Economic Policy, Business, and Management in the Post-Pandemic Perspective

**Edited by Anna Ujwary-Gil,
Anna Florek-Paszkowska, and
Artur Kozioł**

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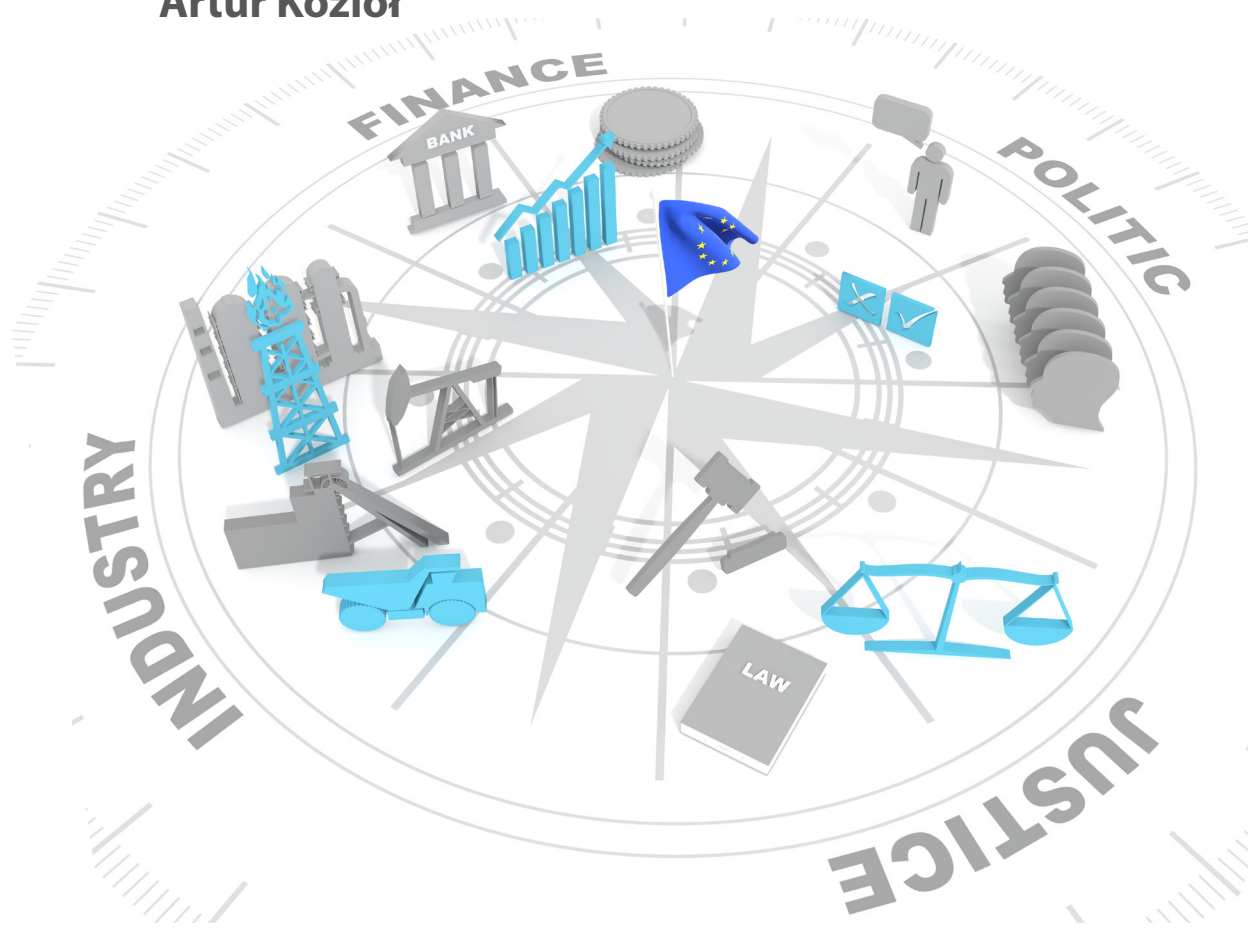Polish Academy of Sciences**

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Anna Ujwary-Gil is a Professor at the Institute of Economics, Polish Academy of Sciences (IE PAS). She recieved her DSc (habilitation) and Ph.D. from the Warsaw School of Economics (Collegium of Management and Finance). Founder and Editor-in-Chief of an international journal entitled *Journal of Entrepreneurship, Management and Innovation* (JEMI), which as a few interdisciplinary journals with a national origin, is indexed in the global Scopus and Web of Science databases in two disciplines: economics and finance; and management. Founder and President of the Cognitione Foundation for the Dissemination of Knowledge and Science, under which she established the international Think Tank – Network Analysis Laboratory (LAS), which currently associates 23 experts from 14 countries. Member of the Board and LAS Expert. The Laboratory is dedicated to analyzing management, business, and economic problems from the perspective of network relations and network structure. The first scholarship holder of the Foundation for the Development of the Education System in Norway. Principal Investigator of the SONATA project, National Science Center; and the project of Regional Excellence Initiative: Socio-economic consequences of the fourth industrial revolution, Ministry of Science and Higher Education. Researcher of 7th RP EU in the international project of Marie Curie Industry-Academia Partnerships and Pathways Program (IAPP). Winner of the first prize for the monograph category entitled *Intellectual Capital and the Market Value of the Company* (Ch & Beck, Warsaw) awarded by the Polish Academy of Sciences in 2010 and a grant receiver for the monograph entitled *Organizational Network Analysis: Auditing Intangible Resources*. New York, London: Taylor & Francis Group awarded by the Ministry of Science and Higher Education as part of the Excellent Science program in 2020.

Anna Florek-Paszkowska received her Ph.D. in economics and management sciences at the University of Warsaw, Poland. Professor at the Department of Management at Centrum Católica Business School PUCP (No.1 Business School in Peru and one of the best MBA business schools in the world with four accreditation). A student of prof. Thomas L. Saaty, USA (creator of Analytic Hierarchy and Network Processes – AHP/ANP) with over 20 years of experience applying and teaching AHP/ANP. Author of over 60 scientific papers and participated in eight grant projects. Participant in the four Erasmus+ Programs for Academic Teachers. President of the Network Analysis Laboratory (Cognitione Foundation). The main topic of research: Sustainable Development; Sustainable Food Production and Consumption;

Food Cooperatives; Application of the Analytic Hierarchy Process and Analytic Network Process in solving economic and managerial problems and developing innovative knowledge-based organizations; Quality Management; Remote Work; Online Education.

Artur Kozioł, Ph.D., local government official, mayor of Wieliczka since 2006. In 2022, he defended his doctoral thesis at the Institute of Economics, Finance, and Management, Faculty of Management and Social Communication of the Jagiellonian University, entitled *„Management in Local Government Units and the Economic Activity Zone in the Krakow Metropolitan Area."* The originator of the creation of the Wieliczka Economic Activity Zone, also a co-organizer on behalf of the Wieliczka commune of the so-called central events during World Youth Day (the largest mass event in the history of the country). Panelist in discussion panels at the Economic Forum in Krynica on innovative management of the municipality, conferences on the organization of World Youth Day, as well as numerous initiatives within the Self-Government Movement. Chairman of the Scientific Council of the Conference „Economic Activity Zones and Management in Local Government" (Niepołomice, 2022). Co-organizer of the 21st edition of the Polish-Peruvian Conference in the series ECONOMY-FINANCE-MANAGEMENT, entitled „Contemporary Challenge in Economic Policy, Business and Management." Initiator of close cooperation between the local government and Kraków's universities (since 2015). He also runs initiatives for students (patronage of student competitions, meetings as part of lectures, coordination of student internships, and support in preparing materials for master's and bachelor's theses).

Dominika Bąk-Grabowska is a Professor at Wroclaw University of Economics and Business. Her scientific interests concentrate on problems of human resources management in the conditions of nonstandard employment and multi-entity structures. Recent publications: "Non-permanent employment and employees' health in the context of sustainable HRM with a focus on Poland" and "The impact of mandate contract and self-employment on workers' health–Evidence from Poland."

Katarzyna Grzesik is an Assistant Professor at Wroclaw University of Economics and Business. Her research interests focus on leadership, human resources management, generational differences in the workplace, and decision-making in the organizational setting. Recent publication: "The determinants influencing decision making in organizational settings – an integral approach."

Svitlana Bondarenko, Ph.D. in Economic Sciences. She is a Professor at the Department of Journalism, National Aviation University, Kyiv, Ukraine. Author of more than 130 scientific works, including: 2 individual monographs, 17 chapters in collective monographs, 50 articles in scientific publications of Ukraine, 20 articles in scientific databases SCOPUS and Web of Science, 5 articles in foreign scientific periodicals, as well as about 70 publications at conferences and round tables, 1 educational and methodical manual in co-authorship. Research interests: Theory and practice of innovative development of enterprises; Economic security, national security; National Resilience; Management of innovative development of enterprises; Institutional principles of building the organizational and managerial system of nature management in the context of administrative-territorial reform; Cost-oriented management of enterprises Theoretical and methodological principles of research and ensuring the balanced development of enterprises; Methodology of formation of effective logistics of commodity markets; Logistics and marketing management of resource flows in the commodity market; Circular Economy.

Oksana Nikishyna, Ph.D. in Economic Sciences, Senior Researcher, Head of Department of Market Mechanisms and Structures, Institute of Market and Economic & Ecological Research of National Academy of Sciences of Ukraine, Odessa, Ukraine. *Author* of more than 260 scientific works, including: 1 individual monograph, 29 chapters in collective monographs, 6 scientific reports and 4 brochures in co-authorship, 100 articles in specialized scientific publications of Ukraine, 5 articles in scientific databases SCOPUS and Web of Science, 9 articles in foreign scientific periodicals, 110 publications at conferences and round tables, 10 certificates of copyright registration for the work. *Scientific interests*: theory and practice of commodity markets; Methodology of selective regulation of the development of commodity markets; Methodical approaches and recommendations for evaluating the effectiveness of the functioning of commodity market systems based on a reproduction approach; Integration mechanisms of commodity markets development; Methodology of formation of effective logistics of commodity markets; "Green" economy, circular economy; Goals of Sustainable Development, a method of comprehensive assessment of the dominant investment and innovation policy of nature use the national economy; Socially responsible business, methodological recommendations for a comprehensive assessment of socially responsible production and consumption based on the principles of greening economy.

Jarmila Duháček Šebestová, Associate Professor, is an experienced researcher focusing on Small Businesses. She has participated in a number

of international projects, including IPREG (Innovative Policy Research for Economic Growth) and the E-WORLD project (International Entrepreneurs Network). She is a Vice President of the European Council of Small Businesses for the Czech Republic. Research interests: Small Business Performance, Small Business Dynamics.

Šárka Čemerková, Assistant Professor, graduated from the Faculty of Science, Palacký University in Olomouc, majoring in General Education. Combination of Mathematics – Descriptive Geometry. She completed her doctoral studies at the Faculty of Economics of the Technical University of Ostrava in 2005 in the field of System Engineering and Informatics. Her research activities are focused on business economics and management, especially in the field of logistics.

Yuji Sato received his Ph.D. degree in Engineering from the Graduate School of Science and Technology, Keio University, Tokyo, Japan, in 1999. He works in the Graduate School of Management, Chukyo University as a full professor. He was the dean of the school from 2017 to 2019. He published chapters from prestigious journals such as the International Journal of Production Economics, Annals of Operations Research, and Industrial Management & Data Systems. He is also the editorial board member of the International Journal of the Analytic Hierarchy Process. In addition to the efforts of his academic pursuit, he is eager to train young researchers and establish their academic research environment.

Nuno M. M. Torre received his bachelor's degree in Marine Engineering from the Nautical School Infante Dom Henrique of Lisbon, Portugal, in 1999. Currently, he is working as a Specialist Engineer at the Companhia Siderurgica Nacional (CSN), Brazil.

Valerio A.P. Salomon received his bachelor's and MSc in Industrial Engineering from the Federal University of Itajuba, Brazil, in 1994 and 1998. Subsequently, he obtained his Ph.D. in Engineering from the University of Sao Paulo in 2004 and developed post-doctoral research at the University of Pittsburgh, USA, in 2007. Currently, he is working as an Associate Professor in the Department of Production at the Sao Paulo State University. His works have appeared in the International Journal of Analytic Hierarchy Process, the International Journal of Production Research, the International Journal of Project Management, the International Journal of Quality and Reliability Management, and several Brazilian journals on industrial engineering. His

research area includes multi-criteria decision analysis, operations management, and quality management.

Vitaliy Tsyganok obtained his Ph.D. degree in Computer Science and later the scientific degree of Doctor of Engineering in System Analysis and Decision Making at the Institute for Information Recording of the National Academy of Sciences of Ukraine, Kyiv, Ukraine. He is presently the head of the Department for Intelligent Technologies of Decision-Making Support at this institute. He is a professor at the Faculty of Information Technology of the Taras Shevchenko National University of Kyiv and the Institute of Special Communication and Information Protection of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute." His research interests include expert assessment methods, decision-making support, operations research, systems analysis, and mathematical modelling of complex weakly structured systems.

From the Editors

Under the patronage of the Embassy of the Republic of Poland in Lima, Peru, and the Embassy of Peru in Poland on October 23-25, 2022, city of Wieliczka hosted the 21st edition of the Polish-Peruvian Conference in the series ECONOMY-FINANCE-MANAGEMENT, entitled „*Contemporary Challenge in Economic Policy, Business and Management.*" The Conference was also under the Honorary Patronage of the Honorary Consul of the Republic of Peru in Krakow, and the Honorary Consulate of Romania in Krakow. The main organizers of this Conference were the Institute of Economics, Polish Academy of Sciences (under the Conference Chair and Head of Scientific Committee – Professor of Institute of Economics, Polish Academy of Sciences – Anna Ujwary-Gil), the Mayor of the City and Commune of Wieliczka (Dr. Artur Kozioł), and the Centrum PUCP, Pontificia Universidad Católica del Perú, Lima, Perú (Dr. Anna Florek-Paszkowska).

The Polish-Peruvian Conference was the most prominent scientific and business event of 2022. We hosted participants from 15 countries, including 68 panelists from Poland, Peru, the USA, Spain, the Czech Republic, Japan, Iran, Brazil, Romania, Ukraine, India, Chile, and Malaysia, as part of an interdisciplinary program combining two disciplines: economics and finance as well as management and quality science. The keynote of this Conference was to create a platform for sharing knowledge and experience between representatives of three environments: people of science, business and local governments represented by the mayors of the cities of Łódź, Wrocław, and Sopot. Undertaking a dialogue between representatives of the world of science, business and local governments, as part of the Conference, was aimed at achieving common goals, such as increasing the flow of information between science and business practice, increasing the level of economic knowledge, as well as in the field of management, deepening and disseminating models of good and proven scientific and business practices. Our strategic goal during this Conference was to expand the scope of the exchange of experiences between the world of science and business practice.

The ceremonial opening of the Conference was performed by

Conference Chairs

Anna Ujwary-Gil (Institute of Economics, Polish Academy of Sciences, Poland)

Artur Kozioł (The Mayor of the City and Commune of Wieliczka, Poland)

Anna Florek-Paszkowska (Centrum PUCP, Pontificia Universidad Católica del Perú, Lima, Perú)

Ambassadors and Rectors

Hubert Wieland Conroy (Embassy of Peru in Poland, Warsaw)

Antonina Magdalena Śniadecka – Kotarska (Embassy of Poland in Lima, Perú)

Tomasz Grodzicki (Vice-Rector for Medical College, Jagiellonian University, Poland)

Institutional Directors

Martyna Kobus, p.o. (Institute of Economics, Polish Academy of Sciences, Poland)

Percy Marquina (Centrum PUCP, Pontificia Universidad Católica del Perú, Lima, Perú)

Representative of the Ministry

Dariusz Latoszek (Ministry of Economic Development and Technology, Poland)

As part of the two-day deliberations, twelve sessions were held, including a scientific panel of honorary guests opening the Conference led by Anna Ujwary-Gil (Institute of Economics, Polish Academy of Sciences, Poland) and Anna Florek-Paszkowska (Centrum PUCP, Pontificia Universidad Católica del Perú, Lima, Perú). The scientific panel was attended by Professor Marian Gorynia (President of the Polish Economic Society, Poznań University of Economics), Dr. Percy Marquina (Director of the Centrum PUCP, Pontificia Universidad Católica del Perú, Lima, Perú), Professor of Jagiellonian University Wiktor Adamus and Professor Mieczysław Morawski from the Warsaw University of Technology. During the panel, we discussed contemporary topics related to the post-pandemic economy, challenges related to social responsibility, a smart („compact") city and its management, and the digital transformation of smart enterprises considering recommendations for urban development. The second panel was dedicated to cooperation between science and local government, which was led by Dr. Artur Kozioł (President of the City and Commune of Wieliczka) and Professor Zbigniew Makieła from the Jagiellonian University and WSB University in Dąbrowa Górnicza. The panel was opened by Professor of Cracow University of Economics, Stanisław Mazur (Rector of the Cracow University of Economics), presenting

cooperation projects between the university and the local government, conditioning their further development. The Mayor of Łódź, Hanna Zdanowska, raised the subject of climate protection and economic benefits. Jacek Sutryk, Mayor of Wrocław, presented the subject of social innovation as a factor in the development of modern cities, and Dr. Jacek Karnowski, Mayor of Sopot – civic self-government in the context of the well-being of citizens. The first day was focused on scientific panels and presentations of contemporary topics and problems faced by local governments. The second day featured three business panels of much greater extent, where we invited business representatives from the USA, Romania, and Peru. The plenary business panel was opened by John Saaty, son of Professor Thomas Saaty (1926–2017), one of the most famous mathematicians in the USA, doctor honoris causa of the Jagiellonian University, creator of the Analytic Hierarchy Process (AHP) and Analytic Network Process (ANP) decision-making methods and their applications in solving problems of the public sector and business. At the end of the Conference, a business session in the form of a discussion panel was led by Mr. Dariusz Latoszek from the Ministry of Economic Development and Technology, Poland, chief specialist for cooperation between the countries of Latin America and the Caribbean. Former commercial counselor at the Embassy of the Republic of Poland in Chile and former consul in Peru and Nigeria. A total of eleven panelists took part in the discussion panel, including:

John Saaty (CEO and Co-Founder – Decision Lens, USA)
Tomasz Lubowiecki (CEO 7R SA – Logistics and Development Sector)
Bogusław Kwiatkowski (CEO Answear.com – Clothing Sector)
Ştefan Porojan (Counsellor to the Minister, Economic and Trade Promotion Office, Romanian Embassy in Poland)
Juan Risi (Agribusiness Director, PRODIGIO Company, Peru)
Sergio Hoyos (Leader in Sustainability in Marketing and Clothing in Alpaca and Vicuńa, Peru)
César Ramírez (CEO Eureka Latam Innovation & Sustainability, Peru)
Kazimierz Murzyn (CEO, Klaster LifeScience, Kraków)
Irena Łobocka (CEO, Cluster "Sustainable Infrastructure")
Marius Gălbenuşă (President of the Romanian Association for Sustainable Local Development, Romania)

The discussion focused on topics such as:

1) Why Poland? Why Peru? Reasons for establishing/developing relations with Poland and Peru. Coincidence, conscious choice, or simple extension after dealing with other countries?

