logistics solutions are being developed.

The key link in the architecture of the implementation of planning processes in SAP is the supply chain planning model. The supply chain planning model is a graph whose vertices are suppliers, manufacturers, transfer points, and demand locations. The edges of the graph are transport relations that characterize the routes of traffic flows. Planning the throughput of the graph vertices corresponding to manufacturing enterprises is carried out using production planning models (Fig. 7.7).

The structure of the company's supply chain planning model is quite complex, due to the wide geography of product supplies, as well as the complex structure of intragroup cooperation between enterprises. The company's supply network includes 14 enterprises, 394 consumers, 1116 transport links (routes).

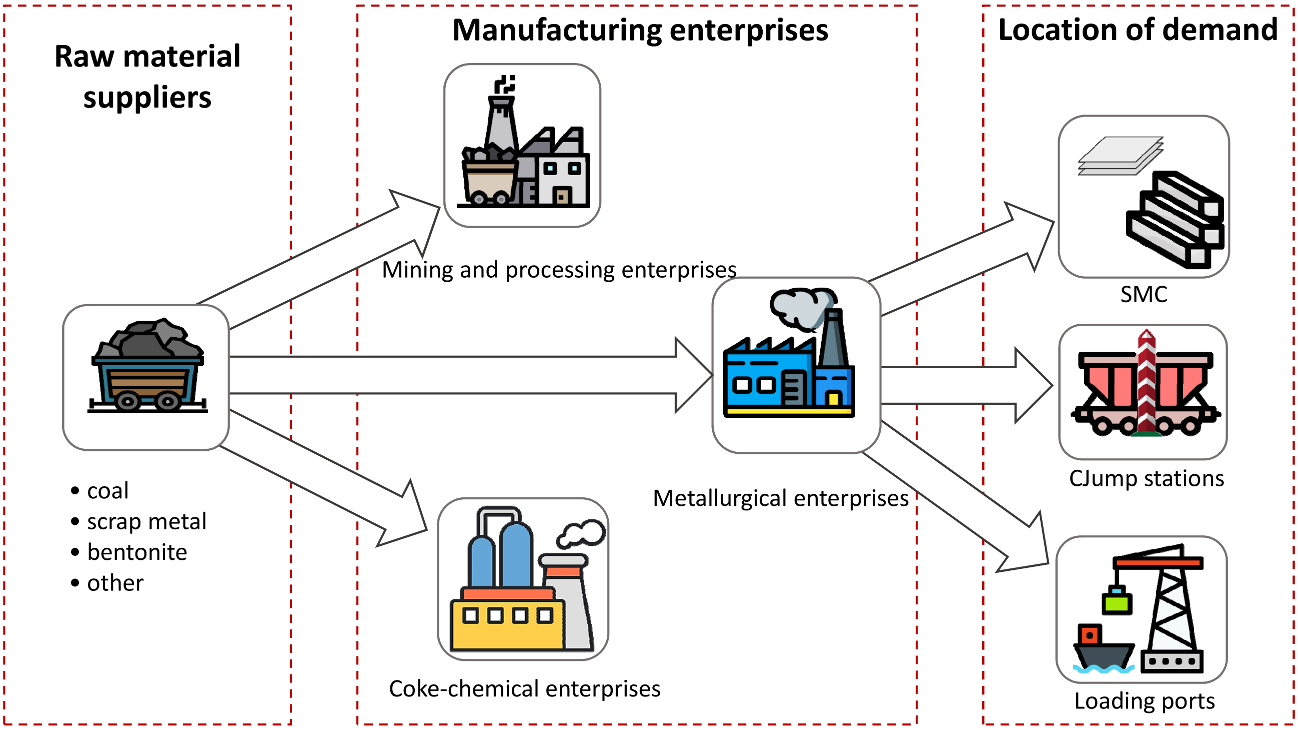


Figure 7.7. Structure of the Supply Chain Planning Model

The main elements of production planning models (Figure 7.8) are:

– the main production units of the enterprise (workplaces);

– a list of materials produced for each production unit;

– a set of basic production data (specifications, datasheets) for each material.

Linear programming models and methods for their optimization play a major role in all types of supply chain management problems [10]. The production planning task takes into account the dynamics of demand, production and storage of products.

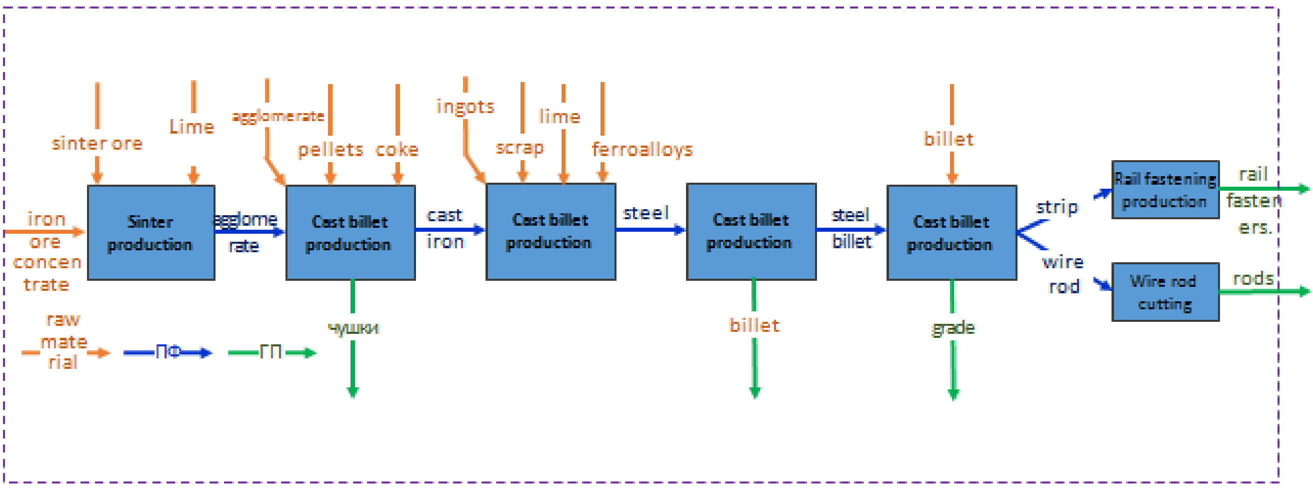


Figure 7.8. Structure of the Supply Chain Planning Model

In order for the supply chain planning process to be as effective as possible, it is necessary to clearly understand what and how to achieve the final result, i.e. there must be some kind of «ideal» model that already exists and is used in the management of other supply chains (a method of using best practice) or designed in a «laboratory» environment, the achievement of the parameters of which must be strived for. It can be difficult, if not impossible, to fully implement the «ideal» model in practice. This is due to the fact that it is impossible to accurately recreate all the conditions in which the already existing «ideal» model of another supply chain operates, and all the more, it is impossible to implement an artificial «ideal» model created in laboratory conditions, since in this case there cannot be all real parameters of the market economy are taken into account.

CONCLUSIONS

Growing globalization, interaction with Western companies, as well as domestic research and publications in the field of logistics and supply chain management make it possible to use world experience in practice. Many foreign companies, expanding the geography of supply chains, include the territory of Ukraine as markets for finished products, as well as with the aim of locating production facilities for their manufacture, into their own supply chain, thus involving Ukrainian partners in world integration.

Thus, at present, Ukrainian companies, along with their Western colleagues, can use or are already using the potential of the concept of logistics and supply chain management, which should contribute to strengthening their competitiveness and economic development.

REFERENCES

1. Dong, Ch., Boute, R., Mckinnon, A., Verelst, M. Investigating synchromodality from a supply chain perspective [Electronic resource] / Ch. Dong, R. Boute, A. Mckinnon, M. Verelst // Transportation Research Part D: Transport and Environment. — 2017. — Mode of access: 61. 10.1016/j.trd.2017.05.011.
2. Harrison, T. P., Lee, H.L., Neale, J. J. Principles for the strategic design of supply chains // The Practice of Supply Chain Management. New York: Springer, 2005. — P. 3–12.
3. Krykavs′kyy, YE. V. Promyslovi lantsyuhy postavok: mizh efektyvnistyu ta vidpovidal′nistyu [Electronic resource] / YE.V. Krykavs′kyy // Aktual′ni problemy ekonomiky. — 2016. — № 5. — P. 30–41. — Mode of access: http://nbuv.gov.ua/UJRN/ape_2016_5_5
4. Tyurina, N. M. Lohistyka : navch. posib. / N. M.Tyurina, I. V. Hoy, I. V. Babiy. — K. : «Tsentr uchbovoyi literatury», 2015. — 392 P.
5. Kochubey, D. V., Hryhorenko, T. M. Osoblyvosti formuvannya lantsyuhiv postavok pidpryyemstva rozdribnoyi torhivli [Electronic resource] / D.V. Kochubey, T.M. Hryhorenko // Biznes Inform. — 2017. — № 10. — P. 264–268. — Mode of access: http://nbuv.gov.ua/UJRN/-binf_2017_10_42.
6. Miaoer, Xu. Distribution Logistics and Logistics Customer Services of B2C E-tailing Industry in the Chinese Market [Electronic resource] / Xu. Miaoer // Thesis 2017. — Mode of access: https://core.ac.uk/download/pdf/93083276.pdf.
7. Council of Logistics Management Conference, Annual Report, 2009.
8. Coyle, J. J., Bardy, E. J., Langlay, C. J. Logictics in the Firm:The Micro, or intrafirm, Enviroment. The Management of Business Logictics, St.Paul 1988, p. 49–67.
9. Mayer, St. Erfolgsfaktoren für Supply Chain Management nach der Jahrtausendwende / St. Mayer // Logistik 2000plus. Visionen — Markte — Ressourcen, H-Ch. — Berlin : Pfohl (Hrsg.), Erich Schmidt Verlag, 2003. 172.
10. Chukhray, N. Formuvannya lantsyuha postavok: pytannya teoriyi ta praktyky: monohrafiya / N. Chukhray, O. Hirna — L′viv : «Intelekt-Zakhid», 2007. — 232 P.

SUBJECT INDEX

Supply chain 1
Production customization 1
Pass-through control 5
Global supply chains 7
Internal logistics 8
Optimized logistics network model 9
Distribution logistics 10
Digital platforms 10
Contract Portals 11
Logistic risks 13
Industry 4.0 Business Models 14
Bimodal supply chains 15
International Standards for Supply Chain Management 15
Forecast of market trends 16
Macro environment risks 19
Risk identification 20
Long-term planning 22
Tactical planning level 22
Medium term planning. 22
Functional strategy 23
Logistics strategy 23
Operational level — current short-term planning
Business Models 24
Data stream 24
SAP modules 25
Linear Programming Models 28
Optimization Techniques 28

CHAPTER 8
HEALTH, SAFETY & ENVIRONMENTAL MANAGEMENT SYSTEMS

Valerii SAMSONKIN
Maral MEREDOVA
Habib HALMAMEDOV
Oksana YURCHENKO

CONTENT

Foreword
List of abbreviations
8.1. Transport system safety and threats on transport
8.1.1. Transport safety measurements
8.2. Safety Regulatory Framework
8.2.1. Emerging challenges and safety performance management
8.2.2. Safety Models. Human Factors
8.3. The interaction of transport and the environment
8.3.1. Sustainable financing
8.4. The concept of an automated system for accounting and analysis of accidents
8.4.1. General methodology for conducting an examination of the state of traffic safety and making management decisions
References

FOREWORD

In recent decades, attention to the issue of safety, in general, has been increasing, and in particular to safety management. The implementation of the results of the scientific and technological revolution (computerization, travelling speed, fundamentally new possibilities of transport) has made significant changes in the life of human society, the risk of traffic accidents with serious consequences has increased significantly resulting in the need to develop and implement additional measures to ensure the safety of traffic of all types of transport. Safety is the main system-forming factor in the activity of transport and the most important social factor. The strategic task of the state is the safe development of the transport system and ensuring its stable functioning. And first of all, the safety of human life has come to the fore in understanding society.

A century ago, the relative underdevelopment of the transport system and the low mobility level had a minor negative impact on the environment. But with the development of the transport system and the awareness of the negative impact of human activity on the environment, as well as to regulate this impact, it became necessary to study the comprehensive relationship between transport and the environment.

LIST OF ABBREVIATIONS

ECI — European critical infrastructure
ALARP — As Low As Reasonably Practicable
TS — traffic safety

RTA — road traffic accident
FS — flight safety
IMO — International Maritime Organization
STI — state technical inspection
EU — European Union
ESCAP — Economic and Social Commission for Asia and the Pacific
SPECA — The United Nations Special Programme for the Economies of Central Asia
SDGs — Sustainable Development Goals
CFE — Connecting Europe Fund
WGT — Working Group on Taxonomy
MSD — Method for identifying hidden regularities
HRGC — Highway-rail grade crossings

8.1. Transport system safety and threats on transport

Transport accidents are a reflection of transport risk. Over the past 15-20 years, there has come an awareness of the stochastic nature of this problem associated with the human factor and requiring the use of the achievements of computer technology.

Sources of threats on transport can be divided into:

1) threats of a sociogenic nature (unlawful interference in the functioning of transport, terrorism, theft, hooliganism, blocking of tracks and vehicles, violation of the rules for operating vehicles, imperfection of these rules and legislative framework, etc.);

2) man-made threats (poor quality of the material and technical part, insufficient qualification of service personnel, etc.);

3) natural threats (floods, landslides, earthquakes, snow and sand drifts on the roads, tsunamis, geo-anomalous zones, typhoons, etc.)

Transport system safety is the ability of the transport system to:

a) work within the specified limits of parameters that ensure the performance of transport work and minimize the level of disruption, which is a potential or realized threat to the life and health of people, the safety of transport, freight and the environment;

b) the ability to change its parameters in the case of a potential threat aimed at preventing at preventing the threat's further development.

The most serious problem around the world is road traffic accidents (RTA) — collisions between cars and trains at highway-rail grade crossings (HRGC). Figure 1 shows the number of fatal and serious injuries from 2006 to 2016 at HRGC in 28 EU countries. The data show that the number of accidents fell by about 34% and the death rate by 37%. Despite the downward trend in the number of accidents with HRGC in the EU, the actual numbers, as well as the economic consequences, are still quite high. The UNECE has identified four main safety issues [1]: (1) the presence of many passive and poorly protected active HRGCs, where it is too expensive to propose any technical solution; (2) lack of evidence regarding the problem, causes and associated costs of HRGC due to lack of proper collision investigation and availability of statistics; (3) lack of effective risk assessment and management due to lack of know-how, capacity and related methods; and (4) poor safety environment due to lack of understanding of the root causes of collisions, responsibility of road users and inadequate investigation of collisions.