2) Successes and challenges in business relations with the other country.
3) Proposals to improve the relationship. The role of public institutions (including government and regional administration) and the private sector – proposals for support from these institutions.
4) Personal impressions from this Conference (business aspect), expectations for the future, and suggestions for further steps in business cooperation.

In the background of this Conference (on October 22-25, 2022), organizers held TL Saaty Decision Making Hackathon, a workshop dedicated to students from all over the world. It was a pioneer event organized in Poland and Europe for the second time (the first edition was held in Pittsburgh, USA). Thirteen registered groups from Poland and Peru, after the training conducted by the Creative Decision Foundation (USA) in the second part of AHP – Hackathon training, the mayor of Wieliczka introduced three issues for the groups to solve:

1) Management of social services through modern communication systems. Creating an information exchange model.
2) Managing a system of integrated public transport connections (railway, bus) with the assumption of increasing the participation of people using organized connections, in favor of resigning from individual transport.
3) Management of activities aimed at strengthening the area of environmental protection. Creation of new ecological projects with a monitoring system.

While working on the business cases proposed by the Mayor of Wieliczka, the students analyzed real cases and proposed specific solutions. Student presentations were assessed based on the teams' ability to analyze the information, clearly define the problem, effectively use decision-making methods (AHP/ANP), show creativity, and communicate the recommended course of action. The winners were selected by a panel of judges experienced in AHP/ANP. Among the judges were members of the international AHP/ANP community composed of scientists and practitioners, as well as professionals who work with both the public sector and business partners.

This monograph contains selected chapters that have been positively evaluated based on critical and valuable reviews, for which we would like to thank all Reviewers. The editors would like to thank the Authors who contributed to the creation of all chapters in this monograph.

Anna Ujwary-Gil, Anna Florek-Paszkowska, and Artur Kozioł

Meeting employee interests depending on the age and form of employment

Dominika Bąk-Grabowska[1], Katarzyna Grzesik[2]

Abstract

The aim of this chapter is the identification and assessment of meeting employee interests among the employed in standard and non-standard forms based on the age criterion. An empirical study was conducted using the CAWI technique covering a sample of 1,000 working Poles. Descriptive statistics methods and statistical tests were used to analyze the findings. The analysis of employee interests was performed by comparing the assessed interests by the representatives of four separate age groups. The statistically significant differences were examined. For this purpose, the non-parametric ANOVA Kruskal-Wallis test and the post-hoc test (statistical significance level * p<0.05, ** p<0.01) were used. The conducted analysis showed common strengths and weaknesses in meeting employee interests regarding the standard and non-standard forms. Providing employees with safe and hygienic working conditions was highly assessed, whereas employee participation was rated low. The specificity of Generation Z was evident, whose representatives (compared to older cohorts) frequently rated meeting employee interests higher. Filling the research gap related to the analysis of the authors' presentation of employee interests regarding the age and form of employment in Poland. The results have practical usefulness for shaping employment, taking into account the above-mentioned variables. The research results covering a representative sample of working Poles fill the empirical data gap, extending beyond the scope of data available in statistical reporting (Statistics Poland, Eurostat). The empirical research used an original concept combining the issue of employee interests with the age and form of employment.
Keywords: *forms of employment, employee interests, age, cohort.*

1 Dominika Bąk-Grabowska, dr hab. inż., Associate Professor, Department of Economics and Organization of Enterprises, Wroclaw University of Economics and Business, Komandorska 118/120, 53-345 Wroclaw, Poland, e-mail: Dominika.bak-grabowska@ue.wroc.pl (ORCID: 0000-0001-5673-6269).
2 Katarzyna Grzesik, Ph.D., assistant professor, Department of Economics and Organization of Enterprises, Wroclaw University of Economics and Business, Komandorska 118/120, 53-345 Wroclaw, Poland, e-mail: katarzyna.grzesik@ue.wroc.pl (ORCID: 0000-0002-3998-8445).

1. Introduction

Professional work is an important stage in human life. When taking up employment, an employee has certain expectations towards the employer, which are manifested in certain economic, professional, or social benefits. These benefits can be defined as the interests of employees that a particular employer can implement to a varying degree (Gableta, 2012; Gableta & Bodak, 2014). The extent of a given interest realization may depend on the form of employment, which determines the specificity of relations in the work environment. Additionally, the expectations towards employers and the need to realize benefits may be influenced by various variables. The variables which shape the needs of employees and thus their expectations include, e.g. age, gender, personality, experience, social impact, and cultural differences. From the perspective of employee expectations and needs, it seems important to consider the stage of professional career development related to the employees' age criterion.

In the existing studies, one of the approaches using the employee age variable is taking the cohort perspective, which conventionally divides the society into groups according to the age criterion covering a period of about 15-20 years (Foster, 2013). Such a division is also the basis for characterizing employees representing different generations. The research shows that the generational characteristics in Eastern countries are not the same as those in Western countries (Murphy et al., 2004) and indicates the existence of intercultural generational differences. It is the result of national cultures and the effect of important historical events and the state system, which influence the preferences and values of the individual generations of employees. In this regard, the indicated determinants should be considered when characterizing the generations of employees in a particular country. The individual generations of employees in Poland also have their own specificity (Smolbik-Jęczmień, 2017), which may translate into their needs and expectations towards the employer. The research conducted so far in Poland has focused on the selected interests of employees or on the specific generation group. There are no research results that take into account the assessment of meeting certain employee interests against the background of other employee interests.

The chapter aims to identify and assess the degree of meeting employee interests among the employed in standard and non-standard forms, including the age criterion. Achieving the purpose of the study was correlated with providing answers to the formulated research questions (RQ):

RQ1) Are there any, and if so, what kind of differences occur between the age groups in assessing employee interests under standard forms of employment?

RQ2) Are there any, and if so, what kind of differences occur between the age groups in assessing employee interests under non-standard forms of employment?

The answers to the above questions were investigated by analyzing empirical data from a survey covering a representative sample of 1,000 working Poles. The research team represented two Departments of Wrocław University of Economics and Business, the *Department of Labor, Capital and Innovation and the Department of Economics and Organization of Enterprises*. The project entitled Forms of employment and meeting employee interests covered a wider substantive scope and was financed by the Ministry of Science and Higher Education as part of the *"Regional Initiative of Excellence" program 2019-2022, project number 015/RID/2018/19*. The research was carried out using the CAWI technique.

The first part of the study presents theoretical considerations regarding the undertaken research subject. The specificity of employee generations in Poland was described, indicating the conditions shaping a particular generation group and the forms of employment functioning in Poland (standard and non-standard). The methodology of the conducted empirical research and the obtained research results are described in the subsequent section. Next, as part of the discussion, the key conclusions resulting from the conducted research are presented.

2. Literature background

2.1. Meeting employee interests depending on the employee's age

Four generations of workers, also referred to as demographic cohorts, are present in the labor market. Therefore, demographic cohorts are approached as groups of people at an approximate age. However, generational affiliation is not only related to the date of birth but also results from the historical and social experiences of generation groups (Egri & Ralston, 2004). The social context in which a generation group develops does influence their values and beliefs regarding work ethics or goals and aspirations associated with professional life (Smola & Sutton, 2002). In addition, such factors as the process of globalization along with the rapid technological progress affect the changing expectations of the subsequent employee generations. Demographic cohorts tend to share a common worldview based on similar shared-life experiences (Edmunds & Turner, 2005). This allows if each of the generational groups

presents specific needs, values, and attitudes that refer to both private and professional life (Dries et al., 2008; Lyons & Kuron, 2014).

Adopting the demographic cohort approach indicates the presence of the following employee generations in the labor market: Baby Boomers, Generation X, Generation Y, and Generation Z. Their proportions among Polish employees have changed over the years. Taking into account the professionally active people, it can be stated that the Baby Boomer generation is gradually retiring, while the youngest Generation Z is entering the labor market (Czyczerska et al., 2020). When analyzing the conditions of the society functioning in Poland, the Baby Boomer generation was born after World War II and grew up in times of political and socio-economic transformations. It was the time of workers' protests, martial law, and the period of free market economy development. Regarding Generation X, these people were educated and reached adult life during the difficult period of economic restructuring. The socio-economic situation, including inflation, high unemployment rate, and employment instability, forced the acceptance of temporary contracts and jobs below qualifications. The representatives of Generation Y belong to the baby boom of the 1980s. They were raised in capitalism, widespread computerization, and the development of the Internet and satellite television, which enabled open communication with the world. The absence of political and social restrictions, the possibility of economic emigration, and also the freedom of speech and religion created their natural reality. Generation Z, currently entering the labor market, is characterized by the inability to function without access to the Internet and electronic media, with virtual and real worlds being the same reality for them. Taking into account the above information, it can be adopted that the representatives of individual generations are distinguished by their typical way of thinking and functioning as a result of social, political, and economic conditions in which their maturation process and the broadly understood development took place (Smolbik-Jęczmień, 2020).

The functioning of various generations of employees in the labor market constitutes a challenge for the managers of organizations (Singh, 2014; Culpin et al., 2015; Holian, 2015; Guerin-Marion et al., 2018). It is related to the transformation of needs and values followed by employees and declared expectations towards the employer. Recognizing and considering these expectations is important in terms of the right approach to human resource management. It is possible by getting to know the specificity of thinking and functioning of individual generations. However, defining the characteristics of individual employee generations is difficult, as these are usually heterogeneous groups featuring internal diversification. It can also be concluded that the boundaries between the discussed groups are gradually blurred as each generation includes the representatives being, to a great extent, different from

other representatives of their generation in terms of their approach to work and life (Smolbik-Jęczmień, 2020). The source literature presents the general characteristics of these generations showing their specificity, which translates into their expectations and needs regarding work. The characteristics of the generations described above are presented in Table 1.1.

Table 1.1. The characteristics of generations regarding the approach to work

Generations	Specificity of the approach to work
Baby Boomers	Representatives of this generation: • appreciate the commitment to work and personal devotion, – remain loyal to the employer; • prefer individual work; • are characterized by high stability of behavior; • show appreciation for authorities; • reveal a greater tendency to accept the rules imposed by the organization; • have workaholic tendencies and no need for work-life balance; • are reluctant to change jobs and follow new technologies; • prefer routine activities; • usually need support in the process of making changes in the organization; • manifest the need for recognition and prestige; • need stable work and safety,; • approach good education as the key to development.
Generation X	Representatives of this generation: • are characterized by work ethic and high responsibility; • are loyal and prudent in their actions; • appreciate stability and a steady job that does not require new challenges; • care for the quality of private and professional life and try to separate work from private life; • are independent in making decisions; • strive for financial independence; • need a sense of meaningful actions; • are focused on independent forms of work and sequential work performance; • are cooperative, however, difficulties/conflicts occur in teamwork; • are open to new technologies; • perceive courses and training as the key to development.
Generation Y	Representatives of this generation: • are much less loyal to employers; • are characterized by a no recognition for authorities; • need independence, but look for someone in their environment who could act as their mentor; • are characterized by a low work ethic, lack of patience and self-discipline; • show greater flexibility and openness to change than the previous generations; • are fulfilled in teamwork; • treat the work-life balance as a priority; • can be involved in work if it meets their expectations and their needs; • are focused on quick rewards, financial and non-financial bonuses; • show reluctance to long-term obligations; • show readiness to learn in line with the idea of lifelong learning.

Generations	Specificity of the approach to work
Generation Z	Representatives of this generation: • show a low level of responsibility, low work discipline and no loyalty to the employer; • are characterized by high flexibility; • wish to constantly change and improve the established processes and try out new working methods; • do not feel the need for stability at work, search for diversity and escape from routine; • are open to new technology and cannot function without the Internet and social media; • are focused on quick rewards; • value group work more than independent work and present high work efficiency in multicultural and virtual teams; • are characterized by mobility, looking for a job not only in their homeland but all over the world; • perform multi-tasking, i.e., can do many things at once and find it difficult to focus on a single activity; • give priority to a successful life and pursuing their passions; • value self-development and prefer interactive development methods.

Source: Authors' compilation based on Rogozińska-Pawełczyk (2014); Żarczyńska-Dobiesz & Chomątowska (2014); Kroenke (2015); Smolbik-Jęczmień (2017).

The research conducted so far in Poland covers the selected generational characteristics, indicating the differences between generations, or is focused on younger generations of employees (Bodak et al., 2016). The addressed research problems include professional career (Smolbik-Jęczmień, 2017; Samul et al., 2018), values in the workplace (Kubacka-Jasiecka & Passowicz, 2014; Palen-Tondel & Smolbik-Jęczmień, 2021), commitment (Kopertyńska & Kmiotek, 2014; Lipińska-Grobelny & Ciesielska, 2018; Żarczyńska-Dobiesz & Boniecka, 2022).

2.2. Meeting employee interests depending on the form of employment

The accumulation of knowledge around meeting employee interests, depending on the forms of employment, is hindered by the ambiguity in defining the standard and the non-standard forms of employment. This is related to, i.e., the differences in using certain forms of employment in various countries, and also in the application of different division criteria regarding the standard and non-standard forms. The approach presented in this study is based on the criterion of the type of contract concluded with an employee. If it is an employment contract based on the provisions of labor law concluded directly with an employee, the form of employment is considered a standard one. Non-standard forms include self-employment, civil law contracts such as a mandate contract or a contract to perform a specified task (used in some countries), temporary agency employment, other forms of personnel leasing,

and undeclared employment (Leighton et al., 2007; Cappelli & Keller, 2013; Bąk-Grabowska, 2016, pp. 95-101).

Providing an answer to the question within these groups (the employed in standard forms vs. the employed in non-standard forms), the interests of employees are met to a greater extent and can be examined based on guarantees resulting from the applicable law. An employment contract is undoubtedly the basic type of legal employment relationship. In Poland, the *Labor Code* (Art. 2) recognizes that *an employee is a person employed based on an employment contract, appointment, nomination or a cooperative employment contract.* Working only as an employee in the strict sense is subject to the provisions of the labor law. Forms such as civil law contracts result in a different legal relationship, called a civil law relationship (Momot & Kotowska 2012, p. 38). The fact of being an employee in the strict sense implies the protection of the essential employee interests, which is reflected, i.e., in the names of some sections and articles of the *Labor Code*: (1) *Equal treatment in employment,* (2) *Benefits for temporary incapacity for work,* (3) *Working time, including rest periods, night work, work on Sundays and public holidays,* (4) *Employee holiday leaves,* (5) *Parental rights of employees,* (6) *Employment of young people,* (7) *Occupational health and safety.* Therefore, we can find references to employee health protection, work-life balance, developing a balanced professional career, considering the age of employees or the needs resulting from parenthood. On this basis, it can be assumed that employees, regardless of age, will find that their interests are met to a greater extent when they are employed in standard forms.

Another perspective to be considered is referring non-standard forms of employment to the phenomenon of precarious employment. It is essential for the precariat concept to understand what the opposite of this notion means, i.e., safe and secure work, and good quality work (Szarfenberg, 2016). Standing (2014, p. 49) distinguishes seven forms of work-related security: 1) the labor market (full employment policy); 2) employment (e.g., protection against arbitrary dismissal); 3) workplace (chances to keep one's place in the organization, professional development related to this place); 4) work (primarily occupational health and safety and working time regulation); 5) reproduction of qualifications (chances for acquiring them through internships, apprenticeships); 6) income (remuneration regulation, including the minimum wage, social security through social insurance); 7) representation (the right to associate, strike). As Ludera-Ruszel (2022) states, the worldwide transformations are beginning to pose a huge challenge for the implementation of the right to decent work, which makes it a "luxury" for the growing number of employees, especially the young ones. At the same time, it

has been indicated that the employment contract remains the *admission ticket to labor protection* (Kullmann, 2018).

The conducted empirical research confirms that the employed in non-standard, periodic forms of employment face lower investments made by the employers in their development, which diminishes both their current position and future chances for a good job (Bernstrom et al., 2019; Hakansson & Isidorsson, 2016). The research completed in Poland confirmed that the degree of meeting employee interests is higher in the case of employment in standard forms and that employees' age and gender remain the important variables in this respect (Bąk-Grabowska et al., 2021; Bąk-Grabowska et al., 2022). Women employed in standard forms compared to those employed in non-standard forms rate higher: employment stability, protection and entitlement to social benefits, health benefits paid by the employer, safe and hygienic working conditions, training paid by the employer, and assistance in the event of dismissal. (Bąk-Grabowska et al., 2021).

Such precise data are, however, not available regarding the criterion of employees' age. So far, a relatively high share of employment in non-standard and unstable forms among young people has been possible to establish (Vacchiano et al., 2018; Kaźmierczyk et al., 2018; Bąk-Grabowska et al., 2022). One of the studies confirmed that the younger the employees, the more frequent declaration that non-standard forms are their choice and that they allow meeting employee interests (Bąk-Grabowska et al., 2022). However, this observation contradicts the results of studies showing a higher share of involuntary and precarious employment (associated with low labor standards) among young people (Green & Livanos, 2017; Bradley & Van Hoof, 2005). The oldest employees represent yet another group within which the share of non-standard forms is significantly higher. It has been shown that they are less likely to express the opinion that non-standard forms allow meeting employee interests (Bąk-Grabowska et al., 2022). Better identification and understanding of the issues related to meeting employee interests in both standard and non-standard forms of employment, taking into account the age criterion, requires conducting analyses by taking into account the division into individual employee interests.

The research conducted so far in Poland presents the discussed problem fragmentarily. Nevertheless, it can be established that the form of employment differentiates the situation of employees, e.g. in terms of remuneration (Goraus-Tańska & Towalewska, 2019), professional development (Kot-Radojewska 2018), experiencing stress at work (Zajdler & Kaźmierczyk, 2021) and employee participation (Cierniak-Emerych & Dziuba, 2017). The diversification connected with employee participation seems particularly

important, as it is not only one of the employee interests but also a way/key to ensuring the implementation of the remaining interests (Gableta et al., 2016).

3. Research methods

To achieve the goal of the study, the results of empirical research aimed at assessing the degree of meeting employee interests in relation to standard and non-standard forms of employment were used. The research was conducted at the turn of 2019 and 2020 using the CAWI technique. The study covered a sample of 1,000 economically active people (N=1,000). The sample size was calculated using the following parameters: population size 15,828,000, fraction size 0.1, confidence level 0.95. The study applied stratified random sampling, where the sampling was based on the proportional stratified random sampling scheme. The stratified sampling was found to be more effective than the simple sampling scheme because it allows conducting a survey representative of the entire community. The sample distribution was performed based on a conversion factor developed using the LFS data (Labor Force Survey) showing the size and structure of labor resources.

In the study, the forms of employment stand for the independent variable, whereas the dependent variable represents employee interests. The age of economically active people is reflected as a moderating variable influencing the assessment of the degree of meeting employee interests. Four age ranges were adopted in the study, reflecting the so-called demographic cohorts functioning in the labor market:

- group A – people aged 18-24 (n=126);
- group B – people aged 25-39 (n=380);
- group C – people aged 40-54 (n=328);
- group D – people aged 55-64 (n=166).

Demographic cohorts constitute a simplified theoretical structure for conducting generational research, where belonging to a particular generation is primarily related to a specific age range (date of birth). The study adopted that the people born in the years 1946–1964 are the Baby Boomer Generation, Generation X – people born in 1965–1979, Generation Y – people born in 1980–1994, while Generation Z – people born in 1995 and later (Schawbel, 2014; Berkup, 2014).

For the purposes of the research, a list of employee interests was prepared because of the conducted source literature review. The list includes the basic interests of employees. At the same time, it should be noted that this list stays open as employee interests are subject to change due to, e.g. transformations

in economic realities. Among the analyzed interests the following were listed: employment stability, safe and hygienic working conditions, influence on the selection of co-workers, remuneration adequate to duties, protection and access to social benefits, training paid by the employer, good atmosphere at work, proper flow of information, influence on the organization of working time, influence on the selection of remuneration components, health benefits paid by the employer, assistance in the event of dismissal, transparent rules of promotion, formal procedures for expressing opinions, assistance of trade unions/ employee councils, opportunities for professional development, participation in management (consultation), participation in management (co-decision).

The division into two groups was adopted regarding the forms of employment, i.e., standard forms and non-standard forms. Standard forms cover an employment contract for an indefinite period and a fixed-term employment contract. In turn, non-standard forms include civil law contracts, such as a mandate contract or a contract to perform a specified task, self-employment, agency employment, personnel leasing, as well as undeclared employment.

The conducted source literature review, the effects of which were presented in the earlier part of this study, allowed putting forward the following research questions (RQ):

RQ1) Are there any, and if so, what kind of differences occur between the age groups in assessing employee interests under standard forms of employment?

RQ2) Are there any, and if so, what kind of differences occur between the age groups in assessing employee interests under non-standard forms of employment?

The analysis of employee interests was carried out based on comparing the assessment of interests by the representatives of four separate age groups. The comparison of the assessments obtained in individual age groups was initiated by performing normality tests, which showed that the distribution of most of the studied variables, in one or all generations, significantly differed from the normal distribution. Additionally, the compared groups of respondents differed significantly in terms of numbers. These arguments determined the choice of non-parametric tests to analyze the intergroup differences. The analysis focused on identifying the statistically significant differences between the studied groups. For this purpose, the non-parametric ANOVA Kruskal-Wallis test and the post-hoc test (statistical significance of differences at the level of * $p < 0.05$, ** $p < 0.01$) were used.

4. Results

The conducted research was based on the perceptions presented by the respondents regarding the degree of meeting employee interests indicated in the research covering employment in standard and non-standard forms. The respondents were asked to assess meeting the individual employee interests. The assessment was performed using a five-point Likert scale. Taking into account the average score (M) based on the provided answers, the respondents indicated the degree of meeting employee interests within standard forms of employment. In the respondents' opinion, their interests are satisfied to the following extent:

- safe and hygienic working conditions (M=4.06);
- stable employment (M=3.92);
- transparent criteria in assessing the implemented tasks (M=3.83);
- good atmosphere at work (M=3.80);
- protection and access to social benefits (M=3.63);
- training paid by the employer (M=3.58);
- proper flow of information (M=3.54);
- opportunities for professional development (M=3.47);
- influence on the organization of working time (M=3.45);
- health benefits paid by the employer (M=3.42);
- remuneration adequate to duties (M=3.39);
- formal procedures for expressing opinions (M=3.31);
- transparent rules of promotion (M=3.26);
- influence on the selection of remuneration components (M=3.12);
- participation in management (consultation) (M=3.12);
- influence on the selection of co-workers (M=3.10);
- assistance in the event of dismissal (M=3.03);
- participation in management (co-decision) (M=3.02);
- assistance of trade unions/employee councils (M=2.98).

In the case of non-standard forms of employment, the average score (M) of meeting individual interests is as follows:

- safe and hygienic working conditions (M=3.78);
- transparent criteria in assessing the implemented tasks (M=3.68);
- good atmosphere at work (M=3.67);
- proper flow of information (M=3.52);
- remuneration adequate to duties (M=3.42);
- influence on the organization of working time (M=3.38);
- stable employment (M=3.36);
- opportunities for professional development (M=3.31);

- formal procedures for expressing opinions (M=3.28);
- protection and access to social benefits (M=3.27);
- training paid by the employer (M=3.26);
- transparent rules of promotion (M=3.24);
- health benefits paid by the employer (M=3.13);
- influence on the selection of remuneration components (M=3.11);
- influence on the selection of co-workers (M=2.99);
- participation in management (consultation) (M=2.99);
- participation in management (co-decision) (M=2.94);
- assistance of trade unions/employee councils (M=2.93);
- assistance in the event of dismissal (M=2.90).

To answer the formulated research questions, the tests examining the differences between the groups were carried out (statistical significance of differences at the level of * p <0.05, ** p <0.01).

In the case of employment in standard forms, the statistically significant differences between the analyzed groups occurred for the following interests (see Table 1.2): remuneration adequate to duties (p=0.01), protection and access to social benefits (p=0.01), training paid by the employer (p=0.01), influence on the selection of remuneration components, (p=0.01), assistance in the event of dismissal (p<0.01), formal procedures for expressing opinions (p<0.01), assistance of trade unions/employee councils (p<0.01), opportunities for professional development (p=0.01), participation in management (consultation) (p<0.01), participation in management (co-decision) (p<0.01).

Table 1.2. Differences in the assessment of meeting employee interests in standard forms of employment based on age

Employee interests	A Age group: 18-24		B Age group: 25-39		C Age group: 40-54		D Age group: 55-64		Significance of differences	Statistically significant differences
	M	SD	M	SD	M	SD	M	SD	p ***	
Stable employment	3.88	0.93	4.00	0.97	3.93	1.00	3.75	1.1	0.11	-
Safe and hygienic working conditions	4.00	0.94	4.09	0.88	4.08	0.93	3.99	0.96	0.65	-
Transparent criteria in assessing the implemented tasks	3.8	0.93	3.9	0.97	3.77	1.02	3.83	1.04	0.35	-
Influence on the selection of co-workers	3.06	1.26	3.19	1.24	3.06	1.29	3.04	1.19	0.41	-
Remuneration adequate to duties	3.55	0.99	3.5	1.18	3.22	1.25	3.35	1.17	0.01*	B>C

Employee interests	A Age group: 18-24		B Age group: 25-39		C Age group: 40-54		D Age group: 55-64		Significance of differences p ***	Statistically significant differences
	M	SD	M	SD	M	SD	M	SD		
Protection and access to social benefits	3.66	1.00	3.75	1.13	3.56	1.12	3.43	1.22	0.01*	B>D
Training paid by the employer	3.65	1.15	3.72	1.24	3.46	1.27	3.42	1.23	0.01*	B>C, B>D
Good atmosphere at work	3.9	0.85	3.87	1.01	3.69	1.08	3.8	0.95	0.13	-
Proper flow of information	3.58	0.96	3.51	1.1	3.48	1.08	3.7	1.02	0.15	-
Influence on the organization of working time	3.35	1.08	3.54	1.15	3.33	1.19	3.54	1.14	0.05	-
Influence on the selection of remuneration components	3.3	1.03	3.23	1.3	2.94	1.29	3.1	1.22	0.01*	A>C, B>C
Health benefits paid by the employer	3.53	1.18	3.51	1.35	3.33	1.09	3.28	1.18	0.16	-
Assistance in the event of dismissal	3.21	1.09	3.17	1.24	2.84	1.18	2.94	1.14	<0.01**	A>C, B>C
Transparent rules of promotion	3.32	1.22	3.37	1.18	3.15	1.21	3.22	1.15	0.07	-
Formal procedures for expressing opinions	3.38	1.00	3.44	1.13	3.12	1.12	3.34	1.06	<0.01**	A>C, B>C
Assistance of trade unions/employee councils	3.17	1.21	3.16	1.35	2.78	1.36	2.81	1.36	<0.01**	B>C, B>D
Opportunities for professional development	3.66	1.06	3.57	1.05	3.34	1.17	3.36	1.08	0.01*	B>C
Participation in management (consultation)	3.27	1.11	3.28	1.19	2.91	1.21	3.07	1.18	<0.01**	A>C, B>C
Participation in management (co-decision)	3.21	1.17	3.19	1.24	2.73	1.2	3.02	1.18	<0.01**	A>C, B>C

Note: M - mean; SD – standard deviation; significance of differences at the level of * $p < 0.05$, ** $p < 0.01$; *** ANOVA Kruskal-Wallis test.

In the case of employment in non-standard forms, the statistically significant differences between the analyzed groups occurred for the following interests (see Table 1.3): transparent criteria in assessing the implemented tasks

(p=0.01), remuneration adequate to duties (p=0.03), and protection and access to social benefits (p=0.04), good atmosphere at work (p<0.01), proper flow of information (p=0.3), influence on the selection of remuneration components (p=0.01), transparent rules of promotion (p=0.01), formal procedures for expressing opinions (p<0.01), assistance of trade unions/employee councils (p=0.01), opportunities for professional development (p=0.01), participation in management (consultation) (p<0.01), participation in management (co-decision) (p<0.01).

Table 1.3. Differences in the assessment of meeting employee interests in non-standard forms of employment based on age

Employee interests	A Age group: 18-24		B Age group: 25-39		C Age group: 40-54		D Age group: 55-64		Significance of differences	Statistically significant differences
	M	SD	M	SD	M	SD	M	SD	p ***	
Stable employment	3.55	1.06	3.38	1.15	3.32	1.12	3.20	1.12	0.07	-
Safe and hygienic working conditions	3.96	0.92	3.83	1.00	3.71	1.05	3.69	1.08	0.09	-
Transparent criteria in assessing the implemented tasks	3.85	0.95	3.76	0.93	3.59	1.02	3.57	1.00	0.01*	A>C
Influence on the selection of co-workers	3.06	1.25	3.06	1.20	2.91	1.17	2.95	1.13	0.29	-
Remuneration adequate to duties	3.59	1.00	3.50	1.07	3.28	1.12	3.37	1.11	0.03*	B>C
Protection and access to social benefits	3.25	1.10	3.40	1.14	3.19	1.14	3.16	1.13	0.04*	B>C
Training paid by the employer	3.44	1.22	3.34	1.20	3.16	1.22	3.14	1.17	0.05	-
Good atmosphere at work	3.93	0.90	3.76	0.99	3.50	1.06	3.61	0.95	<0.01**	A>B, A>C
Proper flow of information	3.75	0.95	3.52	1.03	3.42	1.10	3.54	0.92	0.03*	A>C
Influence on the organization of working time	3.48	1.02	3.44	1.11	3.28	1.13	3.35	1.12	0.21	-
Influence on the selection of remuneration components	3.34	1.09	3.16	1.17	2.96	1.21	3.10	1.17	0.01*	A>C
Health benefits paid by the employer	3.25	1.23	3.17	1.23	3.07	1.22	3.06	1.24	0.38	-
Assistance in the event of dismissal	2.90	1.21	3.00	1.18	2.81	1.15	2.86	1.18	0.19	-

Employee interests	A Age group: 18-24		B Age group: 25-39		C Age group: 40-54		D Age group: 55-64		Significance of differences p ***	Statistically significant differences
	M	SD	M	SD	M	SD	M	SD		
Transparent rules of promotion	3.40	1.08	3.35	1.11	3.10	1.15	3.13	1.11	0.01*	A>C
Formal procedures for expressing opinions	3.44	1.07	3.38	1.07	3.11	1.06	3.23	1.07	<0.01**	A>C, B>C
Assistance of trade unions/employee councils	3.18	1.22	3.02	1.21	2.77	1.29	2.82	1.25	0.01*	A>C
Opportunities for professional development	3.56	0.98	3.36	1.11	3.17	1.13	3.28	1.12	0.01*	A>C
Participation in management (consultation)	3.13	1.16	3.17	1.12	2.78	1.16	2.89	1.14	<0.01**	A>C, B>C
Participation in management (co-decision)	3.13	1.20	3.08	1.15	2.72	1.21	2.91	1.24	<0.01**	A>C, B>C

Note: M - mean; SD – standard deviation; significance of differences at the level of * p <0,05, ** p <0,01; *** ANOVA Kruskal-Wallis test.

When comparing the diagnosed differences in the assessment of the degree of meeting employee interests regarding the employment in standard forms against the employment in non-standard forms, they occur in the case of the following interests: transparent criteria in assessing the implementation of tasks (significant for employment in non-standard forms), training paid by the employer (significant for employment in non-standard forms), good atmosphere at work (significant for employment in non-standard forms), proper flow of information (significant for employment in non-standard forms), assistance in the event of dismissal (significant for employment in standard forms), transparent rules of promotion (significant for employment in non-standard forms).

In the assessment of the degree of meeting employee interests referring to employment in standard forms, in the case of training paid by the employer, a statistically significant difference in the assessment of this interest occurs between group B and groups C and D. This means that the employees aged 25-39 (group A) assess higher possibility of training paid by the employer than older generations of workers (C and D). In the case of assistance in the event of dismissal, statistically significant differences were found between groups A and C as well as B and C, along with the employees aged 40-54 (group C) assessing the realization of this interest worse compared to the younger generations (A and B).

When evaluating the degree of meeting employee interests in non-standard forms of employment, in the case of transparent criteria in assessing the implementation of tasks, a statistically significant difference occurs between groups A and C, which means that the youngest generation of employees evaluates the degree of meeting this interest higher than the employees aged 40-54 (group C). Regarding good atmosphere at work, statistically, significant differences were recorded between groups A and B as well as A and C. The employees aged 25-39 assess meeting the interest in a good atmosphere at work higher than the employees from groups B and C. The degree of meeting the interest – proper flow of information indicates the occurrence of a statistically significant difference between groups A and C, where the youngest generation of employees evaluates the degree of meeting this interest higher. A similar situation takes place in the case of transparent rules of promotion, in the case of which the youngest generation of employees indicates their better implementation than the employees aged 40-54 (group C).