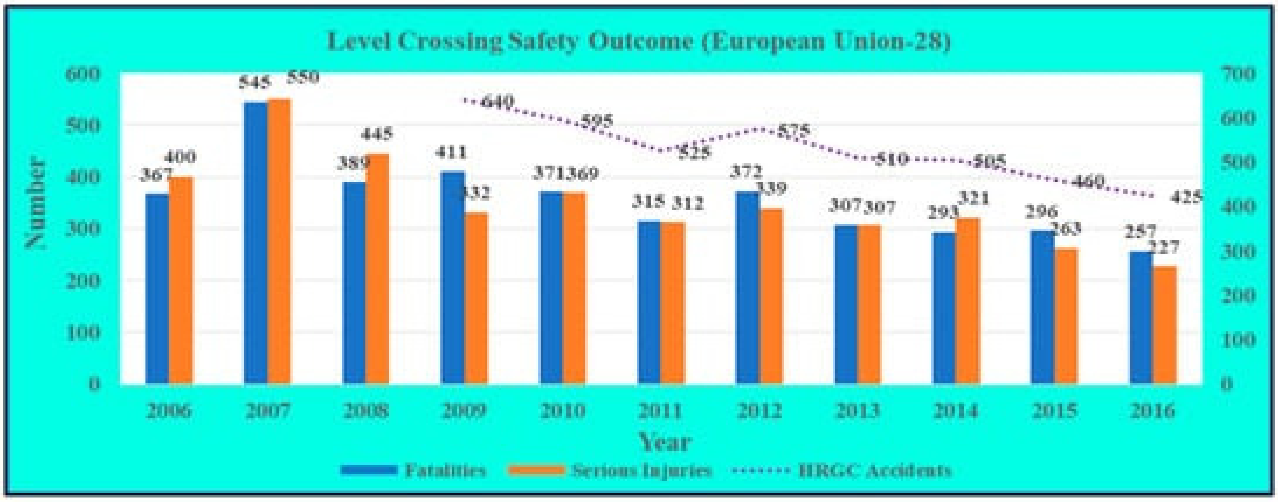


Figure 8.1. Number of fatal and serious injuries at level crossings in 28 EU countries from 2006 to 2016 [Source: UNECE. Statistical Data on Level Crossings and on Their Safety in EU Countries. 2018. Available online: https://unece.org/DAM/trans/doc/2018/wp6/4d_EUAR_LC_safety_stats_June_2018.pdf (accessed on 10 May 2021)]

Following the Guide «Road Transport Safety Management Systems» [2], we give the meaning of the main terms used in the theory of risk on transport:

- *Hazard* — a condition that could lead to an accident;
- *Hazard identification* — the process of finding, listing and characterising hazards;
- *Hazard record* — the document in which identified hazards, their related measures, their origin and reference to the organisation, which has to manage them are recorded and referenced;
- *Risk* — the frequency of occurrence of accidents and incidents resulting in harm (caused by a hazard) and the degree of severity of that harm;
- *Risk analysis* — systematic use of all available information to identify hazards and to estimate the risk;
- *Risk assessment* — the overall process comprising a risk analysis and a risk evaluation;
- *Risk management* — the systematic application of management policies, procedures and practices to the tasks of analysing, evaluating and controlling risks;
- *Risk evaluation* — a procedure based on the risk analysis to determine whether an acceptable level of risk has been achieved;
- *Road haulier* — an economic entity that has a license to conduct economic activity on services rendering of transportation of passengers and (or) cargoes by road;

– *Safety* — freedom from unacceptable risk of harm; достижение системой конечной цели функционирования с минимальным отклонением от норм исполнения, за минимальное время и минимальными материальными затратами;

– *Safety management system* — a structured and documented system of interconnected and interacting elements of a road haulier, an economic entity maintaining vehicles in terms of traffic safety management in order to establish policy, objectives and respective processes of these objectives' attainment;

– *Safety measures* — a set of actions either reducing the frequency of occurrence of a hazard or mitigating its consequences in order to achieve and/or maintain an acceptable level of risk;

– *Safety requirements* — the safety characteristics (qualitative or quantitative) of a system and its operation (including operational rules) and maintenance necessary in order to meet legal or company safety targets.

– *Safety rules* — all rules containing road transport safety requirements established by applicable legal acts, as well as regulatory and technical documentation, the fulfillment of which ensures safety of road transport.

8.1.1. Transport safety measurements

The main task of the safety service is to identify and assess operational errors that create the possibility of accidents.

A fundamental point in creating an effective system of transport safety is an unambiguous interpretation of the term «transport safety». In the countries of the European Union, the term «transport safety» was introduced by EU Directive 2008/114 of December 8, 2008 [3, pp. 74-82]. Each state, depending on various factors, independently determines the number of ECI facilities and makes a preliminary assessment of their «criticality». A four-step algorithm of actions of the states on ECI detection, and also a set of obligatory data for the description of these objects was established.

The safety level is used for numerical safety assessment. This value is determined differently in different countries.

The ALARP (As Low As Reasonably Practical) method has become widespread in many Western European countries. The level of risk is determined in the form of a relationship

$$\rho = \frac{k}{V} ,$$

where k — is the number of human casualties;

v — general indicator of the volume of traffic (more often — passenger traffic).

The essence of the ALARP method is to define areas of transport risk:

$\rho < \rho_1$ — corresponds to an insignificant level of risk and is explained by the objective nature of transport risk;

$\rho \to 0$ — is the desired level of risk, but the situation $\rho = 0$ is almost unattainable;

$\rho_1 \le \rho \le \rho_2$ — is an area of reasonable risk;

$\rho > \rho_2$ — is inadmissible for a society and additional expenses for transfer of system in area of reasonable risk are necessary.

In different countries, this concept varies in the values of ρ_1 and ρ_2 (table 8.1)

Table 8.1. Examples of margin evaluation of risk

State	Margin evaluation of risk	
	ρ_1	ρ_2
Switzerland	Incident with a frequency 10^{-9} with the number of victims — 1000 per hour	Incident with a frequency 10^{-3} with the number of victims — 10 per hour
The Netherlands	-	<u>for passengers</u> — 0.15 fatalities / on 1,000,000,000 passengers per year; <u>for staff</u> — 0.25 / per 10,000 employees per year
England	1 victim per 100,000 insured workers and passengers per year	1 victim per 10,000 insured workers and passengers per year

Accidents on various modes of transport are classified as follows:

(a) Automotive:

✓ material damage;

✓ minor injuries;

✓ moderate and severe injuries;

✓ death of the victim;

✓ especially severe consequences (4 or more people died or 15 or more people were injured).

(b) Aviation:

✓ catastrophe

✓ accident

✓ serious incident

✓ incident

(c) Railway:

✓ catastrophe;

✓ accident;

✓ incident.

(d) Marine:

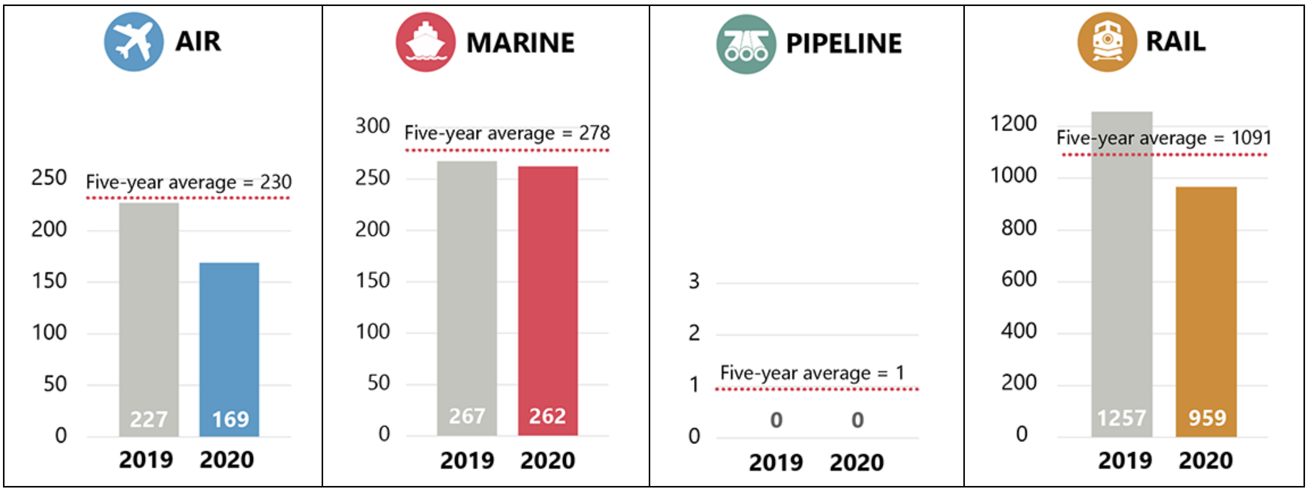
✓ catastrophe;

✓ serious accident;

✓ incident at sea.

In 2019, the Italian region of Lombardia had the highest number of passenger cars (6.2 million) across the regions of the EU. Among EU regions, Province Luxembourg in Belgium had the highest incidence of fatalities in road accidents in 2019, at 171 deaths per million inhabitants. Building on the prelimanary statistics published in February 2021, the Transportation Safety Board of Canada (TSB) today released its 2020 annual statistical summaries on transportation occurrences in the air, marine, pipeline, and rail sectors. The table 8.2. shows the number of reported accidents.

Table 8.2. Transportation accidents reported to TSB (2020)



[Source: https://www.canada.ca/en/transportation-safety-board/news/2021/06/-transportation-safety-board-of-canada-releases-2020-transportation-occurrences-statistics.html]

8.2. Safety regulatory framework

Traffic safety management, as a kind of technological process, cannot take place without an appropriate legal framework. The content and structure of the legislation in the field of traffic safety are aimed at ensuring and controlling the traffic safety of trains. Under the management of transport safety is understood a) the organization of traffic safety, b) regulatory support, c) regulation of functions and tasks of the organization, coordination, prevention and investigation of violations of traffic safety.

The UN Conference (1978) adopted the Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW-78) [4], which was subsequently revised in 1995 (STCW-78/95). Through this Convention, the International Maritime Community seeks to establish a uniform standard for the training of marine professionals and to restore confidence in the authenticity of diplomas and certificates regardless of the countries that issued them.

The obligation of States to investigate marine casualties is enshrined in international legal instruments such as the International Convention for the Prevention of Pollution from Ships, 1973 (MAR-POL 73/78), the International Convention for the Safety of Life at Sea, 1974 (SOLAS 74/78), the International Convention on the Trademark 1966 UN Convention on the Law of the Sea 1982.

In 1992, representatives of 30 countries with 3/4 of the world's fleet established the International Forum for the Investigation of Marine Casualties, the main purpose of which was to unify the investigation and identify all the causes of maritime adventures. Representatives of the Forum created a draft Code for the Investigation of Marine Accidents and Events [5].

8.2.1. Emerging challenges and safety performance management

In the 80s. of the XX century Dan Petersen's safety philosophy [7], related to the study and prevention of casualties and accidents and adopted in civil aviation, gained popularity. D. Peterson's concept includes ten principles:

1. Dangerous act, condition, and accident — symptoms of something wrong in the company's management system.
2. Forecasting the severity of safety breaches and paying attention to them does not allow to reduce their number due to the frequency of inspections.
3. Safety needs to be managed, efforts must be made to ensure it, and achievable goals must be planned, set, and organized.
4. Control and reporting procedures are the key to effective safety.
5. The safety function is to pinpoint and identify technological errors that lead to accidents.
6. The causes of the dangerous course of technological processes can be identified and classified.
7. In most cases, dangerous human behavior is normal behavior as a result of a reaction to the environment. The task of management is to change the environment leading to dangerous behavior.
8. When building an effective safety system, it is necessary to consider three main subsystems: physical, managerial, and behavioral.
9. The safety system must be in line with the culture of the organization.
10. There is no single right way to achieve safety in an organization. For this system to be effective, it must meet certain criteria.

There is no absolute safety in transport systems. We can only talk about relative safety or the level of safety. The vast majority (87%) of accidents on railways are the two most dangerous types: collisions and train collisions — 61%, plus accidents at railway crossings (accidents) — 26%. To reduce them to the traditional measures ensuring the safety of trains additional ones were used: new types of rolling stock designs and infrastructure structures, expanding of the program of testing and entry control, ensuring of the life and health of passengers [8]. Separate measures were required to ensure adequate behavior of representatives of key professions: locomotive driver, station attendant, train dispatcher, etc.

Safety management strategies for flights, train, and ship traffic include:

– Traditional Retroactive (Reactive) strategy — prevention of aviation events, which is based on strict compliance with regulatory requirements and the implementation of preventive measures developed as a result of the investigation.

– Modern — proactive (Proactive) strategy — prevention by identifying hazardous factors and taking measures to reduce the level of risk.

– Highly effective — predictive (Predictive) strategy — fixing the performance of the system in a normal state in real-time and identifying potential problems in the future.

The increased attention to the issues of accidents and the investigation of accidents at sea is explained by the need to identify the causes of death of people, ships, and cargo at sea and to develop measures to prevent or reduce the number of accidents. According to IMO data, approximately 80% of all accidents at sea are caused by human factors: errors of navigators, pilots, operators, dispatchers, and other persons; The London Mutual Insurance Club for Maritime Ships cites a figure of 70% [9]. The safety of navigation and the protection of human life at sea depends to a greater extent on the training and qualifications of the ship's crew than on the specific characteristics of the ship itself, the cargo, and the state of the marine environment. IMO attaches great importance to the education and training of shipboard personnel.

The reasons for sea adventures include: *navigation* (landing on the ground, collision, bulk, loss of stability / buoyancy, storm, ice), *technical* (damage to the main engine, damage to the propeller-rudder complex, damage to auxiliary mechanisms, damage to the hull, damage to ship devices), *explosions* and *fires* [10,11, 12].

There are different approaches to assessing the state of transport safety in different countries and companies. In addition, these assessments are constantly updated. For example, the following sequence of formation of safety assessments is implemented in the EU railway transport: collection of statistical data on safety (CSI data in 2014/88 / EU); changes to the collection of statistics foreseen by the fourth EU rail package; railroad indicators ERA.

This is how the CSI structure looks like [13]:

1. Indicators of accidents

– Significant accidents: train collisions, train derailments, accidents at level crossings, rolling stock collisions with people, fires in rolling stock, others.

– The total number of seriously injured and fatalities in road accidents by category: passengers, personnel, users of level crossings, bystanders, others.

2. Indicators of dangerous goods transportation: total and relative (in relation to train-kilometers) number of accidents during transportation of dangerous goods.

3. Suicide rates.

4. Indicators of the identified prerequisites for accidents: total and relative (to train-kilometers) number of damaged rails, fastenings, signaling systems, hazard indicators, wheels and axles on rolling stock in operation.

5. Indicators for calculating the economic impact of accidents (in euros): the number of deaths and serious injuries multiplied by the prevention factor (VPC); the cost of damage to the environment; cost of material damage to rolling stock or infrastructure; the cost of traffic delays as a consequence of accidents.

6. Indicators of technical safety of infrastructure: percentage of tracks with worn-out automatic protection (ATP), percentage of trains using existing ATP systems, number of ground crossings (total, per kilometer of the track).

7. Indicators related to safety management: internal audits ...

8. Definition: general definitions of CSI and methods for calculating economic impact.

Method of hidden regularities by Samsonkin V.M. and Druz V.A. (MSD) is designed for process safety management [14]. This theory is based on a statistical management approach and represents an efficient approach to managing complex systems in real-time. The input information for MSD is statistics of traffic safety violations: traffic events, failures, errors, train delays, etc. The way out is to support decision-making in the field of safety. In fig. 8.2 the scheme of operations of the Method is presented.