5. Discussion

The following employee interests, implemented to the highest degree in standard forms, correspond, above all, with the approach to work presented by Baby Boomers: (1) safe and hygienic working conditions, (2) stable employment, and (3) transparent criteria in assessing the implemented tasks. This approach emphasizes the need for stable employment and safety, as well as lower flexibility in the work practice and the stability of behavior (Rogozińska-Pawełczyk, 2014; Żarczyńska-Dobiesz & Chomątowska, 2014; Kroenke, 2015; Smolbik-Jęczmień, 2017), which may be conducive to transparent criteria in assessing the results of the work. However, in the case of non-standard forms, the top three employee interests also included (1) safe and hygienic working conditions and (2) transparent criteria in assessing the implemented tasks. The difference is visible in a much lower position of employment stability (seventh place). In turn, the atmosphere at work takes the third place. Both the absence of the need for employment stability and the greater need to experience a good atmosphere correspond with the characteristics of the youngest generation active in the labor market (Rogozińska-Pawełczyk, 2014; Żarczyńska-Dobiesz & Chomątowska, 2014; Kroenke, 2015; Smolbik-Jęczmień, 2017).

It should be positively assessed that in the opinion of employees (regardless of the employment status), the need to ensure safe and hygienic working conditions is met to a high degree. It is confirmed by the results of an earlier analysis conducted using the case study method, in which workplaces were analyzed and found no deviations in the approach towards shaping

material conditions for those employed in standard and non-standard forms (Bąk-Grabowska, 2017). On the other hand, a very low level of meeting interests related to employee participation, both direct and indirect, should be considered a significant problem. Surprisingly, in the case of standard forms, assistance of trade unions/employee councils was ranked lower than in the case of non-standard forms. These results can, however, be explained by the generally low level of unionization in Poland. According to the data provided by Statistics Poland, in 2018, a total of 1.5 million people belonged to 12.5 thousand employee organizations, compared to approx. 16 million of all people working in the national economy. Statistical data show differences in the degree of unionization in individual industries, which the experts associated with the types of employment used in these sectors. The industries with prevailing non-standard forms are also characterized by lower unionization (Szumlewicz, 2014). Therefore, one could assume that the employees working in standard forms feel greater support as part of indirect participation, but this is not the case. As indicated, among others, by Gableta (2016) and Cierniak-Emerych (2012), employee participation is, on the one hand, a way to ensure the realization of employee interests, and on the other, it can serve to develop long-term employee involvement. The general picture that emerges from the presented research results does not fall satisfactorily within the subjective approach to employees or the assumptions of sustainable human resource management (Piwowar-Sulej, 2021).

In this general picture, however, there are differences indicated by the statistical analysis of differences in the declared degree of meeting individual employee interests in terms of age. The youngest employees, working based on standard forms, rated assistance in the event of dismissal higher than the selected groups of older employees as well as the implementation of the interests being a part of direct participation, such as the influence on the selection of remuneration components, formal procedures for expressing opinions, consultation, and co-decision. Even greater satisfaction of the Generation Z representatives working in non-standard forms is more clearly visible in relation to the selected groups of older employees. They assessed the higher degree of meeting employee interests in direct and indirect participation, along with the transparent criteria in assessing the implemented tasks, transparent rules of promotion, or the opportunities for professional development. This may prove that younger employees are able to enforce the realization of their interests, even when legal regulations do not provide such guarantees (e.g., in the case of employment based on civil law contracts). This is in line with the characteristics of Generation Z, which highly values the comfort of life and work and is capable of striving for this comfort with less commitment to the loyalty issue related to the employer (Rogozińska-

Pawełczyk, 2014; Żarczyńska-Dobiesz & Chomątowska, 2014; Kroenke, 2015; Smolbik-Jęczmień, 2017). For comparison, the representatives of older cohorts, the Baby Boomer generation and Generation X did not show a statistically significant higher assessment of meeting any of the interests, both in the case of employment based on standard and non-standard forms.

6. Conclusion

It has been found that the different generations of employees: Baby Boomers, Generation X, Generation Y, and Generation Z represent different needs, values, and expectations towards the employer. Recognizing and considering these expectations can contribute to better human resource management. At the same time, various forms are used in shaping both standard and non-standard employment. The conducted analysis of normative and literature-based approaches allowed concluding that it is the standard form that should ensure, to a greater extent, meeting employee interests. This is related to labor law regulations providing protection of vital employee interests, which is also confirmed by some of the existing research results. Certain approaches towards using non-standard forms identify risks typical of precarious employment. However, the performed analysis of empirical data showed common strengths and weaknesses in the realization of employee interests, both for standard and non-standard forms. Most of all, providing employees with safe and hygienic working conditions was highly rated, whereas employee participation received a low evaluation. The specificity of Generation Z was clearly visible, whose representatives (compared to older cohorts) frequently rated the satisfaction of employee interests higher in standard forms and even more often in non-standard forms. This may indicate greater skills of young people than, in the case of older generations, in ensuring satisfactory working conditions for themselves. It seems worth emphasizing, however, that this does not dispense employers with the need for a balanced approach to human resource management. Responsibility in employing young people in non-standard forms should be manifested in adopting a long-term perspective for considering the consequences and offering employees the possibility of choosing the form of employment.

Acknowledgment

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Biographical notes

Dominika Bąk-Grabowska is a Professor at Wroclaw University of Economics and Business. Her scientific interests concentrate on problems of human resources management in the conditions of nonstandard employment and multi-entity structures. Recent publications: "Non-permanent employment and employees' health in the context of sustainable HRM with a focus on Poland" and "The impact of mandate contract and self-employment on workers' health–Evidence from Poland."

Katarzyna Grzesik is an Assistant Professor at Wroclaw University of Economics and Business. Her research interests focus on leadership, human resources management, generational differences in the workplace, and decision-making in the organizational setting. Recent publication: "The determinants influencing decision making in organizational settings – an integral approach."

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Circular economy in the implementation of the investment and innovation policy of environmental management in post-war Ukraine

Svitlana Bondarenko[1] Oksana Nikishyna[2]

Abstract

The purpose of the study is to develop methodological support for a comprehensive assessment concerning dominants of the investment and innovation policy of nature management based on the circular economy. It also conducts an assessment of current trends and problems in post-war Ukraine. The basic methodological platform introduces the concept of sustainable development. The dominants of the investment and innovation policy of nature management are derivative and closely related to the objectives and indicators of sustainable development goals. To generalize and systematize the categorical apparatus and identify modern vectors of scientific research on this issue, a descriptive analysis was used – based on the sources of the Scopus scientometric database. The modern imperatives of the circular approach in the economy and the possibility of introducing the latest investment and innovation policy of nature management in post-war Ukraine are considered. The scientific novelty of the study lies in the development of methodological support for a comprehensive assessment and is based on: (1) a set of principles (systematicity and complexity, adequacy and dynamism, objectivity and accuracy, effectiveness, purposefulness, scientificity); (2) an expanded system of national indicators of sustainable development within the framework of Sustainable Development Goals 2, 6, 7, 8, 9, 12, 15, which integrates European, author's, economic and environmental indicators focused on an in-depth assessment of investment and natural resource potential in terms of species and structural-sectoral dimension, the relationship between the investment and environmental components of nature management; (3) a 7-stage procedure for quantitative, qualitative and expert assessment of the

1 Svitlana Bondarenko, Ph.D., Professor in Department of Journalism, National Aviation University, Lyubomyr Huzar avenue, 1, Kyiv, Ukraine, 03058, e-mail: svitlana.bondarenko@npp.nau.edu.ua (ORCID: 0000-0002-1687-1172).
2 Oksana Nikishyna, Dr of Economic Sciences, Senior Researcher, Head of Department of Market Mechanisms and Structures, Institute of Market and Economic & Ecological Research of National Academy of Sciences of Ukraine, Frantsuzskiy boulevard, 29, Odessa, Ukraine, 65044, e-mail: ksenkych@gmail.com (ORCID: 0000-0002-7172-3551).

degree of implementation of the dominants of the investment and innovation policy of environmental management in the internal and external dimensions, the results of which form an analytical basis for adjusting the dominants, substantiating directions, ways and mechanisms for implementing the investment and innovation policy of the circular economy. The prospect of further research in this direction is the development of adaptive mechanisms to stimulate the introduction of eco-investments and innovations in the activities of business entities in various sectors of the economy.
Keywords: circular economy, nature management, investment and innovation policy of nature management, sustainable development, Sustainable Development Goals, dominants of investment and innovation policy of nature management.

1. Introduction

In the context of increasing negative influences and fluctuations in the external environment caused by the Russian-Ukrainian war, intensifying threats to the environmental security of Ukraine, and inefficient use of its natural resource potential, there is a need to implement a modern model of investment and innovation policy for environmental management based on the norms and principles of the circular economy (Circular Economy, 2022). The circular economy is regenerative in its scheme, it concerns all activities of reduction, reuse and recycling in production, circulation, and consumption (Alcayaga et al., 2019; Negrete-Cardoso et al., 2022). Its basis is formed, on the one hand, by a system of partnership between the state, science, business, and society based on the introduction of the "quad-spiral" concept; on the other hand, sustainable, environmentally balanced development (European Commission, 2022; Shpak et al., 2020; Bondarenko et al., 2021a).

However, as research shows (Diaz et al., 2022; Foroozanfar et al., 2022; Suárez-Eiroa et al., 2021; Zerkina et al., 2022), strategies for providing resilience to complex socio-economic systems are almost not included in the strategies of the circular economy, which reduces the ability to generate real change. Further research is required to conduct a more holistic analysis based on sophisticated adaptive systems thinking to enhance socially equitable development that preserves the environment. This area of research is the scientific basis for introducing adaptive mechanisms to stimulate the rational use of natural resources of the national economy during the post-war restoration of Ukraine.

The issue of the study is closely related to sustainable development institutions, in particular, the program for the implementation of the Sustainable Development Goals until 2030, proclaimed by the UN General Assembly Resolution № 70/1 (25.09.2015) (Ministry of economic development and trade of Ukraine, 2017), the Strategy for Sustainable Development of Ukraine until 2030 (UNDP, 2017).

The purpose of the study is to develop methodological support for a comprehensive assessment of the dominants of the investment and innovation policy of nature management based on the circular economy and to conduct a comprehensive assessment of current trends and problems of investment and innovation support for nature management in post-war Ukraine. The following research goals (RG) are proposed for consideration:

RG1) *Substantiation of the methodological approach to a comprehensive assessment of the dominants of the investment and innovation policy of nature management on the basis of a circular economy in the dual unity of the conceptual and methodological bases.*

RG2) *Identification of the key dominants of the investment and innovation policy of nature management in the coordinates of sustainable development based on European methods and practices.*

RG3) *Implementation of a qualitative assessment of the dynamics of changes in indicators and an expert assessment of the degree of implementation of the dominants of the investment and innovation policy of environmental management in Ukraine, the identification of «bottlenecks» in the process of implementing the investment and innovation policy of sustainable development of post-war Ukraine.*

RG4) *Substantiation based on the obtained results of directions and ways to increase the degree of implementation of the dominants of the investment and innovation policy of environmental management based on the circular economy in the coordinates of sustainable development of post-war Ukraine.*

2. Literature background

In world practice, a fairly high variability of approaches is used to achieve the goals of circular economy strategies. The circular economy is based on business models aimed at realizing the goals of reduction, alternative reuse, recycling, and recovery of materials in production/distribution (Korchonen et al., 2018).

The circular economy is becoming increasingly important both strategically and economically, laying the foundation for building a resource-efficient and environmentally friendly society. At the heart of business models of the circular economy are:

- innovative methods of reduction, reuse and recycling in production, circulation, and consumption (Kirchherr et al., 2017);
- methods of systematic analysis (Hurochkina et al., 2021; Yu et al., 2022);
- political instruments for the creation and operation of global, regional, national, local, and industrial parks (Ujwary-Gil & Godlewska-Dzioboń, 2022; Brzezinski et al., 2022);
- waste management systems to reduce more effectively, reuse, recycle and dispose of waste in an environmentally friendly way (Wang et al., 2022).

Therefore, the circular economy aims to provide comprehensive and systematic solutions in the following main areas (Parthiban & Gopalakrishnan, 2019; Ujwary-Gil & Potoczek, 2020; Skene et al., 2022):

- sustainable waste management, taking into account the economy, society and the environment;
- achieving a green, low-carbon and cyclical development model;
- development of cleaner production;
- optimization of the industrial structure, policy instruments and adjustment rules;
- social management through green consumption;
- effective management;
- conservation of renewable and natural resources.

Active implementation of environmental innovation and change management through the transformation of the business model of the circular economy is an element and scientific. It also provides a practical approach to the environmental policy of business, which contributes to the incentives for innovative products with less environmental impact during the life cycle.

The main imperatives of the circular approach in the economy are (Reike et al., 2017):

- R0: Refuse;
- R1: Reduce;
- R2: Resell/Re-Use;
- R3: Repair;

- R4: Refurbish;
- R5: Remanufacture;
- R6: Repurpose;
- R7: Recycle Materials;
- R8: Recover (energy);
- R9: Re-mine.

Based on the typology, the researchers identified the imperatives of the circular economy (Figure 2.1).
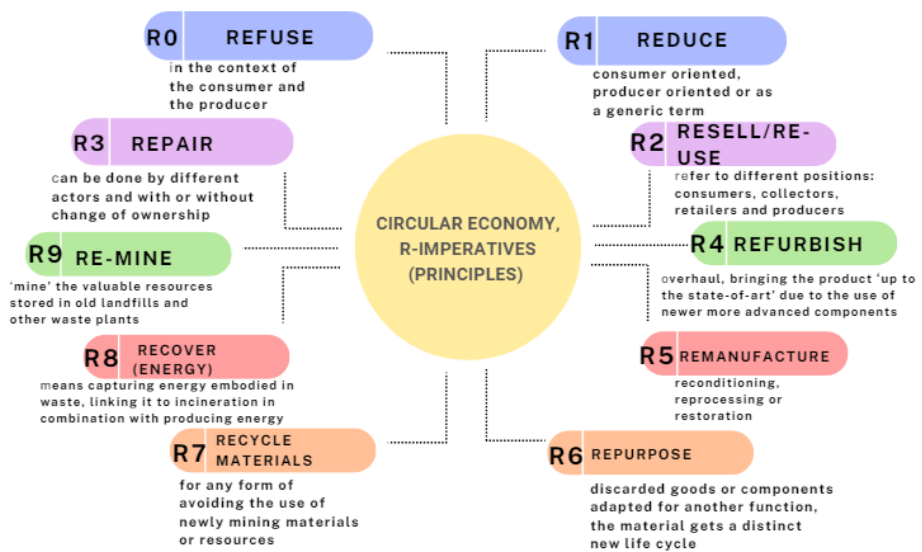
Figure 2.1. Typology of circular economy imperatives

Source: Based on Reike et al. (2017).

The main activities of the circular economy are: impact mitigation, reuse, processing, disposal, and synergy (Table 2.1).

The implementation of the circular economy business model contributes to competitiveness and climate neutrality and is also the basis for developing resilience and sustainability of industrial production of high-quality products (Abreu et al., 2018; Awan et al., 2020). Extending the producer's responsibility for the product to its post-consumer stage, transferring the costs of waste management from local governments to consumers and producers - this political strategy affects not only the physical properties of the product but also environmentally responsible ways of consumption and production (Bondarenko et al., 2021b; Szczygieł, 2022).

Table 2.1. The main directions of activities of the circular economy

The imperatives of the Circular Economy	Characteristics of types of activities
R0: Refuse *R1: Reduce*	• prevent waste generation and pollution at the source, as well as reduce the amount of waste for final disposal, including ecological design of products; • situation monitoring, information analysis, political tools and methods of green living, green procurement, ecological applications to reduce the consumption of energy, water and other resources, as well as to minimize the generation of waste; • increasing the efficiency of resource use through sustainable exploitation, effective management and storage; • green consumption based on the exchange of services and products.
R2: Resell/Re-Use *R3: Repair* *R4: Refurbish*	• implementation of sustainable strategies to extend the life of products, including sustainable consumption; • projects and methods for reuse, repair, reconstruction, cascading use, and remanufacturing.
R5: Remanufacture *R6: Repurpose* *R7: Recycle Materials*	• transformation of waste into secondary resources, including collection, classification, and transformation of waste; • mechanical and physical processing of materials; • heat recovery; • methods of complex utilization; • development of a system of extended producer responsibility. • development of methods, projects, operations, and management of waste treatment and disposal techniques in response to the circular economy and sustainable development, including pre-treatment, disinfection, incineration and other thermal treatment, burial, solidification, stabilization, and joint disposal; • reclamation of the contaminated site; • underground filling of waste; • analysis of material flows, risk assessment.
R8: Recover (energy) *R9: Re-mine*	• comprehensive, systematic and innovative solutions, ideas and methods to promote sustainable waste management, including emission reduction and carbon neutrality; • construction of waste-free cities; • integration and demonstration of technologies, such as cross-industry or inter-enterprise cooperation technologies, cloud and information technologies; • management of the life cycle of materials; • green supply chain.

Source: Based on Reike et al. (2017); Parthiban & Gopalakrishnan (2019); Szczygieł (2022).

Transformations based on digital innovation, climate protection technologies, job creation and growth within the planet contribute to the quality of life of the population and the development of the location, as well as increasing resilience and ensuring greater independence from global supply chains (Antikainen et al., 2018; Chambers et al., 2019). In science, there is

a certain development regarding the methodological support of greening the investment and innovation policy of nature use.

On the basis of the conducted study of of the components of the category "investment and innovation policy of nature use," the authors' definition is proposed, namely: *a set of economic, organizational and institutional measures, mechanisms, methods and forms of management of ecologically oriented investments and innovations for the sustainable use, reproduction and protection of natural components like resource potential, which are implemented by state authorities, representatives of business, science and various stakeholders on the basis of sustainable development of the national economy.* In this definition, the emphasis is shifted to the interaction of four subjects of the investment and innovation policy of nature use through the prism of the concepts of cyclical economy, "quadruple-spiral" and sustainable development of the economy.

In this study, the dominants of the investment and innovation policy of environmental management will be understood as the main goals (strategic priorities) of the policy of investment and innovation support of the sphere of rational environmental management and environmental safety of the state on the basis of sustainable development.

Methodical approaches to assessing "green" transformation based on OECD "green" growth indicators are proposed by Musina and Kvasha (2017). The methodological principles of monitoring the Goals of sustainable development in Ukraine are outlined in the National Report of the Ministry of Economic Development and Trade of Ukraine (2017). Methodical approaches to determining the dominant investment and innovation policy of nature use in the regional dimension were developed by Andreeva and Tyutyunnyk (2020). Methodological recommendations for assessing the impact of economic indicators on the main indicators of "green" growth - by a team of authors of the Institute of Market Problems and Economic and Environmental Research of the National Academy of Sciences of Ukraine (Burkynskyi et al., 2019).

The considered methodical approaches allow multifaceted assessment of various aspects of the investment and innovation policy of nature use. As far as we are concerned, there is no comprehensive, methodical support for this policy's diagnosis of dominants (strategic priorities) based on the principles of sustainable development and the concept of the "quad-spiral." This concept was developed by Carayannis, Bart, and Campbell (2012), expanding the traditional triple innovation spiral by including society and various stakeholders. Modern transformations of the conceptual basis involve innovations in the assessment methodology of the investment and innovation policy of nature management.

Conducted studies of current methodical approaches to the assessment and monitoring of the state of rational nature management, approved by the regulatory and legal documents of Ukraine, proved the limitation and locality of indicators that do not reflect all the strategic priorities of the investment and innovation policy of sustainable development, and do not allow a comprehensive assessment of the cause-and-effect relationships between driving forces, the impact on the environment, the state of health of the population, to analyze the current trends of sustainable development in the structural and sectoral dimension.

Thus, the current methodology for monitoring and evaluating the effectiveness of state regional policy (Verkhovna Rada of Ukraine, 2015) contains single indicators, primarily in the direction of the ecological capacity of the economy. The system of indicators for evaluating the implementation of the state environmental policy, provided for by the Law of Ukraine "On the Basic principles (strategy) of the state environmental policy of Ukraine for the period up to 2030" (2697-VII), adapted for the assessment of the Sustainable Development Goals, however, it does not contain indicators characterizing the investment and innovation provision of rational nature management, as well as the health status of the population.

In modern conditions, the influence of analytical information on the effectiveness of management decisions of authorities at various levels is increasing and the task of analyzing the effectiveness of their policies is deepening. Some traditional approaches to its methods are being revised, considering the requirements of modern transformations. New analytical tasks are emerging, such as monitoring sustainable development trends and assessing the impact of eco-investments and innovations on the sustainable use of natural resource potential and the national economy's ecological capacity. Therefore, there is an objective need for a comprehensive assessment of the investment and innovation policy of nature management, which involves the systematization of indicators taking into account their interrelationships. At the same time, the indicators that variously characterize the components of the investment and innovation policy of nature use should be organically connected to each other in a single complex system.

3. Methodological approach

Descriptive analysis was used to generalize and systematize the categorical apparatus and highlight modern vectors of scientific research on the given issue - based on the sources of the Scopus scientometric database. Analytical study of the main keywords in selected directions (Figure 2.2) made it possible to form a structural and logical scheme of scientific research (Figure 2.3).
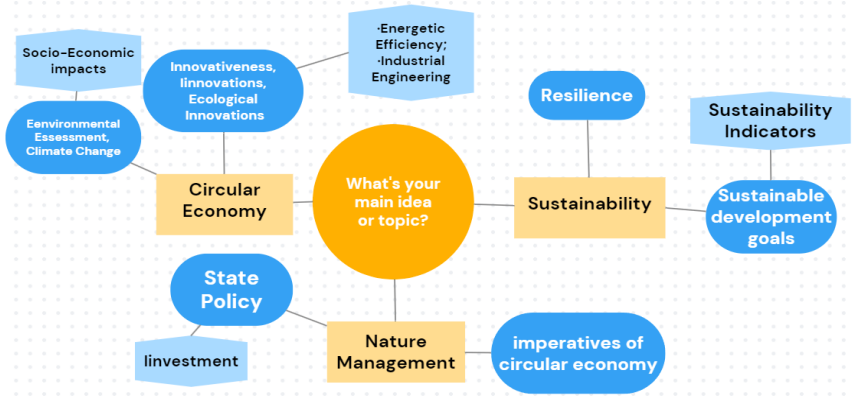
Figure 2.2. Structural and logical scheme of scientific research on the
implementation of the investment and innovation policy of nature use
(by keywords)

Source: Based on Scopus, 2022.
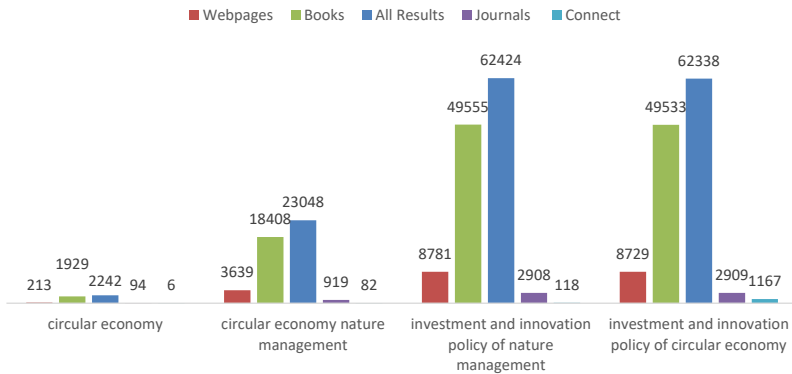
Figure 2.3. Representation of Scopus scientometric database sources by key phrases

Source: Based on Scopus, 2022

As of November 2022, the search query «circular economy» in Scopus
shows: All Results 2,242; Webpages 213; Books 1,929; Journals 94;
Connect 6. Many more sources are displayed in Scopus by search «circular
economy nature management»: All Results 23,048; Webpages 3,639;
Books 18,408; Journals 919; Connect 82. Even more sources by search
«investment and innovation policy of nature management»: All Results 62,424;
Webpages 8,781; Books 49,555; Journals 2,908; Connect 1,180. Regarding
the category «investment and innovation policy of circular economy», then

the sources are displayed in the Scopus: All Results 62,338; Webpages 8,729; Books 49,533; Journals 2,909; Connect 1,167.

The basic methodological platform for determining the dominants of the investment and innovation policy of nature management is the concept of sustainable development. The dominants of the investment and innovation policy of nature management are derived from the Sustainable Development Goals and are closely related to the objectives and indicators of the Sustainable Development Goals (Sustainable Development Goals: Ukraine, 2017). Structurally, the investment and innovation policy of optimal nature management is the development of goals (dominants), tasks, and implementation devices. Indicators of the implementation of the Sustainable Development Goals are not independent variables. That is to say, it is impossible to simultaneously ensure progress in all areas. This implies the need to establish priorities and mechanisms for their achievement on the basis of a consensus of the economic interests of the state, representatives of business, science and society, depending on the specifics of the political and socio-economic situation in the country.

Progress in implementing the dominants of the investment and innovation policy for environmental management and achieving the Sustainable Development Goals will depend on the effectiveness of consolidation and targeted interaction between the institutions of the state, business, science, and society.

4. Results

4.1. Methodological approach to a comprehensive assessment of the dominants of the investment and innovation policy of nature management based on the circular economy

The process of implementing the investment-innovation policy of nature management takes place under the influence of a set of factors that have a different nature, but mainly have an economic meaning, which is determined by the actions of the state, business entities, and various stakeholders.

Dominants of the investment and innovation policy of nature management are derived from the Goals of sustainable development: (2) «Overcoming hunger, development of agriculture,» (6) «Clean water and proper sanitary conditions,» (7) «Affordable and clean energy,» (8) «Decent work and economic growth,» (9) «Industry, innovation and infrastructure,» (15) «Protection and restoration of terrestrial ecosystems» (Figure 2.4).
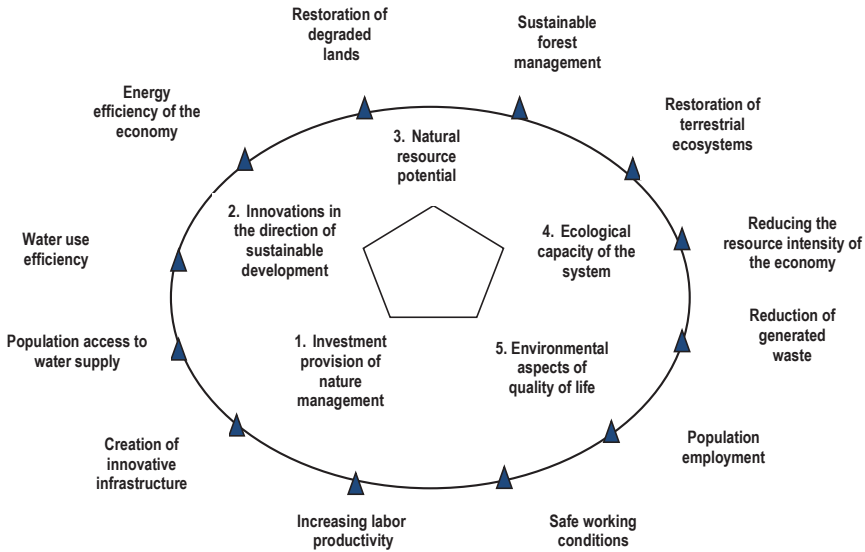
Figure 2.4. Dominants of the investment and innovation policy of nature management in the coordinates of the Sustainable Development Goals

Consequently, some indicators of sustainable development can be used for a comprehensive assessment of the implementation of the dominants of the investment and innovation policy of nature management. The methodological approach proposed by the authors to a comprehensive assessment of the dominants of the investment and innovation policy of the national economy combines the conceptual and methodological basis, the components of which are shown in Table 2.2.

Table 2.2. Methodological approach to a comprehensive assessment of the dominants of the investment and innovation policy of nature management

Conceptual basis: concepts of sustainable development, „green" growth, circular economy, innovative development of the socio-economic system based on the „quadra-spiral"
The purpose of the methodological provisions: a comprehensive assessment of the degree of implementation of the dominants of the investment and innovation policy of nature management and their components through the prism of the Goals and objectives of sustainable development, measuring the progress of sustainable development of the national economy, as a methodological basis for diagnosing the effectiveness of the current investment and innovation policy of nature management and substantiating the directions for its adjustment to increase the degree of implementation of the key dominants of the investment and innovation policy of sustainable development.

Tasks methodological provisions: 1. Systematization of information flows in the context of the main directions of a comprehensive assessment of the dominants of the investment and innovation policy of nature management and their components

2. Assessment of the state and dynamics of economic and environmental indicators in the context of the Goals and objectives of sustainable economic development

3. Evaluation of the relationship and correlation of different indicators both within a certain dominant of the investment and innovation policy of nature management, and indicators of different dominants

4. Determination based on the results of a comprehensive assessment of negative trends and «bottlenecks» in the process of sustainable development

5. Generalization and qualitative assessment of the dynamics of changes in the indicators of the investment and innovation policy of sustainable development.

6. Substantiation of ways and directions for increasing the degree of implementation of the dominants of the investment and innovation policy of nature management, taking into account European practices.

Principles of a comprehensive assessment of the dominants of the investment and innovation policy of sustainable development

1. Systematicity and complexity	The assessment of the dominants of the investment and innovation policy of nature management as a complex system of goals and objectives of sustainable development is carried out taking into account all internal and external links between its elements and their interdependence
2. Adequacy and dynamism	Correspondence of methods and techniques for assessing modern patterns of fluidity of reproduction processes in a circular economy, diagnostics of the dominants of the investment and innovation policy of environmental management in the constant development of socio-economic systems
3. Objectivity and accuracy	The information base for a comprehensive assessment should be reliable, and its results should be based on accurate analytical calculations
4. Effectiveness	The results of assessing the achievement of the Sustainable Development Goals should be of practical importance, serve as an analytical basis for adjusting the dominants of the investment and innovation policy of environmental management, substantiating adaptive mechanisms for sustainable development in crisis conditions
5. Purposefulness	Focus on achieving the main goal of the methodology - a comprehensive assessment of the degree of implementation of the dominants of the investment and innovation policy of environmental management in the coordinates of the Goals and objectives of sustainable development of the state
6. Science	Continuous improvement of methods for diagnosing the dominants of the investment and innovation policy of environmental management and the use of advanced world experience in assessing the progress of sustainable development

Methodological provisions for a comprehensive assessment of the dominants of the investment and innovation policy of nature management. **Stages:**

I. A comprehensive assessment of the degree of implementation of the dominants of the investment and innovation policy of environmental management using groups of indicators of sustainable development:

Dominants	Groups of evaluation indicators of investment and innovation policy of nature management

1. Sufficient investment support for rational nature management of the national economy	1.1. The share of environmental investments in gross domestic product and budget expenditures 1.2. Dynamics and structure of capital investments for environmental protection 1.3. Dynamics and structure of current investments in environmental protection 1.4. Dynamics of aggregate costs for environmental protection in the sectoral dimension
2. Investment support for scientific research and innovation in the direction of sustainable development	2.1. Creation of innovative infrastructure 2.2. Development of innovative activity of the industrial sector of the economy 2.3. State expenditures on research and innovation in the direction of sustainable development
3. Restoration, sustainable use and protection of the components of the natural resource potential of the national economy	3.1.-3.6. Assessment of the use of water, energy, land, forest, mineral and raw materials resources, nature reserve fund in the coordinates of sustainable development
4. Reducing the eco-destructive impact of the socio-economic system on the state of the natural environment	4.1.-4.2. Assessment of the ecological capacity (waste and carbon capacity) of the national economy on the basis of sustainable development
5. Improvement of environmental aspects of the quality of life of the population	5.1.-5.2. Assessment of labor resources in the field of nature management, ecological aspects of the quality of life of the population

II. Assessment of deviations of the actual values of indicators from the targets for sustainable development and the levels of indicators of the OECD countries, determination of sustainable development trends in the internal and external dimensions.
III. Determination of the causes of deviations, cause-and-effect relationships between economic and environmental indicators of sustainable development, problematic aspects of the implementation of the dominants of the investment and innovation policy of nature management.
IV. Qualitative assessment of the dynamics of changes in indicators, an aggregated conclusion about the state of achieving sustainable development.
V. Expert and integral assessment of the degree of implementation of the dominants of the investment and innovation policy of environmental management of the national economy.
VI. Substantiation based on the results of a comprehensive assessment of directions and ways to increase the degree of implementation of dominants I of the investment and innovation policy of environmental management based on sustainable development

Mechanisms to stimulate the introduction of environmentally oriented investments and innovations by business entities by sectors of the economy**:**

1. Institutional	**3. Administrative**
2. Financial and economic	**4. Informational**

The main purpose of the methodological provisions is a comprehensive assessment of the degree of implementation of the dominants of the investment and innovation policy of nature management and their components through the prism of the Goals and objectives of sustainable development. Measuring the progress of sustainable development of the national economy, as a methodological basis for diagnosing the effectiveness of the current investment and innovation policy of nature management increasing the degree of implementation of key investment dominants -innovation policy of sustainable development. Among the identified six main tasks of the methodological provisions, the central place belongs to the analysis of the state and dynamics of economic and environmental indicators in the context of the Goals and objectives of sustainable development, the results of which allow us to identify bottlenecks in the process of sustainable development of the economy. Also, substantiate ways, directions, and mechanisms for stimulating the introduction of environmentally oriented investments and innovations in the activities of economic entities in various sectors of the economy.

An integral part of the methodological approach is the principles of a comprehensive assessment of the dominants of the investment and innovation policy of nature management, to which the authors include the following: (1) consistency and complexity; (2) adequacy and dynamism; (3) objectivity and accuracy; (4) effectiveness; (5) purposefulness, and (6) scientific. The identified principles guide the research vector towards a multidimensional assessment of the dominants of the investment and innovation policy of nature management as a complex system of goals and objectives of sustainable development, taking into account all internal and external relations between its elements. Also, the mutual influence of economic and environmental indicators on the objectivity and accuracy of the information base and analytical calculations, implemented on their basis, on the practical significance of the methodological provisions, their scientific nature, continuous improvement based on the best world experience in assessing the progress of sustainable development of socio-economic systems.

The methodological basis includes methodological provisions regarding a comprehensive assessment of the dominants of the investment and innovative nature management policy based on sustainable development, an analysis of cause-and-effect relationships between economic and environmental indicators of sustainable development, a qualitative analysis of the dynamics of changes in indicators with an emphasis on the structural-sectoral dimension, an integral assessment of the introduction of investment dominants -innovative nature management policy as an analytical basis for making managerial decisions regarding the directions for adjusting the investment and innovation policy of sustainable development and developing adaptive mechanisms to stimulate

the introduction of environmentally oriented investments and innovations in the activities of business entities in various sectors of the national economy.