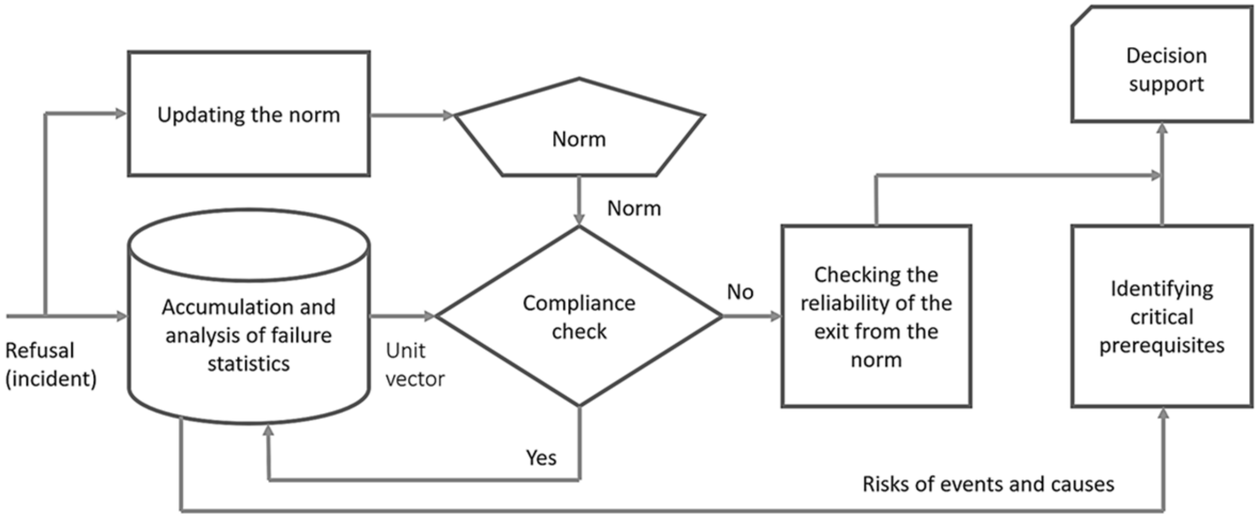


Figure 8.2. Sequence of steps in MSD

The theoretical basis of MSD belongs to the theory of self-organization.

8.2.2. Safety models. Human factors

The desire to find some kind of regularity in the causes that lead to accidents and catastrophes gave rise to several models of causation [15]. The most famous models are Heinrich's pyramid (1931) and «Swiss cheese» by James Reason (1990).

According to Heinrich's accident rate model (Figure 8.2), a catastrophe is preceded by a number of events, first of all, these are incidents that have not been given importance (up to 300), significant breakdowns and personnel failures (29), and, finally, the top of the pyramid is «crowned» by a major accident or catastrophe. There are modifications of the Heinrich pyramid, where the number series starts from 3000 and even from 30,000 and reaches 1 (Fig. 8.3).

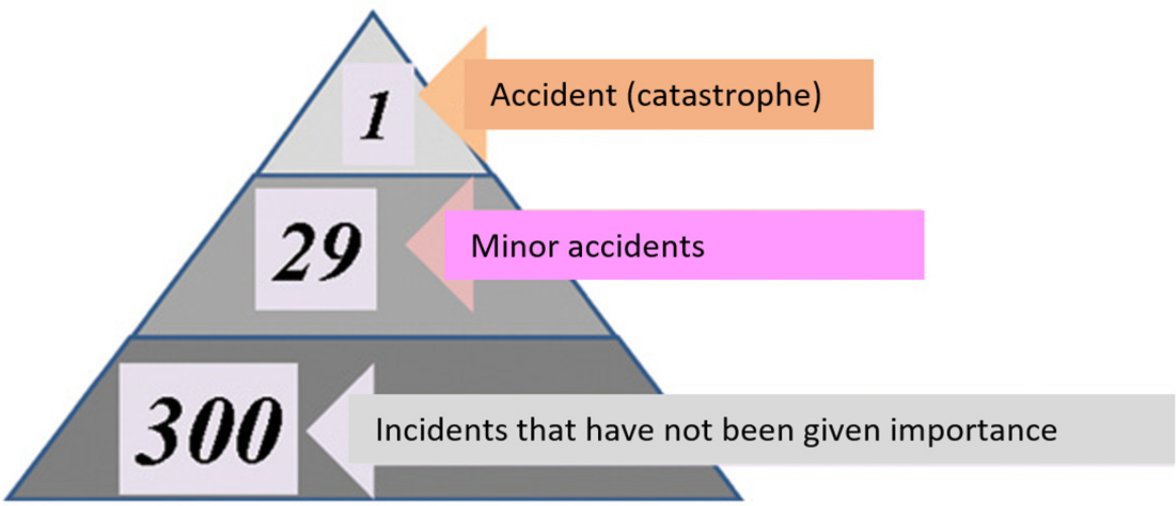


Figure 8.3. Heinrich's pyramid

There is a vulnerability in this model — how to explain disasters like the «Titanic», when a modern at that time ship dies on the very first voyage? Similar situations are encountered in aviation and astronautics.

James Reason came up with an ingenious metaphor for a series of mistakes that lead to a catastrophe: «Every hole in a piece is a separate mistake. Such «holes» in any system are a lot at each of the levels, they are located in different places and have different degrees of potential destructiveness. However, the next slice level, in which there is no problem in the same place, protects the entire system from epic fail» (if fail is a common failure, bad luck, then epic fail is something much more tragic and large-scale, in this situation it is a catastrophe).

This metaphor is well known to risk management professionals and has found applications in aviation, healthcare, and engineering (Figure 8.4).

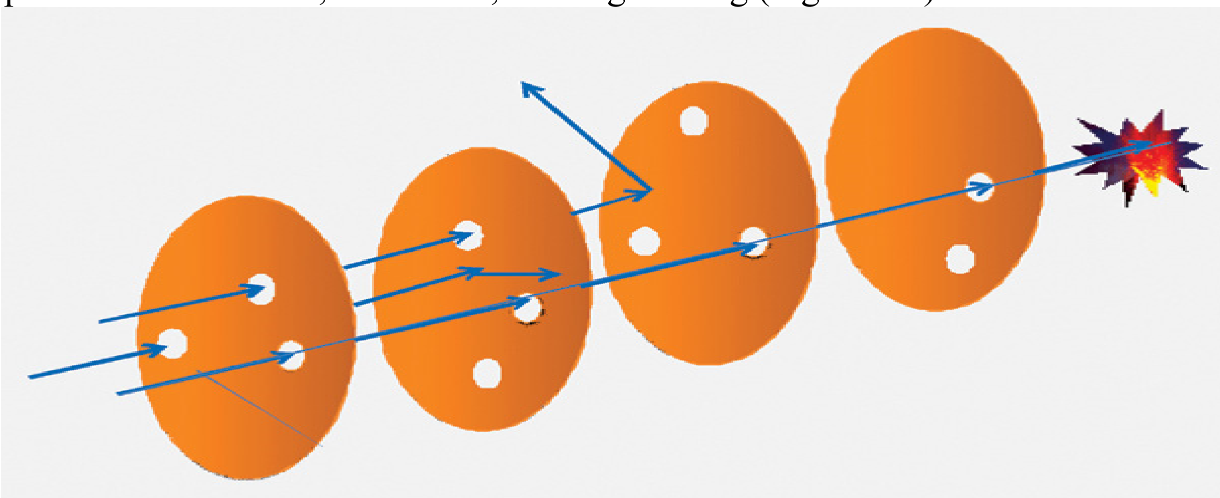


Figure 8.4. Model «Swiss cheese»

Accident rate matrix. When investigating accidents, experts are guided by the linear dynamics of the vessel and are ready to trace the entire dynamics of an event, while events develop in most cases nonlinearly. The sailors noticed this long ago: «when there is a fire in the sea, they give a lot of wise advice on the shore.» An accident rate model based on a system of differential equations describing the behavior of the «ship — person — external influences» system is proposed.

Moving towards each other, two people collide, although there seemed to be no reason for this, because they were perfectly oriented in space and predicted the development of the situation. When a «jump» occurs, there is a transition from a linear (predictable) situation to a nonlinear (unpredictable) one. The result is an «accident».

In retrospect, the Statistical theory of train traffic safety by V.M. Lisenkov should be noted [16]. From the set of technological processes of railway transport, the author singles out a class of responsible for critical technological processes (CTP), in which the parameter values go beyond the permissible limits leads to material losses, the creation of a threat to the health and life of people, and irreparable harm to the environment. CTP is characterized by three states: (a) normal — the process develops in accordance with its algorithm; (b) safe emergency — failure leads to a decrease in the efficiency of the technological process; (c) dangerous emergency, which certainly leads to an accident. The reasons for the occurrence of dangerous situations are failures of technical equipment, dangerous errors in the design and operation of systems, actions of the operator, driver, service personnel.

The human factor is understood as an integral characteristic of a person (or a team) as a subject of professional and labor activity, which includes parameters of professionally important qualities (PIQ), mental states of an employee (adaptation, fatigue, interference of skills, end impulse, frustration, tension, etc.)), driving forces of behavior (motives, interests, relationships) and other social-role functions (formal and informal), provided for by the staff position and due to the personal qualities of the subject of activity or the characteristics of a particular situation. Management decision-making is influenced by the amount of information provided, which is often redundant. And due to a person's limited ability to process a large amount of information (from five to nine sources), taking into account the time constraints when selecting the most important ones due to the dynamics of replacing information with one another and understanding it, a person falls into a tight time frame.

The influence of the human factor on safety in production systems and processes is dealt with by ergonomics. One of the approaches to in-shift monitoring of the condition of a locomotive driver in real-time is based on MSD and is presented in [17].

Numerous applications of the problem of control of the human factor in road transport are presented in [18].

8.3. The interaction of transport and the environment

Transport activities support the growing demands on the mobility of passengers and freight, while at the same time transport activities are associated with environmental impacts. In addition, environmental conditions affect transport systems in terms of operating conditions and infrastructure requirements such as construction and maintenance.

The growth of passenger and freight mobility has expanded the role of transport as a source of pollutant emissions and their repeated impact on the environment. These effects fall into three categories:

− *direct impacts*. Immediate consequences of transport activities on the environment (emissions of noise and carbon monoxide).

− *indirect impacts*. They often have higher impacts than direct impacts and are more difficult to identify. For example, particulate matter, which is mainly the result of incomplete combustion in an internal combustion engine, is indirectly associated with breathing and cardiovascular problems.

− *cumulative impacts*. Climate change with complex causes and consequences is the cumulative impact of several natural and anthropogenic factors, in which transport plays a certain role.

Comparative characteristics of the harmful effects of transport on the environment according to one of the burning parameters — greenhouse gases — is shown in Fig. 8.5.

The transport sector is often subsidized, especially through the construction and maintenance of road infrastructure. If the owner and the regulator are from different branches of government, then there is a risk that the regulations will not be effectively enforced. Failure to take into account the real costs of transport can explain a number of environmental problems. If environmental costs are not included in this estimate, vehicle use is accordingly subsidized by the community and costs accumulate as pollution. This requires due attention, since the number of vehicles, especially automobiles, is steadily increasing [20].

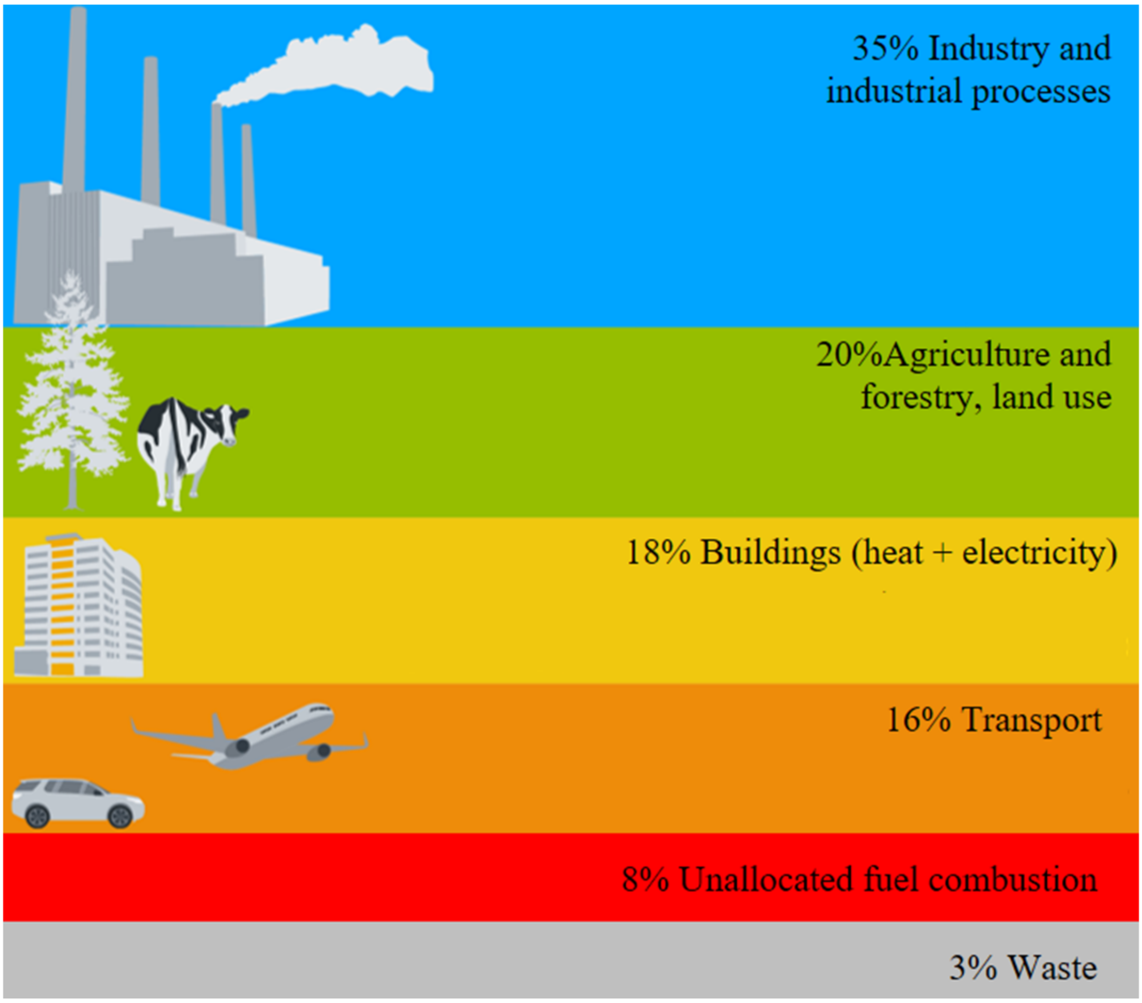


Figure 8.5. Greenhouse gas emissions by sectors

The interaction between transport and the environment is also complicated by two observations:

Impact level. Transport activity contributes to environmental problems, along with other anthropogenic and natural causes, directly, indirectly and cumulatively. In some cases, they may be the dominant factor, in others — insignificant.

The scale of the impact. Transport activity contributes to the emergence of environmental problems at various geographic scales (Figure 8.6), ranging from local (noise and CO emissions) to global (climate change), not excluding the problems of continental / national / regional (smog and acid rain).

In addition to these environmental impacts, the economic and industrial processes that support the transport system should be considered.

The costs of external environmental factors can be viewed from economic, social and environmental points of view. The main types of transport externalities associated with the environment relate to air pollution, water pollution, noise and hazardous materials. The definition of a quantitative assessment of the impact is currently not defined.