In the current legal documents of Ukraine, monitoring and evaluation of rational nature management is a component of the overall assessment of the effectiveness of state policy. Thus, the current methodology for monitoring and evaluating the effectiveness of the state regional policy (Verkhovna Rada of Ukraine, 2015), which integrated 61 indicators in 11 areas, provides for only 5 indicators related only to environmental capacity to assess the rational use of natural resources and environmental quality regarding waste intensity of the regional economy. These indicators include, in particular, the volume of pollutant emissions from stationary sources for 1 billion UAH. Gross regional product, growth (decrease) rate per unit of population, percentage of waste disposed of in designated areas or facilities or incinerated in the total volume of waste, percentage of settlements with separate collection of household waste.

At the same time, in the section «Investment and innovation development and foreign economic cooperation» there are no indicators for assessing the dynamics of environmentally oriented investments and innovations. The section «Renewable energy and energy efficiency» contains one indicator of the energy efficiency of the regional economy. Thus, the current methodology for monitoring and evaluating the effectiveness of the state regional policy, on the one hand, is not adapted for monitoring the state of the Sustainable Development Goals. On the other hand, it contains single local indicators that give an incomplete assessment of the state of nature management, primarily in the direction of the ecological capacity of the economy. Therefore, this technique is unacceptable for conducting a comprehensive assessment of the dominants of the investment and innovation policy of environmental management based on sustainable development.

In the EU countries, to assess the state of the environment and the effectiveness of the environmental policy, several environmental indicators are used, classified according to the scheme of the European Environment Agency (Environmental Indicators, 2020):

$$D — P — S — I — R \text{ (DPSIR)}$$

where

D is the Driving force – socio-economic factors that increase or decrease the load on the natural environment.

P – Preasure – direct anthropogenic impact on the environment, which is carried out through emissions and discharges of polluted waste, and use of natural resources.

S – State – the exact state and trends of change in the surrounding natural environment.

I – Impact – the consequences of environmental change on the population's health, nature, and biodiversity.

R – Respons – certain actions to solve environmental problems.

According to the system of analysis according to the methodological scheme (1), socio-economic analysis increases the pressure on the surrounding natural environment and, as a result, generate environmental changes. This leads to the confrontation of human health, ecosystems and materials, which can cause a negative social reaction, which is supported by driving forces due to pressure on the environment or influencing factors directly, through adaptation or preventive actions. In our opinion, the methodological scheme of the European Environmental Agency (1) can be used in the course of determining the dominant factors in the investment and innovation policy of nature use and the grouping of indicators for a complex and varied assessment in a graduated and stepwise manner.

In order to solve these problems, during the decomposition of the identified five dominants of the investment and innovation policy of nature use (Table 2.2), we will use the methodological scheme of the European Environment Agency (1), the methodological approach to monitoring the Sustainable Development Goals adapted to Ukraine, and the methodology OECD to assess the trend of «green» growth.

A selection system of 5 dominants, 17 components, 38 applied, 133 indicators were used for several evaluations. The methodical basis is the definition of the composition of the methodological provisions, as it provides for the construction of certain economic and ecological indicators, which characterize the degree of implementation of the dominant investment-innovation account of nature use and their composition of criticism of the primordial steel.

The evaluation system that is proposed is complementary to 133 indicators, the active components of which are 37 indicators of the Central Government (28%), 15 indicators of «green» vision (11%) and 81 authors' indicators (61%) (Figure 2.5).
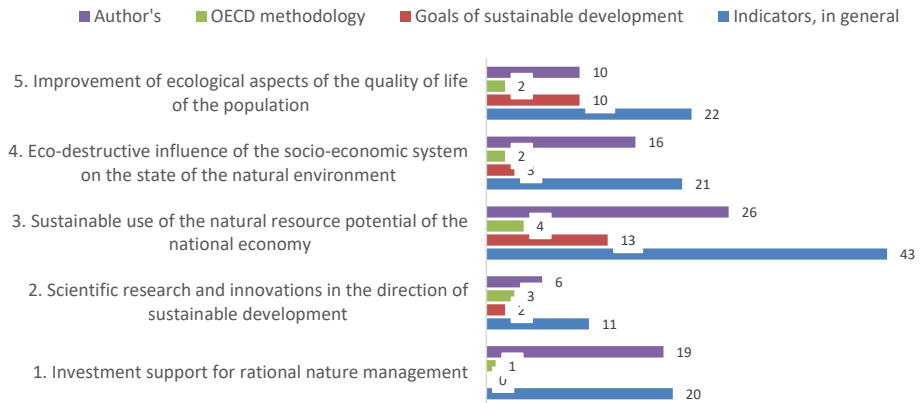
Figure 2.5. Number of indicators for a comprehensive assessment of the dominants of the investment and innovation policy of nature management

The proposed authors' indicators make it possible to comprehensively assess the levels and dynamics of the shares of eco-investments in the gross domestic product, structural changes in environmental protection costs by funding sources, the dynamics and structure of capital and current investments in environmental protection in the specific and sectoral dimensions. A distinctive feature of the system of indicators for evaluating the implementation of Dominant 1 is their specific and structural-sectoral dimension, which makes it possible to determine the structural and dynamic changes in eco-investments in the sectoral context, as well as by types and areas of environmental protection, with an emphasis on financing integrated technologies and research work.

The group of authors' indicators for assessing the implementation of Dominant 2 is focused on analyzing the dynamics and structure of public spending on research and innovation for sustainable development, incl. in the priority area «Rational nature management» in the context of its thematic areas. It should be noted that there are probably no directions for assessing the investment and innovative support of nature management in the works of domestic scientists, which determines the novelty of the authors' methodological approach.

4.2. Assessment of investment and innovation support for rational nature management in pre-war Ukraine

To determine the degree of implementation of the dominants of the investment and innovation policy of nature management through the prism of the implementation of sustainable development goals, we use the method of expert

assessments. The results of a comprehensive assessment of the dominants of the investment and innovation policy of environmental management and a qualitative assessment of the dynamics of changes in target indicators form a powerful analytical basis for questioning specialists on environmental management and sustainable development of the national economy.

We use the appropriate interval scale for a qualitative assessment of the identified dominants of the investment and innovation policy of nature management and their structural components (Table 2.3).

Table 2.3. Scale for assessing the degree of implementation of the dominants of the investment and innovation policy of nature management

Very low	Low	Medium	High Medium	High
0 – 0.20	0.21 – 0.35	0.36 – 0.65	0.66 – 0.80	0.81 – 1.00

The qualitative scale included 5 types of assessments corresponding to certain quantitative values of the dominants of the investment and innovation policy of nature management and their components. With this method of regulation, the degree of implementation of the dominants of the investment and innovation policy of nature management takes on a value from 0 to 1. The closer it is to 1, the higher the degree of implementation of strategic priorities, and vice versa.

Based on a comprehensive assessment of the degree of implementation of the dominant investment and innovation policy of environmental management «Sufficient investment support for rational environmental management of the national economy,» the experts assessed it as low (0.346 points). At the same time, such components as «Share of environmental investments in gross domestic product and budget expenditures» (0.23) and «Dynamics and structure of capital investments in environmental protection» (0.30) received the lowest values, while having higher coefficients significance. It should be noted that the degree of implementation of the task of increasing capital investment, particularly in integrated technologies and research work in the field of environmental protection, was assessed by experts as very low (0.20). This area is unsecured for investment, which significantly slows down the implementation of updated tasks of rational nature management in Ukraine.

The dynamics of the group of indicators that determine the effectiveness of the implementation of task 9.5 «Create an innovative infrastructure that ensures the development of scientific research and scientific and technical developments» Sustainable Development Goals 9 «Industry, innovation and infrastructure» is negative and does not correspond to the target indicators of sustainable development in 2020. In 2019 share the cost of research work in

the gross domestic product amounted to only 0.5%, and the share of innovative products sold in the industrial volume was 0.8%, which reaches 31% and 16%, respectively, of the target values of the indicators. In the sectoral dimension, the highest share of sold innovative products in the total volume was occupied by the printing industry (7.7%), the production of computers (5.8%), and motor vehicles (5%).

The dynamics of indicators characterizing the innovative activity of the industrial sector of the national economy is positive, signaling an increase in the number of introduced low-waste and waste-free technologies in industry. Based on the analysis, it was found that the main subject of the investment and innovation policy of environmental management in Ukraine are industrial enterprises that finance almost 90% of the total costs of environmental protection and the introduction of most environmental innovations into economic practice.

In 2019, the volume of public spending on research and innovation in the direction of sustainable development amounted to UAH 1,425 million, an increase of almost 80% compared to 2015. The structure of this group of expenses is dominated by the financing of life sciences, new technologies for the prevention and treatment of the most common diseases (49.2%), which have a growing trend; the share of expenditures on environmental management and energy efficiency is 22% and 11%, respectively, and is decreasing permanently.

A qualitative assessment of the dynamics of changes in the indicators of investment support for scientific research, development and innovation in the direction of sustainable development is given in Table 2.4.

Table 2.4. Qualitative assessment of the dynamics of changes in indicators of investment support for scientific research, development and innovation in the direction of sustainable development of Ukraine until 2022

Indicators	Dynamics of changes: growth ↑ reduction ↓	Assessment of dynamics: P; N; TIN; TIR, AR
1. Creation of innovative infrastructure (financial and institutional system)		
1.1. The share of expenses for the performance of scientific and technical works in the gross domestic product, %	↓	N; TIN
1.2. The share of implemented innovative products in the volume of industrial production, %	↓	N; TIN
2. Development of innovative activities in the industrial sector of the economy		
2.1. Index of implemented low-waste resource-saving and zero-waste technologies, % until 2010**	↑	P

Indicators	Dynamics of changes: growth ↑ reduction ↓	Assessment of dynamics: P; N; TIN; TIR, AR
2.2. The share of implemented low-waste resource-saving and zero-waste technologies in new technological processes, % **	↑	P
2.3. Index of implemented innovative products in industry, % until 2015**	↑	P
3. State expenditures on scientific research and innovations in the direction of sustainable development		
3.1. Volumes of budget expenditures for scientific research and innovations in the direction of sustainable development, million hryvnias	↑	P
3.2. The share of budget expenditures for scientific research and innovation in the direction of sustainable development in the total amount of budget funding for science and innovation, %	↑	P; AR
3.3. The structure of state expenditures on scientific research by areas of sustainable development, % compared to 2015		
3.3.1. Energy and energy efficiency	↓	AR
3.3.2. Rational use of nature	↓	AR
3.3.3. Life sciences, new technologies for the prevention and treatment of the most common diseases	↑	AR
3.3.4. New substances and materials	↓	AR
3.4. Index of budget expenditures for scientific research and innovation in the direction of sustainable development, total, % until 2015	↑	P; AR
By species:		
3.4.1. Energy and energy efficiency	↑	P; AR
3.4.2. Rational use of nature	↑	P; AR
3.4.3. Life sciences, new technologies for the prevention and treatment of the most common diseases	↑	P; AR
3.4.4. New substances and materials	↑	P; AR
3.5. Index of budgetary funding of scientific research and innovation according to the priority direction „Rational nature management," total, % until 2015**	↑	P; AR
By thematic directions:		
3.5.1. Technologies of sustainable use, preservation and enrichment of biological resources, preservation of biodiversity	↑	P; AR
3.5.2. Technologies for modeling and forecasting the state of the natural environment	↑	P; AR
3.5.3. Technologies of rational use of soils	↑	P; AR
3.5.4. Mineral detection and evaluation technologies	↓	N
3.5.5. Promising technologies of agro-industrial complex and processing industry	↓	N

Indicators	Dynamics of changes: growth ↑ reduction ↓	Assessment of dynamics: P; N; TIN; TIR, AR
3.6. Structural changes in the budget funding of scientific research and innovation under the priority direction «Rational nature management,»% compared to 2015** By thematic directions:		
3.6.1. Technologies of sustainable use, preservation and enrichment of biological resources, preservation of biodiversity	↑	AR
3.6.2. Technologies for modeling and forecasting the state of the natural environment.	↓	AR
	↑	AR
3.6.3. Technologies of rational use of soils	↓	AR
3.6.4. Mineral detection and evaluation technologies	↓	AR
3.6.5. Promising technologies of agro-industrial complex and processing industry		

Note: ** Indicators are proposed by the authors; P - positive dynamics; N – negative; TIN – the target value of the indicator has not been achieved; AR – assessment requires additional research.

The share of budgetary funding of scientific and research work in the direction of sustainable development in Ukraine remains extremely low and is about 28% of the total amount of state funds allocated for science and innovation. Despite the positive trend of increasing state expenditures in all priority areas of sustainable development, their shares in the total amount of budget funding are very low and amount to 6.1% for rational nature management, 5.1% for new substances and materials, 3% for energy and energy efficiency, 1%. Therefore, the innovative way of sustainable development of the state is not secured by investment.

On the basis of a comprehensive assessment, the degree of implementation of the dominant investment and innovation policy of nature use «Investment support for scientific research, development and innovation in the direction of sustainable development» was assessed by experts as low (0.296). At the same time, such components as «Creation of innovative infrastructure» (0.20) and «State expenditures on scientific research and innovation in the direction of sustainable development» (0.31) received the lowest values, in particular, the priority direction «Rational nature management.»

One of the ways to stimulate the introduction of innovations in the direction of sustainable development is to allocate additional budget funds to the implementation of scientific research and development projects in the areas of program-target budget funding, as well as to grant funding of scientific projects in priority areas. This will allow for stimulating competition in the field of scientific research and development, which will contribute to increasing the level of efficiency in the use of budget funds.

4.3. Strategic priorities of the investment and innovation policy of sustainable development in post-war Ukraine

The results of a comprehensive assessment of the dominant investment and innovation policy of nature use and the results of an expert and integrated assessment of the strategic priorities of the investment and innovation policy of sustainable development in Ukraine made possible to determine the shortcomings and «bottlenecks» in the process of its implementation, to substantiate the ways of increasing the effectiveness of the existing in the pre-war period investment and innovation policy of nature management, directions for its adjustment taking into account both internal trends of sustainable development and external trends of rational nature management and advanced practices of European states.

The lowest levels of integral evaluations of the degree of implementation were obtained by the first two dominants, focused on investment and innovation to ensure the rational use of nature in the national economy. This is primarily due to the insufficient amount of ecologically oriented investment, the reduction of the share of budget funds in the financing of environmental protection costs, and the weakening of the degree of state participation in the processes of rational nature management, as an investor and as a regulator.

As a result, against the background of the growing dynamics of the volumes of capital and current investments for environmental protection, negative trends arise, in particular, a decrease in the share of capital and total environmental investments in the gross domestic product (their level is much lower than in the EU countries), a reduction in the volume of capital investment in scientific – research work in nature protection direction, a significant reduction in the capital investment structure of expenditures on the implementation of innovative integrated technologies.

In the pre-war period in Ukraine, the main subjects of the investment and innovation policy of nature management were economic entities, primarily of the industrial sector, which financed about 87% of the total costs for environmental protection; the share of other stakeholders decreased from 14.8% to 6.4% over the past 5 years. Integrated point estimates of the degree of implementation of the dominant investment and innovation policy of nature use and their components and tasks with the lowest level of implementation are summarized in Table 2.5.

Table 2.5. Dominant components of the investment and innovation policy of nature use and tasks with the lowest degree of implementation in the pre-war period in Ukraine

Dominants of the investment and innovation policy of nature management	Grade	Value	Components of dominants and tasks with the lowest degree of implementation	Grade	Value
1. Sufficient investment support for the rational use of natural resources of the national economy	0.346	Low	1.1. The share of environmental investments in gross domestic product and budget expenditures	0.23	Low
			1.2. Increasing capital investment, in particular, in integrated technologies and scientific research	0.20	Very low
2. Investment support for scientific research and innovation in the direction of sustainable development	0.296	Low	2.1. Sustainable development goal 9, task 9.5 «Create innovative infrastructure»	0.20	Very low
			2.2. Increase in budgetary funding of scientific research and innovation under the priority direction «Rational nature management»	0.19	Very low
3. Restoration, sustainable use and protection of the components of the natural resource potential of the national economy	0.487	Average	3.1. Goal of sustainable development 7. Sustainable use of energy resources	0.30	Low
			3.2. Sustainable Development Goal 6, Task 6.3 «Reduce the volume of untreated wastewater discharge»	0.21	Low
4.Reducing the eco-destructive impact of the socio-economic system on the state of the environment	0.546	Average	Sustainable Development Goal 12, task 12.4 «Reduce the volume of generated waste and increase the volume of its processing and reuse based on innovative technologies and production»	0.31	Low
			Investment measurement of waste capacity	0.20	Very low
5. Increasing the environmental aspects of the quality of life of the population	0.613	Average	Sustainable development goal 8, task 8.5. «To contribute to the provision of reliable and safe working conditions for all employees»	0.20	Very low
			To improve the health of the population	0.35	Low

State policy in the field of rational nature management should provide for the balancing of coercive-restrictive and stimulating-compensatory regulatory mechanisms. The insufficiency of the latter and the lack of effective measures to encourage business entities to eco-invest have led to a double reduction in the number of capital investments for waste management measures, which negatively affected the waste intensity of the economy and inhibited the solution of current problems in the field of waste management.

5. Discussion

Analyzing the problem areas in the process of implementing dominants of the investment and innovation policy of nature use, it is necessary to emphasize the close relationship between different dominants, their components and tasks of sustainable development in the system of target priorities. That is, the low degree of implementation of one dominant or its components negatively affects the level of implementation of another dominant, inhibiting the progress of sustainable development.

Based on the results of a comprehensive assessment of the dominant investment-innovation policy of nature use, the determined cause-and-effect relationships between various indicators and tasks of sustainable development, «bottlenecks» in the process of implementing the Sustainable Development Goals, the main directions and ways of increasing the degree of implementation of the dominant investment-innovation policy are substantiated nature management (Figure 2.6).

It is proposed to consider the imperatives of the circular economy as integrating in mutual agreement the dominants of the investment and innovation policy of nature management. The main direction of increasing the degree of implementation of the first two dominants regarding sufficient investment and innovation support for the rational use of natural resources of the national economy is to increase the volume of public spending on science and innovation in the priority areas «Energy and Energy Efficiency,» «Rational Nature Management, including the thematic area and removal of industrial - household waste: R0-R9», «Life sciences, new technologies for the prevention and treatment of the most common diseases» in terms of innovative development of medicine, as well as the provision of state order for the most important developments in sustainable development. It is also necessary to intensify the interaction between representatives of science and government authorities to introduce the results of environmental research into practice and take into account the recommendations of scientific institutions in the course of making managerial decisions and preparing projects of institutions in the direction of sustainable development in Ukraine.

It should be noted that sufficient investment support for the creation and implementation of eco-innovations is an important factor in the sustainable use of natural resource potential on an innovative basis, reducing the ecological capacity of the economy and improving the environmental aspects of the quality of life of the population, as well as achieving sustainable development target indicators that determine the effectiveness of investment and innovation policyof nature management.

R0 R1 R2 R3 R4 R5 R6 R7 R7 R9

Dominants 1, 2	Dominant 3	Dominants 4, 5

Growth of state expenditures on science and innovation under the priority direction *«Energy and energy efficiency»*

Stimulating business entities to implement *energy-saving technologies and production*

Stimulation of domestic investors to environmentally oriented capital investments, in particular, **in the field of waste management**

The growth of state expenditures on science and innovation under the priority direction "Rational nature management", primarily *on «Technologies of utilization and removal of household waste»*

Stimulating the implementation of environmentally friendly production and eco-innovations by subjects by reducing the *environmental tax rate*

Creation of developed **waste processing infrastructure**

Growth of volumes and renewal of budget funding in the direction of «Life Sciences» in the aspect of innovative development of *medicine*

Provision of soft loans and tax preferences to subjects implementing eco-innovations in priority sectors

Creation of safe working conditions for all employees, including spheres of nature management

Creation of new jobs

Provision of a state order for the most important developments in the sphere of *cyclical economy*

Creation of a favorable institutional environment for enhanced reproduction of forests and *sustainable development of forestry*

Intersectoral partnership and involvement of stakeholders

Figure 2.6. Directions and ways to increase the degree of implementation of the dominants of the investment and innovation policy of environmental management in post-war Ukraine based on the imperatives of the circular economy

That is, the introduction of measures to implement Dominants 1 and 2 through a chain of cause-and-effect relationships will increase the degree of implementation of the remaining dominants and their components on an innovative basis. And vice versa, the innovation base's underdevelopment and investment insecurity will slow the sustainable reproductive development of the socio-economic system, the transition from a raw-material to an innovative model of economic development.

The practice has shown that the movement towards sustainable development goals is uneven; for some sustainable development goals, Ukraine has reached the targets of 2020, but some areas have unrealized potential. For example,

the potential for energy efficiency, which in post-war Ukraine can become a real resource for overcoming crisis phenomena, stabilization and transition to a resource-saving type of economic growth. Since energy efficiency is one of the main factors of the country's comparative advantages in world trade, it is advisable to implement a balanced state energy-saving policy that provides for the structural transformation of industry and the expansion of high value-added industries, their modernization based on energy efficient technologies, and the formation of competitive energy markets.

Therefore, one of the main directions for ensuring the sustainable use of the states natural potential is to stimulate business entities to introduce energy-saving technologies and industries on an innovative basis. This applies to both the subjects of the energy sector and other sectors of the economy, which will, on the one hand, reduce the cost of energy production, on the other hand, the cost of domestic goods and services, increasing their competitiveness in the domestic and foreign markets. The implementation of the objectives of the Strategy is divided into three main stages:

1) Reforming the energy sector (until 2020).
2) Optimization and innovative development of infrastructure.
3) Ensuring sustainable development (until 2035).

Achievement of the goals determined by the Strategy is supposed to be carried out through the implementation of appropriate action plans, the implementation of which will create conditions for the transition of the energy complex to a new, qualitative level of development.

An important direction in increasing the degree of implementation of Dominant 3 in Ukraine is to stimulate the introduction of environmentally friendly, resource-efficient production and eco-innovations by business entities, in particular, the environmental modernization of industrial enterprises by reducing the environmental tax rate or in the form of a fixed annual compensation amount. Such a tool is provided for by the Law «On the Basic Principles (Strategy) of the State Environmental Policy of Ukraine for the period up to 2020» (2697-VII). It also provides for the mandatory integration of the environmental component into policies and programs of state, regional and sectoral development, the creation of a tax, credit and investment climate to attract funds from international donors and private capital in environmental activities. Another incentive measure could be government guarantees to investors.

Practice shows the effectiveness of providing preferential loans and tax preferences to business entities that introduce eco-innovations in priority sectors of the economy. It should be noted that the priority development of

agriculture and the food industry will contribute to achieving food security, improving the population's health, and their labor productivity, that is, the implementation of the tasks of the 5th dominant.

The sustainable use of the natural resource potential of the national economy will be facilitated by implementing the sectoral dominant for the sustainable development of forestry. In Ukraine, little attention is paid to this sector, while in the EU countries the provisions of the EU Forest Strategy (1998) and the Forest Action Plan (2006) are being successfully implemented, national forest programs are operating in accordance with the principle of subsidiarity and the concept of shared responsibility. At the same time, the key principles of the EU forest legislation are the permanent management and functional role of forests. Law of Ukraine (2697-VII) provides for the introduction of the main principles of state environmental policy in balanced forest management.

The financial system of forestry in pre-war Ukraine was imperfect, and budgetary financing of forestry activities was insufficient – its share in total expenditures during the decade was about 30%, but in recent years funds have not been provided. There were also no economic mechanisms to stimulate the introduction of environmentally friendly technologies to protect and reproduce forests. To ensure the expanded reproduction of forests, it is necessary to create a favorable institutional environment, simplify the procedure for allocating land for afforestation by forestry enterprises, and resume budget financing. The strategic goals of sustainable development and forest management are reflected in the draft State Strategy for Forest Management of Ukraine until 2035.

The main directions for increasing the degree of implementation of Dominant 4 are the stimulation of domestic investors for environmentally oriented investments, primarily in waste management, and the creation of a developed infrastructure for processing industrial and household waste. The National Waste Management Strategy in Ukraine, dated November 8, 2017, needs to be modernized. The use of innovative technologies and practices for waste management, increasing the volume of their processing and reuse is an important step towards the formation of a circular economy.

Among the areas of implementation of Dominant 5, the main place is occupied by creating safe working conditions for all employees, incl. spheres of nature management and new jobs to ensure the inclusive development of the national economy. Also, the general direction for the introduction of all target dominants is to ensure intersectoral partnerships and involve stakeholders, in particular representatives of state authorities and local governments, science, business, the public, and society for planning and implementing investment and innovative environmental management policies based on sustainable development.

In conditions of economic uncertainty, the role of the state as an important subject of the investment and innovation policy of nature management and the regulator of nature management and environmental protection processes in Ukraine is growing. At the same time, one of the main conditions for the introduction of the dominants of the investment and innovation policy of environmental management is the balancing of coercive-restrictive and incentive-compensatory methods of regulation based on European practices, which will ensure the effectiveness of the investment and innovation policy of sustainable development in Ukraine.

6. Conclusion

The methodological approach to the comprehensive assessment of the dominants of investment and innovation policy of environmental management on the basis of sustainable development in the duality of conceptual and methodological bases, based on a set of assessment principles (systematic and comprehensive, adequacy and dynamism, objectivity and accuracy, effectiveness, purposefulness, scientificity), on the expanded system of national indicators of sustainable development within the framework of Sustainable Development Goals 2, 6, 7, 8, 9, 12, 15, which integrates European economic and environmental indicators, a 7-stage procedure for quantitative, qualitative and expert assessment of the degree of implementation of the dominants of investment and innovation policy of environmental management, which, in addition to assessing the dynamics of changes in indicators and their deviations from target levels within the national economy, provides an external dimension of the assessment (interstate comparisons), the results of which form a powerful analytical basis for adjusting the dominants, justifying the directions, ways, mechanisms and measures for the implementation of investment and innovation policy of environmental management on the basis of sustainable development.

The analysis of the existing methodological approaches to assessing the effectiveness of the state regional policy and implementation of the state environmental policy in Ukraine has shown the insufficiency of the composition of indicators for a comprehensive assessment of the investment and innovation policy of sustainable development. Based on the methodological scheme for assessing the effectiveness of environmental policy and grouping of indicators developed by the European Environment Agency, five dominants of the investment and innovation policy of environmental management were identified, namely: (1) sufficient investment support for the rational use of natural resources of the national economy; (2) investment support for research and innovation in the field of sustainable development;

(3) restoration, sustainable use and protection of the components of the natural resource potential of the national economy; (4) restoration, sustainable use and protection of the natural resources of the national economy; and (5) investment support for the sustainable development of the national economy. Each dominant requires the introduction of appropriate evaluation indicators.

The comprehensive assessment revealed a downward trend in all indicators of resource intensity (water, energy, and material intensity) and one indicator of environmental capacity (carbon intensity) of the national economy. At the same time, the highest rates of decline were characteristic of water intensity (65,1% of the 2015 level) and carbon intensity (83,9%). The dynamics of the waste intensity indicator is growing (103,9%). In general, the dynamics of changes in all indicators of resource and environmental capacity of GDP in 2015-2018 is due to the complex interaction of positive (growth of eco-investments and their structural transformations) and negative changes (decrease in industrial production and population) of the following factors.

Based on the results of the comprehensive assessment, the components of the dominants of the investment and innovation policy of environmental management and the tasks with the lowest degree of implementation were identified, namely: Dominants 1 and 2, the task of increasing energy efficiency of Dominant 3, the task of reducing waste intensity of Dominant 4, and the task of improving the health of the population of Dominant 5. The main directions and ways to increase the degree of implementation of the dominants of the investment and innovation policy of environmental management are substantiated, in particular: (1) increase of state expenditures on R&D and innovations in the direction of «Energy and energy efficiency,» «Rational environmental management,» renewal of financing of «Life Sciences» in the aspect of innovative development of medicine; (2) stimulation of economic entities to introduce energy-saving technologies, environmentally friendly production and eco-innovations by reducing the rate of environmental tax; (3) creation of a new system of environmental taxation; and (4) introduction of a new system of environmental taxation.

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Biographical notes

Svitlana Bondarenko, Ph.D. in Economic Sciences. She is a Professor at the Department of Journalism, National Aviation University, Kyiv, Ukraine. Author of more than 130 scientific works, including: 2 individual monographs, 17 chapters in collective monographs, 50 articles in scientific publications of Ukraine, 20 articles in scientific databases SCOPUS and Web of Science, 5 articles in foreign scientific periodicals, as well as about 70 publications at conferences and round tables, 1 educational and methodical manual in co-authorship. Research interests: Theory and practice of innovative development of enterprises; Economic security, national security; National Resilience; Management of innovative development of enterprises; Institutional principles of building the organizational and managerial system of nature management in the context of administrative-territorial reform; Cost-oriented management of enterprises Theoretical and methodological principles of research and ensuring the balanced development of enterprises; Methodology of formation of effective logistics of commodity markets; Logistics and marketing management of resource flows in the commodity market; Circular Economy.

Oksana Nikishyna, Ph.D. in Economic Sciences, Senior Researcher, Head of Department of Market Mechanisms and Structures, Institute of Market and Economic & Ecological Research of National Academy of Sciences of Ukraine, Odessa, Ukraine. *Author* of more than 260 scientific works, including: 1 individual monograph, 29 chapters in collective monographs, 6 scientific reports and 4 brochures in co-authorship, 100 articles in specialized scientific

publications of Ukraine, 5 articles in scientific databases SCOPUS and Web of Science, 9 articles in foreign scientific periodicals, 110 publications at conferences and round tables, 10 certificates of copyright registration for the work. *Scientific interests*: theory and practice of commodity markets; Methodology of selective regulation of the development of commodity markets; Methodical approaches and recommendations for evaluating the effectiveness of the functioning of commodity market systems based on a reproduction approach; Integration mechanisms of commodity markets development; Methodology of formation of effective logistics of commodity markets; "Green" economy, circular economy; Goals of Sustainable Development, a method of comprehensive assessment of the dominant investment and innovation policy of nature use the national economy; Socially responsible business, methodological recommendations for a comprehensive assessment of socially responsible production and consumption based on the principles of greening economy.

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Plan or die: Entrepreneurs' response to crisis situation

Jarmila Duháček Šebestová[1], Šárka Čemerková[2]

Abstract

Thanks to the COVID-19 epidemic, the last two years have been filled with changes for entrepreneurs. As a result, the change leads to a new level, much higher than the previous one. It is a long-term strategy focused on debt levels, risk-advantage approaches, reinvestment in profits, and organizational changes. The purpose of this chapter is to present the results of the entrepreneurs' response to the situation within and nearly after COVID-19 restrictions. Research findings are based on primary research in more than 300 companies in the Czech Republic (2 rounds of survey – 2020 and 2021). The comparison contrasts the change in strategic thinking due to long-term crisis. The results showed that measurable goals are extremely important during the crisis to maintain discipline in business (an increase of 91%). On the other hand, the exit strategy as a response to crisis is not the preferred solution (the lowest preference). Findings could be applied in managerial practice as a recommendation when research findings illustrate a possible combination of optimal business behavior within a crisis environment. Originality could be seen in the importance of ongoing profit investments and planning of individual activities in the company and the need for an active approach of the entrepreneur.
Keywords: COVID-19, crisis behavior, changes in future goals, planning activities, entrepreneurs

1. Introduction

A crisis situation can test every entrepreneur and is among the most commonly examined situations faced by organizations that cannot deal with routine

1 Jarmila Duháček Šebestová, Ph.D., Hab., Associate Professor, Department of Business Economics and Management, Silesian University in Opava, School of Business Administration in Karviná, Univerzitní nám. 1934/3, 733 40 Karviná, Czech Republic, e-mail: sebestova@opf.slu.cz (ORCID: 0000-0002-7493-0759).
2 Šárka Čemerková, Ph.D., Assistant Professor, Department of Business Economics and Management, Silesian University in Opava, School of Business Administration in Karviná, Univerzitní nám. 1934/3, 733 40 Karviná, Czech Republic, e-mail: cemerkova@opf.slu.cz (ORCID: 0000-0002-1462-0169).

situations (Booth, 1993; Pedersen et al., 2020). Changes in the business environment, government restrictions, and war can disrupt customer-supplier relationships (Georgieva, 2020; Cortez & Johnston, 2020). It is up to the entrepreneur how flexible he/she is or how he/she perceives possible risks from the external environment (Clark et al., 2020).

A preliminary plan and a clear definition of goals can help entrepreneurs and will support them in this unusual situation (Ritter & Pedersen, 2020; Kaiser & Young, 2009). As an example of such a "non-standard" crisis situation, we can take the COVID-19 pandemic, which disrupted not only business activity as such, thanks to government restrictions, but also its duration, almost two years. The situation of "recovery" in Europe is still being complained about by the war in Ukraine and the deterioration of trade relations with Russia (Meyer, Prescott & Sheng, 2022; Kammer et al., 2022). This raises the question of whether entrepreneurs are ready for a similar situation because of their entrepreneurial mentality or whether they will get lost in their decision-making.

Following that, when the question of whether age and length of experience in business are essential for an entrepreneur to manage their decision-making, or is it enough to have the right goal and a plan subordinated to it? These questions will be answered in this chapter that compares the results of two types of research conducted in 2020 and 2021, with the aim of revealing changes in perceptions and decisions about the future of one's business. This chapter is divided into the following sections. In the first section, theoretical research is conducted to support and explain the research gap as a starting point for empirical investigation. In the second section, the conceptual framework of the investigation is explained, followed by the presentation of the key research findings. In the final section, the results are discussed with previous studies or surveys in this area, and a practical recommendation is proposed.

2. Literature background

The process of strategic management in small businesses has seen many changes over the past two years. Still, it always contains a set of interconnected stages through which the company creates, implements, and controls its own long-term business goals. It can be argued that strategic management is one of the most important aspects of successful business in the modern business environment (Kang et al., 2021; Bapuji et al., 2020). Therefore, the most important stage of strategic management is the dynamic implementation of the strategy into normal business processes under changing conditions. This is a process where the company's management implements the planned strategies, and here, the human factor is particularly important (Cortez & Johnston, 2020; Sheth,2020; Obal & Gao, 2020; Kim & Bettis, 2014).

Above all, employees will decide whether a given strategy will be successfully implemented or not. When small and medium-sized businesses are the core of each national economy, everything is in the hands of the owner, and motivation to act plays an important role (Sharma et al., 2020). A short summary is given in Table 3.1.