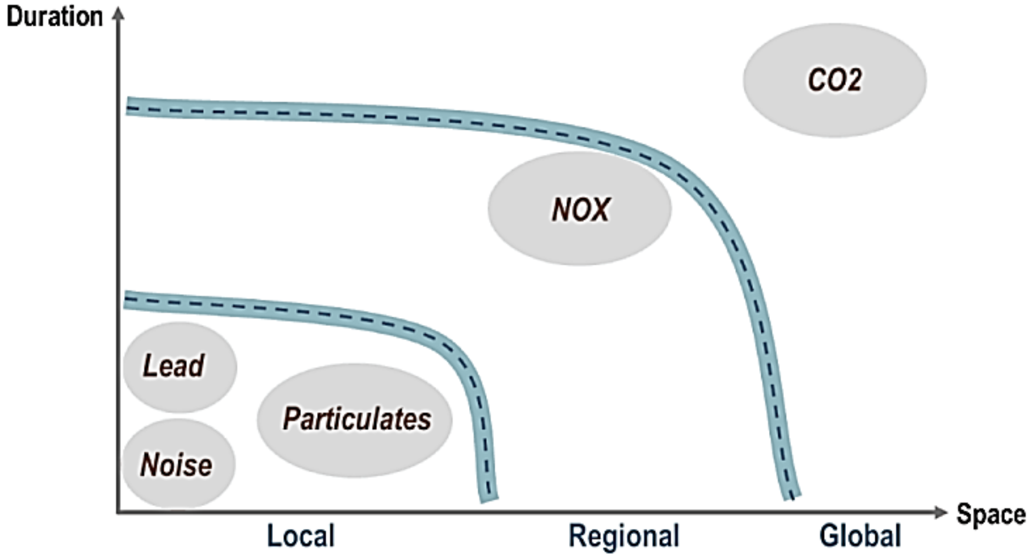


Figure 8.6. Spatial and temporal environmental effects of transport activities
[Source: George Mason University Center for Transport Policy, Operations and Logistics]

Sources of pollution (emissions) are rarely responsible for this. This has several implications. When it comes to road transport, users only take into account the direct costs of ownership (vehicle, fuel, insurance, etc.). Society typically takes on the role of providing and maintaining infrastructure and other indirect costs such as damage to structures and infrastructure, loss of productivity, cleanup, health care, and damage to ecosystems. The geographic distance between sources and victims is often a sharp controversy. Acid rain and climate change are prime examples. At the local level, noise levels can have a much greater impact on society.

There is a trend towards a shift from direct to indirect environmental impacts. For example, the absolute level of emissions of pollutants into the atmosphere has dropped significantly in developed countries. The problem of reducing sources of pollution from transport was solved as it was a direct cause of emissions. An attempt to reduce the economic costs of ecology will lead to a decrease or to a deterioration in the social and ecological channels of human life. Today, society is less willing to bear costs and endure the effects of external factors for various reasons: awareness, quality of life, high health care costs, etc.

Air pollution is the most important source of environmental factors of transport due to the rapid and all-round spread of pollutants. While the nature of air pollutants is well defined, the magnitude of their impact on the biosphere is a matter of controversy. On the positive side, emissions of the most harmful air pollutants such as carbon monoxide and volatile organic compounds (VOCs) have declined despite significant increases in the number of vehicles, indicating an increase in vehicle environmental compliance. Carbon dioxide emissions have increased in proportion to the increase in transport use.

There are two main groups of factors that contribute to air pollution in urban areas:

structural factors — the level of the economy. Income and education are generally proportional to emissions;

behavioral factors — individual consumption and transport preferences. The car is systematically preferred even when other modes of transport are available.

In general terms, the costs of air pollution associated with transport can be grouped into economic, social and environmental costs.

External factors associated with water pollution are almost all indirect.

Noise emissions can be thought of as point (vehicle), linear (highway), and surface (multi-street) sources. The source is vibration. Noise can create unreasonable risks to human health, safety and property. The best vehicles can have positive economic, social and environmental impacts.

Earlier in Israel, there were often major accidents at level crossings. A decision was made: to make all intersections of road and railways multi-level. In 3-4 years, 20 new interchanges were built and the problem was resolved. All traffic infrastructure facilities meet strict standards — traffic is organized according to scientific calculations, and pedestrian crossings are specially equipped for increased safety.

There are proven mechanisms by which you can reach statistics of the EU countries in road traffic — no more than 3 fatal road traffic victims per 100,000 of population:

1 — the availability of the political will of the government,

2 — the course for the reform of the road traffic system should be stably held for a long time, subject to its funding;

3 — a necessary interdepartmental coordinating body that will be responsible for road safety and introduce new mechanisms.

8.3.1. Sustainable financing

In May 2018, the Commission of the Foundation for the Connection of Europe (CFE) presented a package of measures to create a unified European classification system for sustainable economic activities («taxonomy»). The ultimate goal is to develop a system that provides clarity on what activities are considered environmentally sustainable. A Taxonomy Working Group (WGT) was established to recommend technical criteria for assessing the economic sustainability of activities that may be included in this taxonomy.

In the first phase, WGT for Transport worked on the segments of the transport sector that have the highest share of total CO_2 emissions — land transport. An open consultation was held to receive comments on activities that contribute significantly to climate change mitigation.

In June 2018, the European Commission presented an EU action plan to improve the safety of passengers and railway personnel in the EU by creating new agreements for cooperation and coordination. The goal is to increase the effectiveness of measures to prevent and respond to possible terrorist attacks by creating an effective environment for cooperation.

Transport authorities and transport operators in the EU have long been tackling safety risks, but the new environment is forcing them to develop adequate responses. However, measures taken unilaterally by individual Member States can create barriers, be ineffective and lead to cost losses. In this regard, the Action Plan foresees the creation of an EU Platform for Rail Safety. EU road safety statistics show a reduction in fatalities of about 2%.

The mobility package aims to implement a new industrial policy strategy adopted in September 2017 and completes a process that was launched under the 2016 Low Emission Mobility Strategy and previous European mobility packages. For example, the Connecting Europe Fund (CFE) has supported over 690 transport projects with EU funding of € 23 billion, which equates to a combined EU transport infrastructure investment of € 48.3 billion. All of these initiatives form a coherent set of strategies that cover multiple interrelated aspects of the transport system [23].

As part of the Decade of Action for Road Safety, ESCAP is working towards the global goal of stabilizing and reducing predicted road traffic deaths. The overall goal is a 50% reduction in road traffic deaths and serious injuries in Asia and the Pacific. ESCAP is conducting research on the two main causes of road accidents: (a) speeding and (b) driving under the influence of alcohol and drugs, with the aim of developing appropriate recommendations for member countries. In this regard, in April 2019 in New Delhi, and in October 2019 in Baku, Regional Workshops were held. Subsequently, ESCAP organized a similar Workshop for the North and Central Asia subregion. At these meetings, the conceptual framework of statistical geospatial indicators and indices of SPECA countries for monitoring and reporting on progress towards the implementation of the Sustainable Development Goals (SDGs) was discussed.

The proposed framework and indicators helped policymakers and experts from SPECA countries to develop more effective strategies and measures to reduce disaster risks and prevent or mitigate human, economic and environmental losses.

The proposed measures contributed to improving the statistical accuracy of the already established SDG indicators of the Asia-Pacific Plan of Action for Sustainable Development 2018-2030, the development of the ESCAP Regional Roadmap for the SDGs and the UN global system (programs such as the UN Global Statistical Geospatial Framework).

8.4. The concept of an automated system for accounting and analysis of accidents

The main task of accounting and analysis of accidents remains the full and effective use of information obtained during the investigation in order to prevent further accidents on the same or the same type of equipment.

Accident investigation is a step-by-step solution of a sequence of tasks:

1. Collecting factual information about the event and operational actions of the personnel, visual inspection of the place and object of the accident.

2. Study of the technological and technical characteristics of the accident object.

3. Analysis of the history of the facility (similar accidents, maintenance and repairs carried out).

4. A clear definition of the object, additional research as needed (if additional research refutes the hypothesis, a new one is put forward, the reliability of which is tested).

5. Determination of the causes of the accident, accompanied by technical factors, the culprits (development of a confirmed working hypothesis).

6. Development of emergency response measures.

7. Monitoring the implementation of emergency measures.

The use of modern developments in the field of artificial intelligence is promising. Existing solutions have already found application in medicine, geology, etc.

An enlarged diagram of the proposed system is shown in Fig. 8.7.

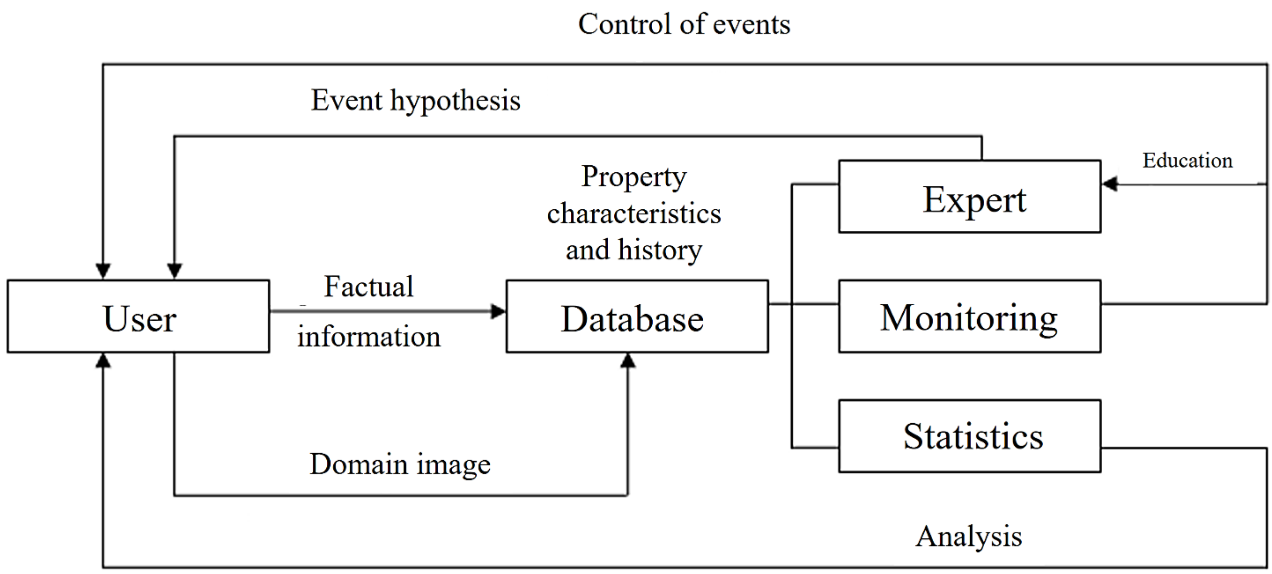


Figure 8.7. Accident accounting and analysis system

8.4.1. General methodology for conducting an examination of the state of traffic safety and making managerial decisions

The method of expert systems / assessments is a method of predicting and evaluating future results of actions based on the forecasts of competent specialists. When applying the method of expert assessments, a survey of a special group of experts (5-7 people) is carried out in order to determine certain variables necessary to assess the issue under study. The main methods of conducting expert assessments: individual, interviewing, analytical method, Delphi method, brainstorming method, conference of ideas.

It is advisable to use this methodology when the following factors complicate making the best decision:

− there is an impossibility of accurately predicting the consequences of the decision;

− absence or incompleteness of statistical information on the basis of which a decision is made;

− the presence of factors that cannot be controlled by the decision-maker;

− the presence of several options for solving the problem and the need to choose one of them;

– the uniqueness and impossibility of experimental verification of the predicted course of events and the results of the processes of solving the problem.

The competence of experts is carried out using one of two methods of assessing the competence of experts: objective and subjective ones. The essence of the individual method lies in the fact that each expert gives his/her own assessment independently of the others, and then these assessments are combined using statistical methods into a common one. To form the final assessment of a group of experts, the average values are most often used — the arithmetic mean or the median, for which such an assessment is taken, in relation to which the number of large assessments is equal to the number of smaller ones.

REFERENCES

1. Highway-rail grade crossing (HRGC) accidents [Electronic resource] / — Mode of access:https://encyclopedia.pub/14194

2. Guide «Road Transport Safety Management Systems» [Electronic resource] / — Mode of access: https://mtu.gov.ua/files/Guide%20on%20Road%20Safety%20Management%20Systems.pdf

3. Council Directive 2008/114 / ЄC of 8 December 2008 on the identification and definition of European critical infrastructures and the assessment of the need to improve their safeguarding and protection [Electronic resource] / — Mode of access:https://zakon.rada.gov.ua/laws/-show/984_002-08#Text

4. International Convention on the Training, Certification and Watchkeeping of Seafarers [Electronic resource] / — Mode of access: https://mirmarine.net/poleznaya-informatsiya/stcw/1199-international-stcw-convention

5. International Code of Conduct for the Investigation of Accidents and Incidents at Sea 1997 [Electronic resource] / — Mode of access: https://seaspirit.ru/morskie-konvencii/morskoe-pravo/mezhdunarodnyj-kodeks-provedeniya-rassledovanij-avarij-i-incidentov-v-more.html

6. International Convention for the Safety of Life at Sea — SOLAS 74 (as amended on 24 May 2018) [Electronic resource] / — Mode of access: https://docs.cntd.ru/document/901765675

7. Petersen D. Techniques of Safety Management: A Systems Approach / D. Petersen / San Diego: Amer Society of Safety Engineers, 2003. ─ 364 pp

8. The European Parliament. Directive 2004/49 / EU (Railway Safety Directive). European Union: Official Journal of the European Union [Electronic resource] / — Mode of access: https://forinsurer.com/news/16/04/05/33679

9. International Life-Saving Appliance Code (LSA Code) (as amended on June 15, 2017). Adopted by Resolution MSC.48 (66) dated 04.06.96 [Electronic resource] / — Mode of access: https://docs.cntd.ru/document/499032094 https://mtu.gov.ua/files/Guide%20on%20Road%20Safety%20Management%20Systems.pdf

10. Chernyshev, V. F., Kanatov, Yu. A., Remnev, A. N., Demidov, B. Initial (basic) training on safety at sea in questions and answers (in 3 parts): Study guide / V. F. Chernyshev, Yu. A. Kanatov, A. N. Remnev, B. Demidov / Novorossiysk: State Medical University named after Admiral F.F. Ushakov, 2007.

11. Official site of the Federal Service for Supervision in the Sphere of Transport «Gostransnadzor» Section «Safety of navigation and shipping» [Electronic resource] / — Mode of access: www.rostransnadzor.gov.ru

12. Clarhaut, J. Raiillway performance: new challenges and safety indicators management / J. Clarhaut / CRENG Project — 21/01/2020. — 85pp.

13. Samsonkin, V. N., Druz, V. A. Method of statistical regularity in railway traffic safety management / V. N. Samsonkin, V. A Druz / Donetsk: DIZhT, 2005. — 158 pp.

14. Safety Models — Human Factors [Electronic resource] / — Mode of access: http://www.morvesti.ru/tems/detail.php?ID=61992

15. Lisenkov, V. M. Statistical theory of train traffic safety / V. M. Lisenkov / M.: VINITI RAN, 1999 — 332 p.

16. Samsonkin, V., Petinov, Ja. Development of the method of efficient monitoring of the main activity of a train driver / V. Samsonkin, Ja. Petinov // Eastern-European Journal of Enterprise Technologies. — 2016. — № 6/3(78). — P. 52-59.

17. Stepanov A. V. Vehicle safety in the transport process / A. V. Stepanov / Kharkiv: Rare Books of Ukraine, 2018. — 727 pp.

18. Tomilin, A. N., Kuzmenko, V. A., Chernyshev, V. F. Marine Life-Saving Appliances: Tutorial / A. N. Tomilin, V. A Kuzmenko, V.F. Chernyshev / Novorossiysk: State Medical University named after Admiral F. F. Ushakov, 2013. — 13 pp.

19. Rodrigue, J. P. The Geography and Transport Systems. 5-th edition / J. P. Rodrigue / New York: Routledge, 2020. — 456 pp.

20. Handling Manual. — Freefall lifeboat Greben FFL-28. — 1992.

21. Transportation's impact on climate change chapter of «Ahead of the Curve: State of Transportation Planning 2013». — American Planning Association, 2013. — 56 pp.

22. UN. Economic and Social Council. Changes in transport in the European Union for 2018 [Electronic resource] / — Mode of access: https://unece.org/DAM/trans/doc/2019/itc/ECE-TRANS-2019-9r.pdf

CHAPTER 9
PROJECT TEAM MANAGEMENT AND PERSONAL EFFECTIVENESS

Andrii DOROSH
Nataliia CHERNOVA
Yolly MYRADOV
Atageldi GARAJAYEV

1. INTRODUCTION

One of the substantive problems of the modern Ukrainian economy is the shortage of professional managers and managerial personnel. Research has shown that professional knowledge in the field of economics, finance or business alone is not enough to successfully manage modern organizations. That is why today we need a new type of leaders who are able to create an atmosphere of cooperation in a team and lead people.

Research has indicated that fundamental theoretical knowledge, skills, or competencies in a particular specialty do not guarantee personal success or success for the very organization. Therefore, according to the study [2] published by *Deloitte* about 70% of respondents is obvious to see the reason for the national economic downturn in the leadership crisis and lack of leadership development. Nowadays, a successful manager of any level must have both professional skills (*hard skills*), and purely personal (*soft skills*). At the same time, studies have found that only 15% of career success is provided by the level of professional skills, while the remaining 85% are «soft» skills.

2. SUBSTANTIVE MATERIAL

2.1. The concept of *hard skills* and *soft skills*

According to the classical definition, skills in general and «soft» skills in particular are skills formed through prolonged repetition. They are quite difficult to identify, clearly demonstrate, check, and evaluate. However, if the skill is devellopped, then the person begins to act automatically, without thinking about what to do and how to do it.

Soft skills — is a complex of non-specialized skills related to personal qualities that allow you to interact harmoniously with other people, increase the efficiency of work in your industry, and also make it possible to change the field of activity, while maintaining your relevance. They are universal in nature and are not related to a specific field of activity. In practice, along with the term *soft skills*, we use a number of terms with identical content: social and personal competencies, «soft» competencies, «soft» knowledge, «soft» skills, «*soft*» knowledge/skills/abilities. A set of personality characteristics included in the concept *soft skills*, is equally necessary for both everyday life and professional activities. However, according to research, it is especially important for success in professional activities [1].

Surveys of leading domestic employers and labor market research indicate that potential applicants should have developed *soft skills* since it is their employers who consider them no less important than thorough professional knowledge and skills (*hard skills*). In addition, it is believed that professional skills and abilities sometimes lose their relevance, and *soft skills* they are always relevant.

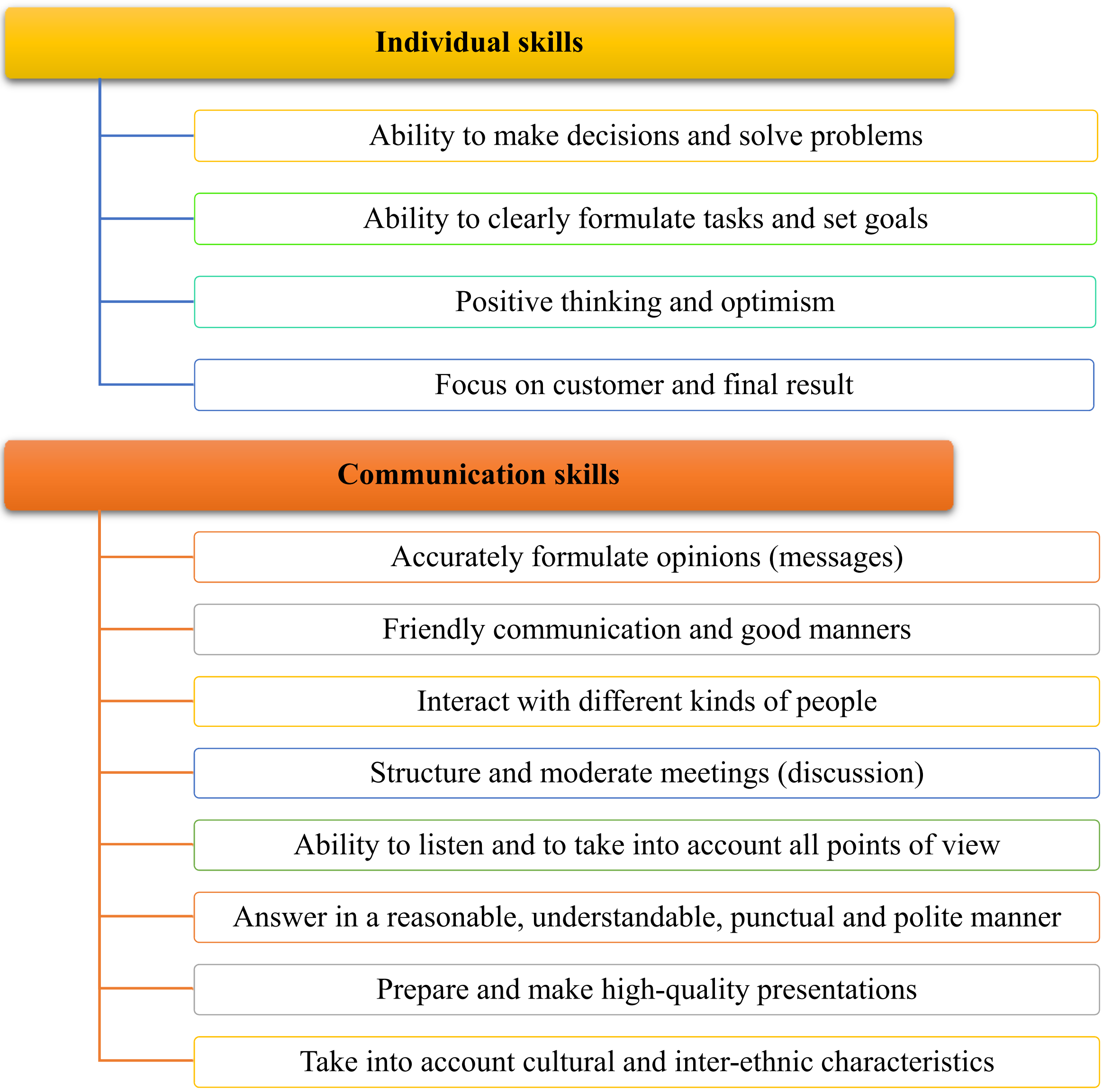
The group of *hard skills* includes professional knowledge, skills and abilities that are necessary when performing the tasks of the enterprise; they are easy to measure and they are quite objective. The group of *soft skills* can attribute a significant number of skills, in particular: critical thinking, the ability to plan, clearly formulate thoughts and tasks, manage time, honesty, initiative, hard work, learning ability, creativity, teamwork skills, persuasion, endurance, the ability to compromise, the ability to resolve conflicts, and so forth. These skills are difficult to measure, and therefore the assessment is subjective.

2.2. Classification of «soft» skills

Usage *soft skills* implies the ability to use different behaviors [3] even in the same situations, quickly set priorities and adapt to new circumstances, be stress-resistant to stress, be able to achieve your goals, etc.

Traditionally there are three main large groups *soft skills* (fig. 1):

1) individual skills;
2) communication skills;
3) management skills.



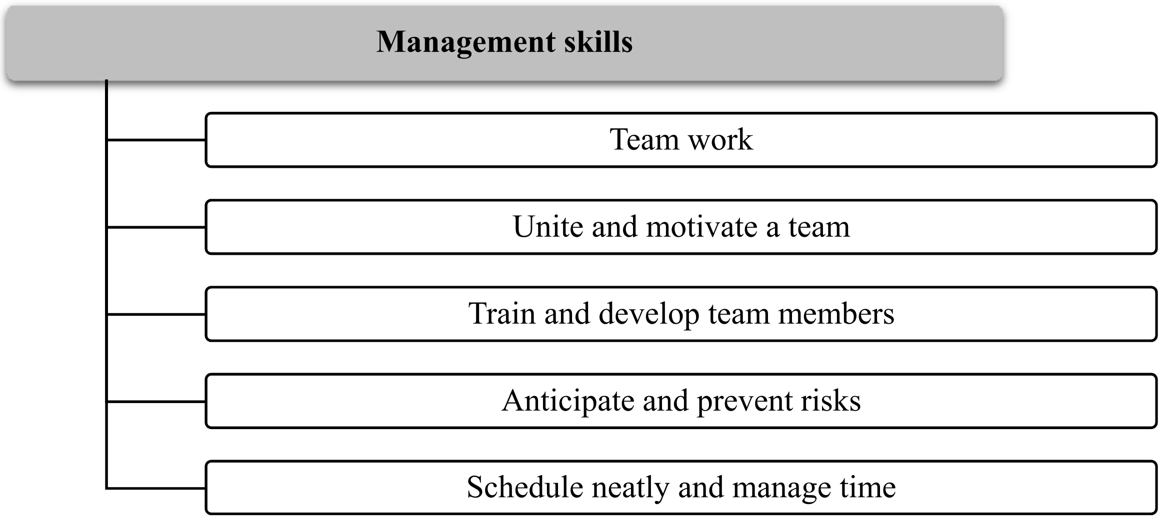


Figure 1. Classification of «soft» skills

Fig. 1 provides the detailed classification of *soft skills* however, this classification cannot be exhaustive and take into account absolutely all «soft» skills.

2.3. Ability to set goals and achieve them

The ability to set goals and achieve them is one of the basic competencies of effective employees at any level of the hierarchy of an enterprise, company, institution or organization. In a workplace, they regularly receive tasks, strive to complete them, therefore complete them achieving the goals of both their personal and the goals of the division or company as a whole.

Practice shows that not all cases based on enthusiasm and confidence are completed successfully. Neither regular planning, strict control of the manager, nor self-control salvages the situation. There is no salvaging of the situation with the help of such-meaningless work performance of functional duties or routine activities in your personal life. In addition, certain actions delay success and make it impossible.

Conscious, «smart» goals, making decisions on the way to them, immediate and visible results motivate employees and help them achieve success in their professional and personal lives. So, life and professional activities are successful when they are clearly and accurately directed, and the direction and accuracy of certain actions is indicated by the goal [10].

What is a goal?

In order to become an effective person, it is very important to be aware of your life, set goals for yourself, plan your future and achieve what you want. The concepts of «goal» and «goal setting» are generally considered to be relevant only to the development of the individual. However, this is a mistake.

Goal setting is an activity that is implemented in any area where you need to achieve concrete results.

The term «goal» has many definitions in various fields of life and science; let's list some of them.

Psychology. Goal is representation of the result to be achieved.

Social Psychology. A goal is a desired result; something that a person wants to achieve or do.

Management. Goals are specific indicators that an organization strives for over a certain period of time.

Psychology of work and management. A goal is an ideal or mentally presented result of an activity; something that is not yet really there, but should be obtained as a result of the activity.

All these definitions combine words such as: result, desire, achievement. That is, **goal** — this is the formulation of the desired future, which we strive for and achieve. The process of setting goals for ourselves is called «goal setting».

Why do we need a goal?

The West Statistical studies have illustrated that only 1% of people can say exactly what they want to achieve in life [12]. Benjamin Franklin knew this for sure as his efficiency and determination gave him away. Even in his youth, he made a plan and tried to implement it. It's been about the global task to be divided into smaller ones, and those even into smaller ones.

This system has become one of the most famous goal setting tools, namely, The Franklin's pyramid (fig. 2).

Figure 2. «The pyramid of life» by Benjamin Franklin

1. The first block of the pyramid, or, in other words, the foundation of life, is made up of values — what is important, significant, and interesting. Values answer the eternal question «Why do I do what I do?».

2. Values determine the entire path of life and add up to the global goal of life. Determining the main goal of your whole life at first seems to be an absolutely impossible task. Therefore, Franklin specified that the global goal of life is the most desired result, the highest point of success.

3. On the way to achieving the global goal of life, we solve strategic goals. This is a master plan and step-by-step instructions for achieving a global goal. These are quite big goals — for decades. The next blocks of the pyramid divide strategic goals

into long-term (5 years), medium-term (1 year), short-term (3-6 months) and current ones (week, day).

Thus, everything you do today, tomorrow, this week and this month — directly affects whether you will achieve your goals, whether you will be successful and happy in many years to come. The pyramid of life tells us that it is important to formulate goals correctly, plan the way of their reaching, and reinforce the desire and motivation to achieve them [14].

A well-set goal organizes your life and simplifies the decision-making process, which ultimately leads to a significant increase in personal effectiveness.

How do we formulate a goal correctly?

The most well-known method of setting a goal is *SMART*, the author of which is considered to be J. Doran. The interpretation of the abbreviation *SMART* is described in his article: «*There's a S.M.A.R.T. way to write management's goals and objectives*».

So, the goals that are set for a corporation, company, or department should be:

S *(Specific)* — specific; aimed at certain aspects in one area;

M *(Measurable)* — in order to deduce an indicator of progress based on their analysis;

A *(Achievable)* — with a focus on results that can be achieved based on available resources;

R *(Relevant)* — fulfillment of the goal really necessary to achieve the desired result;

T *(Time-related)* — the limits of achieving the goal should be clearly defined.

However, almost immediately these criteria were implemented for personal development. However, not all people can immediately and easily understand and use these criteria. Below, they are arranged in the necessary rotation for you to check your goal. So, step by step, you will be able to formulate the correct goal, which you can start implementing today.

1. True purpose

Your goal must be real. True goals come from desires, dreams, and your «I want it». These are natural needs, realizing which you will begin to feel complete. Such goals are easily achieved and do not cause any special difficulties.

If you have now mentioned a goal that is very difficult for you to achieve, then there is a high probability that it is «not yours». If the goal is imposed by society or close aides (example of parents, influence of friends), then you consider it through the perspective of «necessity» — I need to find a high-paying job, I need to start a family.

2. Positive goal

Positive motivation is always stronger than negative motivation. Therefore, the goal should be formulated as a desire for something, and not an escape from something.

Wrong: quit the job.

Correct: find a new job that meets my interests and needs.

3. Specific goal

The goal should be specific, i.e. it should indicate what exactly needs to be achieved. There should be no ambiguities, uncertainties, or contradictions. Looking at the goal, you should immediately understand what kind of result you want to have.

Wrong: I'll start a new life on Monday.

Correct: Until September 16, I will reach the system diet: I am eating 4 times a day (at 9:00, at 13:00, at 17:00 and at 20:00).

4. Measurable goal

The measure is needed in everything, in the goal too. Measurability is what tells you that the goal has been achieved. Specifying a measure gives you an understanding of what you need to strive for. And, as a result, awareness and satisfaction at the moment when you achieve it. The measure can be quantitative, i.e. contain figures, indicators, or qualitative, i.e. emotionally intense.

Wrong: I want to earn a lot of money.

Correct: as of May 1, I will find a job with a starting salary of 20 000 UAH.

5. Time-related

The goal must have clearly defined time limits for achieving it. Specifying the time to achieve the goal, firstly, determines the period of time during which you should cope with the goal, secondly, it allows you to check its reach, and thirdly, strive to implement it within the planned time frame.

Wrong: Graduate from University.

Correct: I will receive my Higher Education Diploma in June 2021.

6. Reach

The goal set, as well as the mechanism for achieving it, must be real. To achieve your goal, you must have enough resources — time, effort, energy, knowledge, skills, etc. When setting a goal, it is important to identify possible risks and obstacles, as well as ways to overcome them [11].

Wrong: I want to lose 20 kg of weight in a week.

Correct: On December 31, I weigh 50 kg, that is, I lost 2 kg in 10 days.

7. Ecology

Social ecology and ecology of world in general. If your goal involves other people, society, or nature (shared vacation with your family; production that will cause a lot of non-recyclable waste), then care must be taken to ensure that the goal does not harm other participants.

SMART technology along with all other methods is not a universal method of goal setting. The choice of a suitable method depends on personal preferences, understanding the essence of the method and seeing what you want.

2.4. An active life position and pro-activity

Human consciousness is influenced by society, culture, society, collectives and other personalities. This effect may or may not be accepted. The main thing is that acceptance or rejection should be a conscious action, and not a passive consequence of upbringing and external events.

The essence of an **active life position** — is a conscious reaction that positively affects the fate of a person:

- it enables overcoming of stereotypes of social behavior that are imposed from the outside and interfere with the movement towards the goal;
- it expands and diversifies life roles;

- it provides an opportunity to participate in the formation of cohesive and efficient teams.

An active life position contributes to self-realization and success, since a person in this case shows courage, initiative and willingness to act [4]. The person doesn't wait to be «acquainted» with a world view, knowledge, job, financial opportunities, and so forth. Instead, it actively processes information and acts in accordance with external (environmental) and internal (motives, desires, feelings) influences. Such an employee is valued in modern market conditions, as they become a powerful force that helps to implement any promising business idea. They are characterized by initiative, activity, independence, and integrity.

An active life position means:

- orientation in the environment and in social values;
- conscious attitude to other people;
- readiness for action and for various forms of activity.

Factors influencing the formation of vital activity:

- forming your own worldview;
- acquisition of social and professional skills;
- communicating with other people;
- labor activity;
- socio-political activities, etc.

Areas in which an active life position is manifested:

- professional sphere — obtaining new knowledge — skills, and experience in the profession, growing from an intern to a qualified, highly paid employee;
- social direction-organization and implementation of new projects, volunteering — etc.;
- personal direction-attending trainings and seminars for self-development, etc.

Directions and types of a life position

Depending on the direction of action or inactivity the life position can have two directions:

- positive (affirmation of good and overcoming evil);
- negative (activity to the detriment of others).

Depending on whether a person has learned to participate in solving their own and social problems, there are **active or passive** life positions**.**

A person with an **active** life position:

- is not satisfied with the existing reality;
- has an idea of what a new, more advanced being will look like;
- actively acts to rebuild reality.

A person with a **passive** life position:

- has no personal mission, tends to inertia, indifference;
- has no responsibility for their own actions;
- if an event occurs, there is always a reason to do nothing;
- everyone around them is to blame for all personal failures.

Pro-activity — is clear awareness of personal goals and values and activities in accordance with them, and not under the influence of external circumstances. At the same time, a person acquires knowledge, makes decisions, acts consciously and planned, does only what will help to achieve goals, and does not waste time on trifles.

Proactivity in most cases is formed before the age of 30 and is born from an active life position.

It is necessary that an active life position is harmoniously combined with prudence and wisdom, a desire to help others and a sense of proportion. Otherwise, the desire for transformation can have negative consequences of various scales — starting with your own unhappy families to the death of millions of people.

2.5. Analytical and critical thinking

Analytical thinking — is the ability to analyze the information received in a logical way. It can be considered as an analysis, synthesis and evaluation of data, as a result of which the obtained facts, problems and concepts are supplemented with new content. Thinking about the acquired knowledge, a person comes to a more complete understanding of the world.

Analytical thinking is impossible without logic that specifies the rules, laws, or norms that thinking must obey in order to be true. That is why all classical education is based on analytical thinking. In addition, all scientific directions and trends use the principle of analyzing facts, transforming them and obtaining new conclusions.

The development of analytical thinking begins in early childhood and continues throughout life. There are a large number of techniques and ways to develop analytical thinking, most of which consist in training on solving certain problems from everyday life [9]. To successfully apply analytical thinking, you need to have reliable facts and a mechanism for drawing conclusions from existing facts.

Critical thinking — this is a type of scientific thinking that leads, firstly, to making well-thought-out, balanced, conscious decisions and, secondly, to self-improvement. It is believed that critical thinking is the type of thinking that ensures scientific and technological progress.

The process of critical reasoning in solving a problem can be represented by several stages (fig. 3):

Stage 1 — is generating a problem and realizing the task;

Stage 2 — is an attempt to overcome the problem with known actions and knowledge;

Stage 3 — is restructuring of ways of action and knowledge and development of a new view, new approaches, which ends with the birth of an idea;

Stage 4 — is justification of the found solution and presentation of the results of solving the problem.

Properties of critical thinking: independence, awareness, introspection, purposefulness, controllability validity, organization.

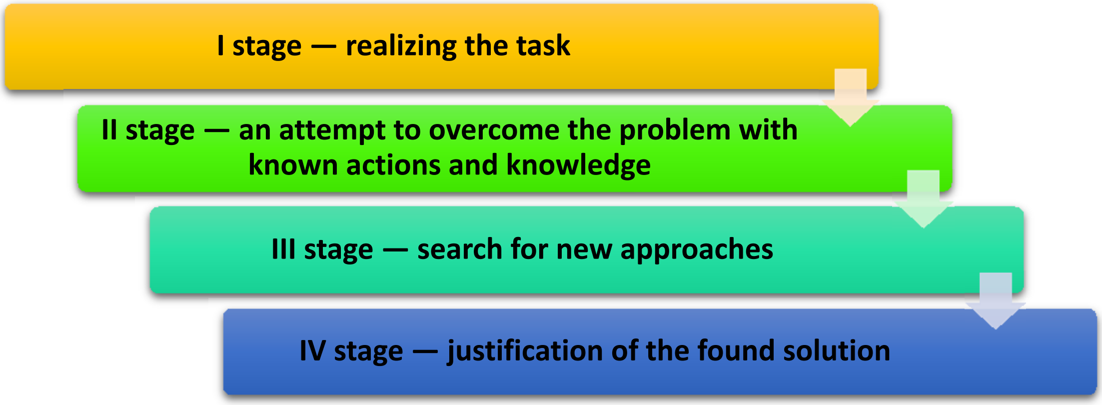


Figure 3. The process of critical thinking

2.6. Communication skills

According to the classical theory of management, **communication** — is the exchange of information between two or more people. At the same time, the goal is to ensure that the recipient understands the information that is the subject of exchange.

The communication process can take many forms depending on the number of participants, the goals of the parties involved, the means, strategies, and channels used. There are a large number of communication models.

Aristotle's Model. There are three main elements of communication: speaker — speech — listener (fig. 4). These elements are also reproduced in subsequent communication models. Only with the development of mass communications through radio, film, and television and under the influence of the need to improve propaganda methods did the classical model change.

Figure 4. Aristotle's Communication Model

The Lasswell Model it is revealed when answering consecutive questions (fig. 5): who communicates and with what intent? what does he say and how? in what situation does communication take place? what audience? what is the result?

Figure 5. Lasswell's model of communication

Communication it consists of the following elements of the information exchange process (fig. 6):

- *sender* (the person who generates the idea, or collects and processes information for transmission);
- *message* (information provided verbally or otherwise using symbols);

• *channel* (means of transmitting information);
• *recipient* (addressee to whom the information is intended);
• *feedback* (reaction).

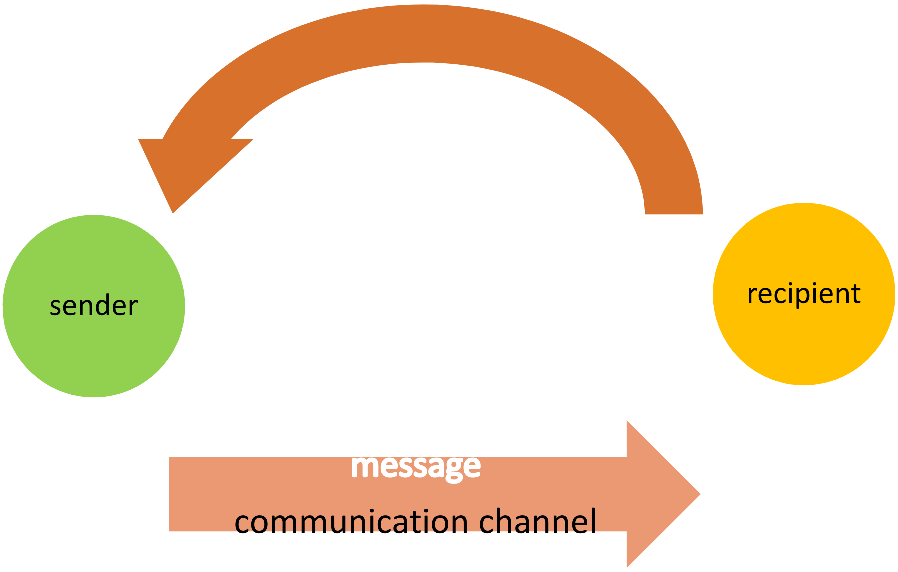


Figure 6. Elements of the information exchange process

Communication skills can be divided into:

• ability to form an informational message (speak, write, or otherwise express yourself);

• ability to respond appropriately to messages (ability to listen, meaningful reaction, emotional reaction);

• ability to use various communication channels (oral speech, letter, message, email, social networks).

As Napoleon Bonaparte once said: «those who do not know how to speak will not make a career». The same ability to speak and formulate thoughts in order to convey your ideas, requirements or just feelings to others is one of the main indicators of the development of communication skills. Of course, without it, working in any team or perform any work is impossible.

Recommendations for effective communication

Successful businessmen, politicians, and public figures pay a lot of attention to the development of communication skills. Often these skills have been the very ones for them to have achieve success, become who they are now. Therefore, if we use recommendations formulated on the basis of the experience of famous personalities, communication will be more effective.

«When communicating, we need to be concise and clearly formulate our messages» — advises Richard Branson, billionaire and owner of the group *Virgin*. When preparing a presentation or any written message, one should keep in mind that anything other than «one text message for pager» is too much. Branson notes that «everything I write, I consciously try to express it so concisely that it fits into the format of a tweet. Even if I manage to shorten my message to just a couple hundred characters, I think I expressed my opinion more effectively than if it were ten times longer.» [5]. Conciseness in communication is a sign of good taste also because the time of both your own and your colleagues is valued.

The ability to listen is just as important for successful communication as the ability to speak. R. Branson recommends [5]: «Listen — so you will seem smart». What a person hears, and therefore perceives, will determine whether the information is fully received. There will always be losses in perception, but you need to try to keep them as small as possible. The development of communication skills involves and **improving the ability to perceive information**. Notes and short remarks are a good habit, and they can refresh or reveal additional content in further communication. Winston Churchill once said: «Courage is to stand up and speak; courage is also to sit down and listen».

Communications and the social circle need to be constantly expanded and changed, meet new people, keep in touch with colleagues and friends. In a modern informative society, the wider the social circle, the more successfully the individual's communication abilities are realized and developed. Often it is random communication that becomes the beginning of successful projects or startups. For example, Larry Page and Sergey Brin (founders *Google*) met by chance over a cup of coffee precisely because both did not have enough tickets to the cinema.

For communication skills, ***developed ability to use different communication channels, depending on the situation, need or expediency*** is also important. Do we need to make an appointment if we can resolve the issue over the phone? Should we put the proposal on paper if it is better to discuss it? Thanks to a technological development, everyone has the opportunity to choose from a wide range of communication channels. Face-to-face conversations, phone conversations, video calls, chat or Messenger correspondence — modern means of communication between people who need a quick and adequate response, make communication skills extremely necessary and important.

It is also worth mentioning such a concept as ***reasonable frequency of communication and interaction***. The regularity of communication for maintaining contacts, for awareness of the course of events, for systematic influence or lobbying, etc. depends on specific situations and objects of communication. As a rule, everyone gets such knowledge only through their own experience.

2.7. Emotional intelligence

The ability to understand the emotions of your own and others contributes to a person's social adaptation and professional success.

Emotional intelligence *Emotional intelligence* (*EI*) — the ability to manage and use the emotional component of the personality, that is:

- awareness of emotions (joy, sadness, fear, anger, etc.);
- reaching the appropriate level and generate emotions to promote thinking;
- recognizing the emotions of your own and others (the ability to name and understand what they mean);
- managing your emotions.

Emotional intelligence is needed for:

- communication with people — for managers, *hr*-managers, businessmen, advertising agents, PR managers, engineers, etc.;

- personal and professional development;
- stress management — stress tolerance;
- countering manipulation — through advertising, NLP technologies, and manipulative people (conscious and unconscious);
- understanding your own priorities and goals.

Components of emotional intelligence: self-knowledge and self-control, social skills (communication and interaction with others), empathy, motivation [6].

Techniques for developing emotional intelligence:
- monitor your own emotional reactions;
- listen to your own body language to understand other people's body language;
- identify and analyze the relationship between emotions and behavior (for example, anger makes you scream, shame makes you speak softly, etc.);
- to master emotions if they escalate the situation;
- develop emotional memory — analyze the relationship between emotions — actions, and consequences to correct behavior;
- practice the desired emotions — for example, positive thinking;
- develop empathy;
- being emotionally honest i.g. — not hiding your emotions.

2.8. Empathy

Successful professional activity requires not only theoretical knowledge and practical skills, but also openness, tolerance, flexibility, tolerance, self — esteem, readiness for dialogue-everything that somehow indicates a person's ability to empathize [8].

Empathy — the ability to understand the experiences of another person, the ability to communicate in a special way and act on the basis of this understanding.

Empathy
- **promotes increase in levels of:** intelligence, creativity, responsibility; self-discipline, self-organization; personal autonomy; self-awareness; self-esteem; spontaneity; freedom of self-realization;
- **reduces** physical and verbal aggression; vandalism; violation of discipline.

Empathy contains 3 components:
- cognitive-understanding the state of another person without changing your own state;
- emotional-understanding the state of another person and changing your own state (empathy, empathy);
- behavioral-understanding the state of another person, changing one's own state, actively supporting and helping another person.

Character traits of a person capable of empathy:
- tolerance for how other people express their emotions;
- understanding the inner world of another person;
- adapting your own states and emotions to the corresponding states and emotions of another person.

Consequences of insufficient empathy:

- communication problems are increasing;
- the number of conflicts and misunderstandings is increasing;
- professional growth slows down, etc.

The ability to empathize can be developed: learn introspection, develop sensitivity, learn empathic listening, and adequately demonstrate your own emotions.

2.9. Stress tolerance

The body's natural response to stress is Fight Or Flight Response. In certain situations, this is an adequate response, especially if a primitive person is fighting for life in the ancient jungle. In the modern world, such reactions are often ineffective, and sometimes even dangerous. In particular, the World Health Organization calls workplace stress a disease of the 21st century.

Negative effects of stress:

- diseases;
- reduced performance;
- interpersonal conflicts.

However, there are also **positive effects of stress:**

- mobilization of physical and mental abilities under stressful conditions;
- reassessment of life values and self-improvement.

Stress — is the body's response to various stimuli — stressors (table. 1).

Physiological and psychological reactions form a certain characteristic behavior of a person — «flight» or «fight» [7]. These terms manifest themselves both directly (escape, struggle) and figuratively («escape» — illness, avoiding certain situations, hiding emotions, etc., «struggle» — psychological readiness for action, mobilization of efforts, etc.).

Stressors — factors, influences, and situations that can cause stressful reactions of «running away» or «fighting».

Table 1. Stress responses

Physiological response	Psychological reaction
- muscle tension increases; - heart rate (pulse) increases; - blood pressure increases; - sweat production increases; - nervous excitement increases; - the concentration of certain substances (sodium, glucose, hydrochloric acid, etc.) changes	- fear; - anger and aggression; - confusion; - anxiety, etc.

Some of the stressors are the same for all people, and some are unique for each one (table. 2). For example, dismissal from work for one person is a disaster, for another — a chance to start a new life.

Table 2. Examples of stressors that occur during training and on workplace

Stressors during training	Stressors in the workplace
- first year of study outside the home (changing your lifestyle, choosing a professional activity, etc.); - ratings; - academic overload; - social networks relationships (friendship, love, etc.); - violence; - shyness; - self-doubt, etc.	- insufficient participation in decision-making; - role problems — lack of understanding of one's own role in the enterprise, overload or lack of responsibilities; - job dissatisfaction (low salary, poor conditions, threat of staff reductions, etc.); - workaholism; - occupational burnout, etc.

Natural responses to stress in modern life are often useless. For example, in the workplace, an employee receives a task that is difficult for them. Absenteeism (analogous to the «flight» reaction) or a quarrel (analogous to the «fight» reaction) will be an unhealthy reaction — the task is not being completed, employees, managers, and owners have problems.

On the other hand, on the eve of the exam, students study with greater efficiency, and worrying about public speaking helps to better prepare for it.

Therefore, physiological and psychological responses to stress can be controlled and used to your advantage. This is called stress tolerance.

Stress tolerance — is the ability of a person in a stressful situation not to be in a state of stress**.**

A stressful situation consists of the following stages:

- life event-stressor;
- perception of the situation;
- emotional changes;
- physiological changes;
- consequences of the situation.

Between neighboring stages of a stressful situation, you can put certain «barriers» — that is, consciously interfere with natural reactions, change them. Then the situation will become less traumatic, and actions will become more useful and productive. [13].

Barriers to dealing with stress:

- at the stage **«event — perception»** — sedatives, strong-willed efforts (perseverance, stubbornness, willpower);
- at the stage **«perception — emotions»** — positive thinking;
- at the stage **«emotions — physiological reactions»** — relaxation techniques;
- at the stage **«physiological reactions — consequences»** — physical activity (sports).

The best way to increase stress tolerance is to apply all barriers comprehensively and consciously. General **stress management algorithm** contains three components:

- changing the perception of a situation, looking at it from a different angle;
- changing your own physiological state — concentration, rest, calming down;
- solving the problem.

There is a special Holmes and Rahe scale for self-assessment of stress load. By evaluating it, you can predict the likelihood of health problems and find ways to overcome stress on your own. Anyone can independently use the well-known levers of stress management and turn the life situation to their advantage.

«Our response should be the best possible alternative to solving problems, maintaining good relationships, and conserving energy. This is the reaction of a person who is able to control the level of stress!».

2.10. Crisis management

Conflict — is a situation (a set of circumstances) in which there is a clash of opposing parties, forces or views, or there is a lack of agreement between two or more subjects.

Mandatory components of a conflict situation:

- participants (parties) of conflict;
- object of conflict (phenomenon, cause);
- driving force (incident) of conflict.

Here is how the famous banker David Rockefeller describes the long-term interpersonal conflict with his colleague in his memoirs: «The higher we climbed the career ladder, the more acute and obvious our personal and professional conflict became. Institutions work in the best manner when they have strong and goal-oriented leadership. His unwillingness to promote the plan proposed by me gave rise to a lot of delays and missed opportunities».

To successfully resolve a conflict and choose the best behavior strategy, one need to know what stage the conflict is at (Table. 3)

Table 3. Conflict stages

Conflict stage	How to resolve a conflict
Latent	- Restore mutual understanding
Demonstrative	- Demonstrate readiness for normal communication - Clarify the positions of the parties
Aggressive	- Destroy the image of the enemy - Reduce suspicions about the other party’s aggressiveness and treachery - Reduce your own desire to do evil
Battle	- Truce - Efforts for peaceful coexistence - Stopping aggressive actions - An agreement not to go bad

Conflict resolution methods

A well-established opinion when conflicts are compared with various troubles and adversities, disputes, enmity are destructive and do not have positive signs. However, in addition to the negative role, conflict also plays a positive role — it helps the organization move forward and brings to the surface factors that hinder this process. In any case, a conflict needs to be resolved. **Existing methods of conflict resolution are divided into structural and interpersonal.**

Structural methods of conflict resolution:

- explanation of requirements for content of the work (delegation of clear powers);
- principle of using hierarchy (refer to manager);
- subordination of goals to overall goal of the organization;
- influence on behavior through reward system.

Interpersonal methods of conflict resolution:

1. *Avoidance style, evasion*. A person who adheres to this strategy seeks to avoid conflict. This strategy may be appropriate if the subject of disagreements is not of great value to a person, if the situation self resolvable (this is rare, but it still happens), if now there are no conditions for an effective resolution of the conflict, but after a while they will appear. The avoidance style can be applied in the following situations:

- the source of disagreements is trivial and insignificant for you compared to other more important tasks, and therefore you think that it is not worth wasting your energy on it;
- You know that you can't or don't even want to solve the problem in your favor;
- you have little power to solve the problem in the way you want;
- you want to buy time to study the situation and get more information before making a decision;
- trying to solve the problem immediately is dangerous, because disclosure and open discussion of the conflict can only make the situation worse;
- subordinates can successfully resolve the conflict themselves;
- you had a rough day, and solving this problem can bring additional frustration.

2. *Smoothing style*. This style is based on the theses «I have no wish to rock the boat», «Let's all get along». «Smoother» seeks not to let out signs of conflict, confrontation, calling for solidarity. At the same time, the problem underlying the conflict is often forgotten. As a result, there may be temporary peace. Negative emotions do not appear, but they accumulate. Sooner or later, an ignored problem and accumulated negative emotions will lead to an explosion, the consequences of which will be dysfunctional.

3. *Compulsion style*. Anyone who follows this strategy tries to force them to accept their opinion under any circumstances; they are not interested in the opinion of others. This style is associated with aggressive behavior, and it uses coercive power and traditional power to influence other people. This style can become effective if it is used in a situation that threatens the organization's existence or prevents it from

achieving its goals. A manager defends interests of business, interests of organization, and sometimes he simply has to be persistent. The main disadvantage of the manager using this strategy is the suppression of initiatives of subordinates and possibility of repeated outbreaks of conflict.

4. *Compromise style*. This style is characterized by accepting the other side's view, but to a certain extent. The ability to compromise in management situations is highly valued, as it reduces ill will and allows you to resolve a conflict relatively quickly. But after a while, dysfunctional consequences of a compromise solution may also appear, for example, dissatisfaction with «half-hearted solutions». In addition, the conflict may arise again in some modified form, since the problem that gave rise to it remains unresolved.

This approach to conflict resolution can be used in the following situations:

- both sides have equally compelling arguments and have the same power;
- satisfying your desire is too important to you;
- you may be satisfied with a temporary solution because there is no time to develop another one, or other approaches to solving the problem have proved ineffective;
- compromise will help you gain something rather than lose everything.

5. *Collaboration style*. It is based on the belief of the participants in a conflict that differences of opinion are an inevitable result of the fact that smart people have their own ideas about what is right and what is not. With this strategy, participants recognize each other's right to their own opinions and are ready to understand each other, which gives them the opportunity to analyze the causes of disagreements and find an acceptable way out for everyone. Those who rely on cooperation do not seek to achieve their goal thanks to others, but seek a solution to the problem.

This style is the most difficult because it requires longer work. The purpose of its application is to develop a long-term mutually beneficial solution. This style requires the ability to explain your desires, listen to each other, and restrain your emotions. The lack of one of these factors makes this style ineffective.

To resolve conflicts, you can use this style in the following situations::

- it is necessary to find a common solution if each of the approaches to the problem is important and does not allow compromise solutions;
- you have a long, strong and mutually beneficial relationship with the other party;
- the main goal is to gain joint work experience;
- the parties are able to listen to each other and state the essence of their interests.

Evaluating the features of different styles of behavior in a conflict, you should proceed from several main points.

First, it is impossible to absolutize any of the described methods or say that it is «the most correct», «better than others», since each of the participants in the conflict in the relevant situation will behave in accordance with their individual style of behavior, which in turn depends on temperament, characteristics of the emotional sphere, ability to communicate, and so on.

Secondly, each of the participants in the conflict will most often use different styles of behavior depending on the context of the conflict, the significance of the needs and interests that are realized in it, on the people with whom he interacts, on the characteristics of the opponent, since his own behavior in the conflict is often a «reflection» of the latter's behavior.

Third, each of the participants in the conflict is capable of changing their behavior style. Therefore, given that the style of cooperation is the most effective, since it makes it possible to satisfy the interests of all its participants, you should focus as much as possible in a particular situation on the implementation of this particular style.

The ability to resolve conflicts is optimally based on **methods of conflict resolution by solving the problem:**

A) identify the problem, identify the cause of the problem, and not focus on dealing with its consequences;

B) after identifying the essence of the problem, consider options for solving it that would suit all interested parties;

C) focus on the problem, not on the personal qualities of the opponent;

D) create an atmosphere of trust by improving the exchange of information;

E) strive to achieve results during communication, do not give up your own positions and take into account the constructive comments of the other party.

2.11. Crisis management

Crisis management — is an art of mastering a complex situation, eliminating risk and uncertainty, controlling processes, leading to a successful course of events as a result. Crisis management has become so important today that companies have a special position — crisis manager [15]. Crisis managers are divided according to Mccoby into four types: «specialist», «jungle fighter», «firm man», «player».

One of the most important skills of a crisis manager or just a person who has to resolve a conflict situation in a team is the ability to negotiate and maintain a dialogue. These skills are very valuable in critical situations, when a conflict is brewing or already in full swing.

The main purpose of negotiations is to offer your own terms and win over all parties to your side. Skilled experts often put points in their conditions that are clearly contradictory, conflicting and unacceptable to the other side. Subsequently, during the negotiation process, as if making concessions, they remove these points. As a result, the impression of a compromise solution is created, although in fact a pre-conceived scenario works.

Psychologists and marketers have different approaches and many recommendations on how best to prepare and negotiate so that they are successful:

- conditions and environment for communication to take place matters: those for whom this environment is more familiar or more familiar will have an advantage;
- it is important to prepare for possible objections to the proposed position, immediately think through the arguments in order to answer them;
- it is important to be self-contained during negotiations — too many emotions reduce negotiations to the level of an argument or even a quarrel;
- the level of awareness of participants helps to quickly and constructively negotiate-those who are better informed lead the dialogue in the right direction;

- however, one does not need to immediately post all the known information, intrigue helps to keep your attention;
- one should note that attention weakens over time, so the first half hour is the most productive in negotiations;
- it is necessary to keep in touch between the parties while having a conflict, even in the most difficult situations, because as long as there is a dialogue, there is hope for success.

2.12. Project team management

The modern concept of Personnel Management in projects is based on the growing role of the employee’s personality, knowledge of his motivations, their ability to form and manage in accordance with the tasks facing the project team.

Management allows you to achieve results «with the help of people», and the results of work largely depend on how the project manager communicates with people and how these people relate to each other. An effective organizational system, structured planning and control, and good team relationships are essential for the success of the project.

Effective HR management is the foundation of Project Management. Main goal of project HR management:

– ensure that the behavior of each member of the project team contributes to the achievement of the organization’s goals and the overall implementation of the project;

– creating a project team to implement the project optimally (in terms of quality, time and cost).

The main areas of HR management in projects are:

1) project manager’s leadership;

2) Team Development and group work;

3) motivation of individuals and groups;

4) conflict management.

Increasing the complexity of projects and using new technologies requires the creation of integrated teams. They consist of different specialists working with each other.

A project team is a group of people who work together to achieve a common goal. They work directly on the project and are accountable to the project manager. The project team is formed for the duration of the project implementation and is dissolved after its completion.

Teamwork can bring people together to increase their productivity without losing their personality. Teamwork has a synergistic effect when different offers are processed, when one team member is constructively helped by others, which contributes to better results.

Benefits of working together:

1.teamwork is a tool that provides support and success for management.

2. the team can be updated independently by recruiting people as individual members retire.

3. the team creates a «Bank» of collective experience, information, and rules that can be passed on to new members.

4. many people work more successfully in a team than alone.

5. team synergy produces more results than the amount of individual contributions.

What gives everyone the opportunity to work in a team:

1. It satisfies the social need to belong to something or be in a group.

2. It promotes the formation of self-esteem in the process of analyzing their relationships in the group.

3. It provides assistance in achieving the goal (exchange of ideas, constructive criticism, alternative suggestions, etc.).

4. It distributes risk among team members.

5. It creates a «psychological home».

The complexity of project implementation management tasks requires high technical competence, a large amount of economic, legal, and managerial knowledge. Therefore, creating a professional project team is a prerequisite for effective project work. The project team must combine skills in three categories:

– technical and functional, i.e. professional, skills (hard skills);

– problem solving and decision-making skills;

– interpersonal skills (soft skills).

Goals for creating a project team:

1. Improve the distribution of employment. Combine skills, abilities, and abilities and distribute your tasks among participants according to time.

2. Work Management and control. The work of each group is organized and supervised by other members.

3. Problem solving and decision-making. It is always easier to do this by combining the skills, abilities, and knowledge of a group of people.

4. Verification and approval of decisions. Check the reality of the decision that was perceived from the outside, or approve such a decision.

5. Communication and information for those who need to know how to make decisions or provide the necessary information.

6. Accumulation of ideas, information, and advice.

7. Coordination and communication between functional divisions.

8. Increase the responsibility and involvement of team members, creating a favorable environment for participation in the organization’s planning and activities.

9. Negotiations and conflict resolution at different levels of management.

10. Analysis of project implementation results in order to improve the information base for their assessment.

Main organizational tasks of creating a project team:

– creating a professional and stimulating environment;

– implementation of competent management;

– provision of qualified technical personnel;

– providing management support and a consistently friendly environment.

Team members should see themselves as part of the project team and develop common values and norms before working as a team. The process of forming a unified sense of the team and a common team takes time. The project team usually goes through five stages of creation.

Team creation stage:

1. Formation.

At the team creation stage, the main problems arise for the following reasons:

– own feelings of team members (whether they feel like complete members of the team, how they are treated);

– relationships within the team (who interacts with whom and who has influence);

– the place of teams in the organization as a whole.

At first, team members come together with a sense of mutual misunderstanding. Motivation is high because they were selected to implement the project, but the effect of the first stage is low because the team members are not confident in themselves.

2. Period of participants' response.

The main questions that arise at this stage:

– complexity of teamwork (no promotion, transfer of responsibility);

– manifestations of characters (love of power, informal, lyricist, «soap bubbles», laziness, etc.);

– discussion of issues (dispute or absolute consent);

– incorrect reporting methods (underestimation of results, attribution, poor-quality information);

– control errors (rapid fluctuations, mood swings, lack of clear planning, weak control);

– relationships (hostility, lack of support and trust, conflicts).

When team members start working together, they find that they have different ideas about how best to achieve their project goals. They also find that there are different approaches to working on a project. These differences can cause conflicts, reducing the effectiveness of the team.

3. The period of functioning in a proper manner (each has its own role and place).

Team members begin to agree on various issues. Through negotiations and compromises. As a result of this adaptation, they begin to develop a sense of unity and certain common norms and values. It forms the basis for team members to work together. Efficiency and motivation begin to grow to a certain level.

4. Reorganization (due to changes in the scope and type of work, temporary professional involvement).

Project managers need to maintain a high level of productivity achieved in the event of forced changes in the project team.

5. Dissolution (after completion of work).

As one approach the end of work, efficiency increases when team members focus on the current task, or decreases when team members express regret about the completion of work and the breakdown of established relationships. The latter happens when the team's future is uncertain.

For a team to work effectively, the project manager must do the following:

– determine the organizational structure of the team;

– distribute functional responsibilities;
– appoint managers and those responsible for a specific area;
– ensure timely planning and division of Labor;
– clearly explain goals and objectives;
– overcome obstacles and avoid collisions;
– interest, help;
– creating an attractive team image.

The following methods are used to create and develop teams.

– Role analysis and selection of team members in terms of psychological fitness.
– Conducting seminars, organizing courses, situational analysis.

There are different approaches to defining possible roles in a team. According to one of them, all roles are divided into two groups.

– a role of contributing to the completion of the task;
– a role of creating the necessary microclimate within the team.

For example, the well-known Belbin test helps determine the role of each performer in the team.

The quantitative composition of the team is determined by the following factors:

1) The number of people required to complete the project.
2) Necessary expertise for the project.
3) The optimal number from the point of view of conflict.

Experts believe that the optimal number of people is 5-10 people.

Project managers who have formed a team need to maintain a certain level of efficiency.

Team performance evaluation is based on the following indicators:

– Clear understanding of your goals and focus on the final result.
– Clear separation of functions and responsibilities.
– Availability of a team development plan.
– Team solidarity.
– Mutual understanding and non-conflict;
– Attendance of working meetings and active participation in problem solving.

A team will succeed if:

1) Leader has an appropriate management style in terms of project effectiveness and team members.
2) At least one of the team members offers innovative ideas as a way to solve the problem.
3) The team consists of people with good mental abilities.
4) The team is created by different people and gives them the opportunity to maintain a balance.

In other words, the team must be creative and flexible.

Project management requires a permanent project team. The project manager and his team are united and should act as a well-oiled mechanism. Creating a team of experts for a new project is already the responsibility of the project manager at the first stages of its work. This process requires a set of administrative skills: the ability to identify and bring together specialists from different departments and organizations.

In a matrix structure with double subordination, recruitment is carried out by the project manager and the head of the functional department. The recruitment process discusses project goals and objectives, expected results, resource costs, roles and responsibilities of team members, accountability, expected rewards, and the importance of the project to the organization. Candidates can join a team that meets professional requirements and is very interested in the success of the project. Project managers who form teams connect people based on common goals.

Novelty, uniqueness, risk, and transience are unique features of a new project. They cause difficulties in forming teams, which are complicated by the fact that people who have not worked together do not have common values and norms, and their activities must be effective. The team needs time to grow within the group and set common norms, standards, and values. All this must happen before the team can operate at «full capacity».

Project managers should contribute in every possible way to the process of rethinking the team of specialists into a team. First of all, it is necessary to create an atmosphere of favorable psychological climate to ensure the adaptation of participants. The project manager solves the following main organizational problems:

– Create a professionally stimulating environment.
– Implementation of competent leadership;
– Providing qualified personnel.
– Providing support from management and a supportive environment.

Project managers create an environment where new project team members can experience professional satisfaction, confidence in their position, and a clear understanding of relationships and responsibilities, mutual trust, and mutual respect.

Organizational structure of the project team.

Despite the fact that teams are temporary groups operating within an organization, they have a special organizational structure, the nature of which depends on the goals, objectives, and other parameters of the project.

In project management practice, two types of project team structures are used.

Matrix format of the command structure.

Suitable for small and medium-sized projects with a life cycle of up to 2 years. The essence of the matrix format is that specialists from the functional divisions of the organization are selected for the project team on a temporary basis. The matrix format has its own strengths and weaknesses.

Advantages:

– Flexibility in organizing and developing the team.
– There is no duplication of functional departments.
– Having «confidence in the future» of team members.

The project manager has the opportunity to invite as many professionals from the functional department to the team as is necessary to complete the workload for a certain period of time. With the advent of new types of work, when the amount of work increases and decreases, he can again change the composition of the team at the expense of specialists of the functional divisions of the organization.

The project team structure does not create its own functional department, so the powers and functions of individual project specialists do not coincide with the permanent functional departments of the organization. After the project is completed, the team members will return to the functional department. That means they don't need to look for a new job. This is a very important positive factor in the matrix structure.

Restrictions:

– Lack of the principle of managing one person;

– Team timeliness.

– Problems with resource allocation in the organization.

– Complexity of relationships in the organization.

The main disadvantage of the team matrix structure is that it violates the principles of managing one person. The intersection of vertical and horizontal links makes it difficult to form a team and manage it. Team members who work permanently in the organization's departments and are temporarily engaged in a project may not be able to decide who to report to and whose tasks to perform. Constant dilemma: What is more important? Belong to a team of functional divisions or to a project team?

The lack of unity of command creates serious problems for Project Managers. It's hard to manage if people are focused on a different leader. The temporary nature of the project worries both the manager and the entire team. Team members need time to understand each other, find common ground, make friends, and «work together». For small projects, there is often no time to complete this process, and relationships are interrupted.

The timeliness, duality of participants ' positions, and dual power create conflicts within the organization on such important issues as the appointment of experts and the allocation of resources within it. This largely depends on the relationship between the project manager and the head of the organization, the head of the functional department, as well as on the ability to create a convincing image of the project.

Project format of the team structure.

Special project organizational structures are increasingly being used to manage large projects. A certain «smaller copy» of the organization is created to implement a large project within the organization. This organizational structure also has its own strengths and weaknesses.

Advantages:

– The principle of unified leadership;

– Confidence in the situation within the organization.

– Team effort and focus on project results.

The team is created for a long period of time (more than two years), so it is fully focused on the project and its goals. The most important advantage of the project form is that all efforts can be focused on achieving the main goals of the project, without distracting participants to perform other duties in the functional departments of the organization.

The permanent team is focused on long-term cooperation. Team members do not feel temporary and take a certain position within the organization. As a general rule, large projects have priority, even if the organization has other projects. This provides advantages for selecting specialists and allocating resources, so project managers are less likely to struggle with these problems.

Disadvantages:

– Duplication of functions within the organization.

– Lack of flexibility in Team Development and reorganization.

– Uncertainty of team members in employment after the project is completed.

Being in the project group of «branches» of the organization's functional departments leads to duplication of functions. This entails additional costs for the organization. The intersection of functions and powers of the team and key functional departments of the organization is a source of conflict. In the process of developing or reorganizing a team, it is difficult for project managers to hire specialists and attract new specialists from key departments of the organization. After completing an important project, most participants do not have the opportunity to return to their previous work. This factor works in two options.

The first option. A new order is expected for an important project, which will be transferred to the same project manager. At the final stage of project completion, team members strive to be more productive by declaring the need to join a new project team.

The second option. No new projects are expected. Labor productivity drops sharply at the end of the project, as participants are concerned about finding new jobs.

In the case of the second option, the task of the project manager is to find new interesting motives for resuming intensive team activities and do everything possible to provide work for colleagues after the project.

Effective team characteristics.

The effectiveness of a team can be evaluated according to generally accepted criteria adopted by any organizational structure. However, there are certain features that are specific to the project team. First of all, the entire team is focused on the final result, initiative and creativity in solving the problem. High productivity, a focus on the best solutions, and lively and interested discussions of new issues complement the characteristics of an effective team.

The selection of professionally trained specialists determines the competent solution of a new problem. Effective teamwork means clearly tracking the relationships and interactions of participants, an atmosphere of trust and participation, enthusiasm and creativity. Destructive conflicts are rare, and constructive conflicts are maintained to help solve the problem better. All team members feel responsible for implementing the entire project and completing individual tasks.

To build a cohesive and effective team, project managers need to make the most of their knowledge and skills, including organizational skills, professional authority, and relationship knowledge.

1. Main difficulties and barriers.

The project manager should understand that various changes are waiting for him in the process of building a team. First of all, it should avoid such mistakes:

– unclear objectives or frequent changes in goals and priorities;

– lack of resources and funding;

– power struggles and conflicts in the team;
– insufficient technical equipment;
– lack of interest and support from management.
2. Distribution of responsibilities and powers.

The project manager must first approve senior positions in the fields of activity, appoint appropriate specialists, distribute functions and responsibilities among them, and delegate the necessary powers. All appointments should be discussed with each candidate separately. To create an atmosphere of mutual selection of other personnel, it is necessary to do this together with the heads of various fields. Face-to-face conversations, meetings of small groups according to instructions, as well as general team meetings are appropriate here. The main focus should be on issues related to the main goal of the project, its significance and significance for the entire organization, as well as the participation of team members in its implementation.

3. Planning the team's activities.

Activity planning should begin at an early stage of the project. The project manager must combine the efforts of all functional sectors of the team to effectively use and allocate project resources, achieving interested and creative participation of all team members. Its task is also to involve team members in discussing issues and problems that arise, analyzing and taking into account their views.

4. Team Development.

In the field of view of the project manager, all changes that occur in the team that he leads should occur. Frequent conflicts, reduced intensity, and repeated mistakes are a signal of trouble in the team. If the project manager cannot independently determine the causes of this phenomenon, he should contact consultants who can offer fresh ideas for establishing a normal psychological climate in the team.

Of course, leaders should strive to avoid complex problems, especially psychological ones. This requires some experience and knowledge of the practical psychology of human behavior. The leader, through the potential causes of destructive conflicts, helps to avoid them.

However, the development of the team is associated not only with solving subjective issues. It also provides for quantitative and qualitative changes in the team caused by changes in the scope of work, the emergence of new types of work, the involvement of other subcontractors or subordinates, and so on.

5. Creating an attractive team image.

It is extremely important for the project manager to ensure that the team is properly supported by management. The project manager's relationship with senior management and the ability to get their support determine the trust of team members, and therefore the popularity and image of the project.

3. CONCLUSION

Thus, constant development of *soft skills* it is necessary for successful achievement of established objectives, competent use of skills, knowledge and abilities both in personal life and in professional activities, including to achieve the necessary level of competitiveness in the labor market.

LITERATURE

1. Brewer, Laura. The top 6 skills today's employers want? [Electronic resource] / Laura Brewer. — Mode of access: http://iloblog.org/2014/04/11/the- top-6-skills-todays-employers-want/

2. Johnson, Tim. Crisis Leadership: How to lead in times of crisis, threat and uncertainty / Tim Johnson / Bloomsbury Business, USA. — 2018. — 272 pp.

3. Abashkina, Olha. Soft skills: key to career / Olha Abashkina // Handbook of Personnel Management: Scientific Journal. — 2008. — № 9 (September). — 124–126 p.

4. Bakhtiiarov, Oleh. Active Consciousness / Oleh Bakhtiiarov / — M. : RIPOL Classic, 2015. — 330 p.

5. Brenson, Richard. The Virgin Way / Richard Brenson ; [trans. from English Nataliia Lavska, Alina Mishta]. — K. : Land of Dreams, 2015. — 352 p.

6. Houlman, Deniiel. Emotional Intelligence in Business / Deniiel Houlman; [trans. from English]. — M. : Mann, Ivanov and Ferber, 2013. — 512 p.

7. Dzherold C. Hrynberh. Stress Management / Dzherold C. Hrynberh. — SPb. : Peter, 2002. — 496 p.

8. Dolhova, Valentyna. Empathy: monograph / Valentyna Dolhova, Elena Melnyk. — M. : Pero Publishing House, 2014. — 185 p.

9. DeBono, Edvard. Six Thinking Hats / Edvard DeBono; [trans. from English A. Zakharchenko]. — SPb. : Peter Publishing, 1997. — 256 p.

10. Yskhakov, Эduard. How to set a goal and motivate yourself to achieve it / Эduard Yskhakov. — M. : Publishing Solutions, 2015. — 70 p.

11. Kerolain, Arnold. Microsolutions. A proven path to big goals / Arnold Kerolain ; [trans. from English]. — M. : Mann, Ivanov and Ferber, 2014. — 288 p.

12. Mauer, Robert. Step by step to achieve the goal. Kaidzen method / Robert Mauer ; [trans. from English]. — M. : Alpina Publisher, 2014. — 192 p.

13. Melnyk, Sheron. Stress Tolerance. How to remain calm and highly effective in any situation / Melnyk Sheron ; [trans. from English]. — M. Mann, Ivanov and Ferber, 2014. — 310 p.

14. Moran, Braian. 12 weeks a year. How to do more in 12 weeks than others can do in 12 months / Braian Moran, Maiul Lennynhton ; [trans. from English]. — M. : Mann, Ivanov and Ferber, 2014. — 208 p.

15. Pushkar, R. Management: Theory and Practice, tutor. / R. Pushkar, N. Tarnavska. — Ternopil: Carte Blanche, 2003. — 490 p.

Scientific edition

Nataliia **Chernova**, Nofal **Hajiyev**, Viacheslav **Matsiuk**, Iuliia **Bulgakova**, Ilgar **Khurshudov**, Valiyeva **Sapargul**, Hudaygulyyev **Nuraly**, Yevhen **Demchenko**, Andrii **Dorosh**, Maryna **Khara**, Iryna **Nikolaienko**, Andrii **Lyamzin**, Valerii **Samsonkin**, Maral **Meredova**, Habib **Halmamedov**, Yolly **Myradov**, Atageldi **Garajayev**, Fuad **Dashdamirov**, Nijat **Zohrabov**, Sharifov **Allahverdi**, Olha **Halan,** Oksana **Yurchenko,** Arif **Najimov.**

CRISIS AND RISK ENGINEERING FOR TRANSPORT SERVICES

Collective monograph

Edited by Nataliia Chernova, Konrad Lewczuk

Computer layout — *Dumanetska Svitlama*
Cover design — *Babynets Nadiya*

Signed before printing 08.06.2022.
Format 60x84/16. Mind. printing. sheet. 12.
Edition 100 copies. Order № …

Publisher and manufacturer «Talcom» LLC.
23, Lviv Str, Kyiv
tel./fax (044) 424-40-69, 424-56-26.
E-mail: ukraina.vdk@email.ua.
Certificate of the subject of the publishing business DK №.4538 dated 05/07/2013.