Table 3.1. A short review of important studies

Author	Study context	Main results
Alves, Lok, Luo & Hao (2020)	SMEs strategy for crisis management, 6 interviews, case studies, Macau	Firms without a formal crisis plan are firms with a weaker market position, fewer resources and lack a sense of crisis, three firms.
Bapuji, de Bakker, Brown, Higgins, Rehbein & Spicer (2020)	Theoretical Review of COVID-19 on business activities	The crisis presents opportunities for digitalization and new business models.
Clauss et al. (2022)	Eight cases from Austria, Germany, and Liechtenstein focused on a business model	Temporary business models, preference for proactive innovation strategy and increased business network.
Cucculelli & Peruzzi (2020)	Analysis of 67,241 Italian manufacturing firms, relationship between survival and business model within crisis environment	The business model changes by using a set of measures of the company's business structure, such as the degree of vertical integration, the intensity of investments in intangible assets, and the complexity of the external services network.
Elali (2021)	Theoretical, introducing the concept of Strategic Agility	A conceptual model was proposed. The independent variable is strategic agility with three dimensions of strategic sensitivity, leadership unity and shared responsibility, and liquid reserves. The dependent variable is competitive capabilities, which are measured with three indices of sustainability, profitability, customer satisfaction, innovation, and growth.
Fabeil et al. (2020)	Recovery strategy after COVID-19 restrictions, 2 interviews, Malaysia	Experience of crisis leads entrepreneurs to act more rationally, engage in planning when making decisions and impact reduction strategies.
Kang, Diao & Zanini (2021)	Cash flow effects of business processes within a relationship with marketing strategies, 54 interviews, China	The request of anticipating behavior, innovation offer to be successful within the crisis, relationship within plan, goals and anticipating behavior confirmed.
Katamadze (2022)	Business strategies, Georgia	Crisis analysis to support business adaptability, ROA analysis.
Pedersen, Ritter & Di Benedetto (2020)	Theoretical review of crisis management strategy	Speculating that each crisis is unique and unpredictable so that findings from one cannot transfer to another situation.

Author	Study context	Main results
Peńarroya-Farell & Miralles (2022)	Business models, 10 case studies, Spain	Three phases of business model adaptation: reaction, planned adaptation and stabilization. The influence of digitalization is mentioned.
Setiawan, Prastyan & Kijkasiwat (2022)	business sustainability, 778 respondents, Indonesia	The business sustainability model after the crisis based on the digitalization strategy (43%) is preferred against other possibilities, human resources (14%) and financial (31%).
Toniolo-Barrios & Pitt (2021)	Working conditions within COVID-19, theoretical paper	Recommendation of how to change processes and tasks for remote work.
Wenzel, Stanske & Lieberman (2021)	Theoretical review of crisis strategies	Three concepts are presented such as retrenchment in a short time frame, persevering, and innovating for a medium and long-time frame. Exit as a strategic response to a crisis.

The business strategy actively responds to environment changes by optimizing its internal processes and the resources used. The way of behavior increases its opportunity to develop the business itself and the possibility of growth. Thus, the dynamics of corporate resources support business growth and business sustainability, and last but not least, help create competitive advantages within changing conditions (Kang et al., 2021).

2.1. Strategies responses to crisis situation

A survey conducted among 5,206 entrepreneurs in 23 countries (in the period from April to August 2020), provided by Stephan et al. (2021), showed that up to 61% of entrepreneurs considered the existence of their business was at risk due to a significant decline in commercial activity during the COVID-19 pandemic. The authors' results contribute to our understanding of the importance of connecting business goals and strategy in a non-standard environment. Many studies focus on recovery strategies after the financial crisis and natural disasters (Flynn, 2007; Devece, Ortiz & Armengot, 2016).

McCarthy (2003) suggested that entrepreneurs who experienced a crisis situation are more rational and prefer to plan their activities. Keeping that in mind, Cook (2015) mentioned that a crisis recovery plan would help businesses after the crisis, and 75% of companies without any goal or strategy will exit the operation after the crisis. Entrepreneurs use different approaches to deal with crisis, e.g. new distribution channels and cheaper promotional activities (Fabeil et al., 2020).

Pedersen et al. (2020) highlight four managerial imperatives connected with crisis management. They are divided into two dimensions, the tools (to

analyze or to do it) and the horizon (myself and others). That is, there is (1) *sales awareness* (doing others), which means 'sell intelligently.' It means a change in the sale process – finding new customers, new ways of selling, or adaptation to the sales force; (2) *stakeholder awareness: Think allocentric* (analyzing, others), which means to open entrepreneurial mindset and to think about the period after the crisis by relationship development; (3) *Institutional awareness: Change proactively* (doing, myself) – means the change in processes which are motivated by a business owner to cope with the crisis; (4) *Situational awareness: Understand fast* (analyzing, myself), high levels of uncertainty prevent exact planning, and analyze quickly.

Following that, Alves' study (Alves et al., 2020) extends the work by Pedersen et al. (2020) on a practical application to examined companies. The result is that small firms with a shorter business history and less experience in crisis seem to lack plans of resilience and strategic renewal plans. Small businesses must plan to enhance networking with customers, diversify products with the help of technology, and explore new market sectors after the crisis. Conversely, Wenzel et al. (2021) motivate managers and business owners to exit current business when they see other better opportunities in the market. The key to success could also lie in the agility of strategy to overcome the crisis situation (Elali, 2021) or the change of the business model depending on the return of sales (ROS) and previous experience (Cucculelli & Peruzzi, 2020).

Research gap formulation. Based on the research mentioned above, it was found that most studies within the framework of entrepreneurial behavior deal with the general creation of a business model or the setting of relationship marketing (Clauss et al., 2022; Peńarroya-Farell & Miralles, 2022). Unfortunately, the studies lack specific examples of factors that influence an entrepreneur's decision-making in a crisis situation, they do not represent the competencies or knowledge that an entrepreneur actively uses (Bapuji, de Bakker, Brown, Higgins, Rehbein & Spicer, 2020; Elali, 2021; Wenzel, Stanske, & Lieberman, 2021). Therefore, in the example of monitoring entrepreneurs in two periods, it is possible to see a change in their behavior or a change in priorities, thereby showing our approach to the problem and a possible concrete proposal.

3. Methodological approach

The response of companies to a crisis situation can be different (Pal, Andersson & Torstensson, 2012). Some used the crisis to develop and optimize processes; others were forced to end their business because they were not adaptable enough (Petzold et al., 2019). Therefore, the objective of the two primary investigations was to find out how businesses behaved in the context of the

COVID-19 crisis and how they had to adjust their priorities. The main thing was to address the person who is responsible for the final strategic decision-making of the business entity (Duháček Šebestová et al., 2021).

In the guided interview (Cavana et al., 2001), emphasis was placed on three areas, namely business behaviour affected by the crisis, as well as financial decision-making and drawing state support. The second phase was supplemented by the entrepreneur's plans for the future, thanks to the experienced non-standard situation. It can be said that, in this way a change in the priorities or behaviour of entrepreneurs can be detected.

The research had two sub-goals. First, describe the change in business behavior and, at the same time, connect it with the change in funding priorities and the definition of business goals. The field of Business behavior was focused on the attitudes of the researched subject in business - what motivates him/her, what he/she follows, and what he/she prefers. On the other hand, the description of the change in behavior was captured by a change in quantifiable indicators such as evaluation of future goals, investment of profit - preference for internal financing, or changes in the method of distribution between individual priorities (marketing, innovation, development). At the same time, the most common link, i.e., the age and experience of business, has been considered, which may affect changes in decision-making. The research concept is shown in Figure 3.1.
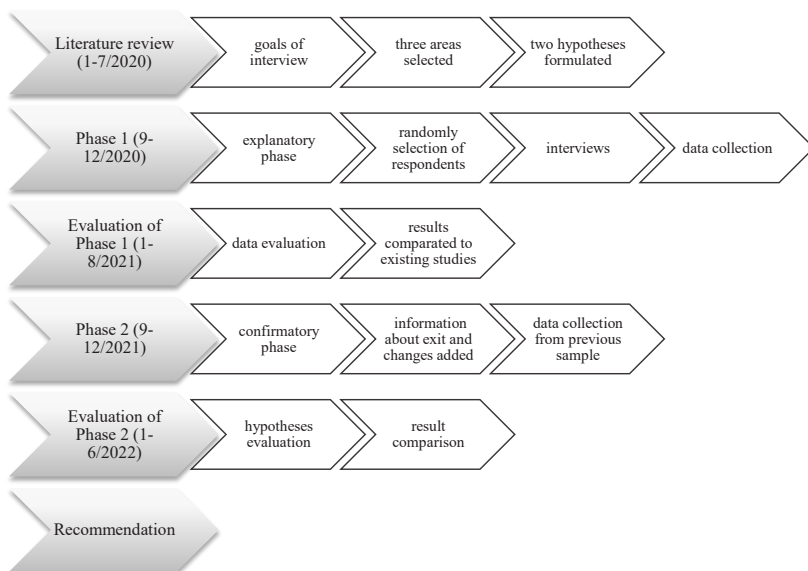
Figure 3.1. Research design of the study

The content of the survey was based on the previous literature review, especially Alves, Lok, Luo, and Hao (2020) and Kang, Diao, and Zanini (2021), when two hypotheses were established:

H1: The age of the respondent will influence the determination of goals in general.

H2: The length of business experience will positively influence the degree of profit from reinvestment in the company.

3.1. Background of the study: Czech entrepreneurial behavior

The pandemic had a negative impact on the ratio of defunct companies within the Czech Republic. As a result of the pandemic, far more companies have disappeared in a period without fluctuations in the economy. Therefore, the failure rate exceeded 50% (Table 3.2).

Table 3.2. Closed and new companies within the years 2012 to 2020

Year	Number of closed companies (A)	Number of company birth (B)	Rate of birth (B/A)	Closed companies ratio % (A/B*100)
2012	5 322	22 454	4.22	23.70
2013	5 249	22 845	4.35	22.98
2014	5 144	24 870	4.83	20.68
2015	6 640	26 953	4.06	24.64
2016	8 079	28 837	3.57	28.02
2017	11 517	32 187	2.79	35.78
2018	12 692	31 270	2.46	40.59
2019	15 044	29 781	1.98	50.52
3Q2020	11 212	20 093	1.76	55.80

Source: Parlamentni listy, 2020, online.

Primary research was conducted in two phases. The first phase took place from September to December 2020, that is, in the first period of assistance to entrepreneurs from the government MPO, 2020). This resulted in a sample of 488 active respondents (response rate 40.7%) out of 1,200 randomly selected from the business database Amadeus, filtering all business units registered in Czechia. This phase was called 'explanatory' to learn behavioral factors in response to the crisis situation.

In this phase, 68.8% of men, 31.2% of women aged 18 to 25 years (10.7%), 26 to 40 years (32.3%), 41 to 55 years (44.7%), and 55+ (12.4%) participated in the interviews. Most of them had 20 years or more (37.3%),

respondents with up to 10 years (25.8%) formed a large group, and the third category was work between 10 and 20 years (23.6%). A relatively small group had an experience of around three years (13.3%).

The second phase took place from September to December 2021, when all those who participated in phase 1 (N=488) were approached, and a sample of 295 active respondents (response rate 60.45%) was obtained to observe changes.

In this phase, 66.4% of men, 33.6% of women aged 18 to 25 years (8.8%), 26 to 40 years (27.5%), 41 to 55 years (50.8%), and 55+ (12.9%) participated in the interviews. Most of them had 20 years or more (43.7%), respondents with up to 10 years (26.1%) formed a large group, and the third category was work between 10 and 20 years (20.0%). A relatively small group had an experience of around three years (10.2%). By comparison of the sample structure, it is possible to compare the results that those two samples are homogenous in the structure.

In both cases, these were controlled interviews via MS Teams, Zoom, or telephone, thanks to the current anti-epidemic measures in the Czech Republic. Each interview lasted approximately 20 to 25 minutes. Answers were recorded and saved in a database sheet created in Google Forms to be able to work with them later on (each phase is saved separately).

4. Results of the study: Plan or not plan goals?

The results of primary research are presented in three areas. The first area is entrepreneurial behavior, then financial management, and results are supplemented by a change in goals during the second year.

Tables 3.5 and 3.4 show a considerable difference between two variables, age and business experience in a two-round comparison. Each variable was evaluated by a Likert scale from 1 to 5 (1 – strongly agree to 5 – strongly disagree). The percentage share within the table presents positive responses from a survey (scales 1 to 2). A Cramer V coefficient was used to explain the links between the nominal values and factors influencing business behavior within two years of COVID-19 influence. A statistical significance was verified at a value of 0.05, alternatively 0.1. The share captures the evaluation of positive answers (strongly agree and agree) in the surveyed sample of respondents (Table 3.3 to Table 3.4).

From the data shown in Table 5.3, it is apparent that internal funding had increased from 51.8% to 76.6%. It could be related to the lack of available sources of debt financing or awareness of debts due to the crisis situation. A significant difference was found between two factors – *knowledge of risk solution* (increase of 312.3% in the second round) and *adaptation to changes in*

a business environment (increase of 226.1% in the second round). A decrease in risk behavior was observed when entrepreneurs were not interested in risk transactions (-32.5%).

Table 3.3. Business behavior, based on age/business experience

| Factor | Round 1 | | | | | Round 2 | | | | | % change |
| | Age | | | Business experience | | Age | | | Business experience | | |
	%	CV	Sig.	CV	Sig.	%	CV	Sig.	CV	Sig.	R1-R2/R1
Internal financing	51.8	0.094	0.647	0.092	0.414	76.6	0.122	0.609	0.123	0.325	47.9
No changes when it successful	65.8	0.151*	0.004	0.115	0.021	98	0.183*	0.014	0.153*	0.053	48.9
Deep thinking in decisions	62.3	0.099	0.508	0.085	0.306	97.6	0.138	0.309	0.120	0.390	56.6
Cost calculation	66.2	0.116	0.156	0.127	0.023	91.9	0.111	0.764	0.117	0.433	38.8
Market analysis	34	0.110	0.250	0.103	0.216	73.6	0.102	0.904	0.136	0.154	116.4
Measurable goals, mostly financial	44.3	0.105	0.358	0.114**	0.090	84.7	0.146	0.193	0.202*	0.000	91.2
Preference of profit evaluation	80.2	0.100	0.491	0.075	0.775	98.3	0.183*	0.014	0.204*	0.000	22.6
Adaptation to changes in business environment	20.7	0.098	0.550	0.111	0.116	67.5	0.148	0.173	0.096	0.819	226.1
Maximum amount of lost	24.4	0.107	0.321	0.097	0.307	53.9	0.157**	0.087	0.133	0.180	120.9
Investment plan	44.3	0.097	0.554	0.105	0.187	87.8	0.136	0.343	0.129	0.230	98.2
Risk preference	34.2	0.151*	0.001	0.167*	0.000	23.1	0.136	0.347	0.164*	0.010	-32.5
Knowledge of risk solution	20.3	0.101	0.466	0.133*	0.011	83.7	0.121	0.642	0.120	0.385	312.3
Knowledge of business economics	48.6	0.124**	0.067	0.149*	0.001	93.2	0.114	0.756	0.114	0.505	91.8

Note: CV= Cramer V coefficient. Statistical significance at a value of 0.05 is shown as "*", at a value of 0.1 is displayed "**".
Source: Author´s primary survey data.

If we look at the links associated with age, then factors "*no changes, when it is successful', risk preference and knowledge of business economics* can be considered essential in phase 1. However, in phase 2, the preference for *profit evaluation* and *maximum amount of loss* was given more importance. On the contrary, business experience has a statistically significant effect in phase one on factors "*no changes, when successful; measurable goals, mostly financial; risk preference, knowledge of risk solution,* and *knowledge of business economics*. In the second phase, however, there is an exchange for

preference of profit evaluation in a statistically significant effect. Looking at the results again, there is a shift in entrepreneurial thinking, which is consistent with Wenzel, Stanske, and Lieberman (2021). This confirms that the response to the crisis situation has changed preferences.

Even if no strong statistical links were established with age or business practice, the most changes were recorded in four factors. As already mentioned, it is (1) *knowledge of the risk solution* and (2) *adaptation to changes in the business environment* and then (3) *maximum amount of loss* (120.9%) and (4) *market analysis* (116.4%), which exceeded the annual increase by more than 100%.

On the other hand, imagine changing financial management within those entities. As mentioned above, the entrepreneurs agreed that it is necessary to monitor profit or the maximum loss. Therefore, it was necessary to describe your financial decision-making in moments of crisis (Table 3.4). It is necessary to mention that just 49.8 % actively used COVID-19 programs for business support.

Table 3.4. Financial behavior, based on age/business experience

| | Round 1 | | | | | Round 2 | | | | | % change R1/R2 |
| | Age | | | Business experience | | Age | | | Business experience | | |
Factor	%	CV	Sig.	CV	Sig.	%	CV	Sig.	CV	Sig.	
%share of profit investment	17.2	0.147*	0.006	0.144*	0.035	26.1	0.200*	0.001	0.124	0.799	51.7
Inv. Marketing	42.2	0.131	0.791	0.190*	0.006	53.9	0.104	0.982	0.183*	0.023	27.7
Inv. Company development	47.4	0.112	0.987	0.163	0.125	39.6	0.163	0.495	0.143	0.845	-16.4
Inv. to HR	40.6	0.114	0.629	0.118	0.495	41.6	0.182*	0.014	0.134	0.629	2.5
Inv. to technology/innovation	25.8	0.216*	0.000	0.184*	0.032	30.5	0.224*	0.000	0.140	0.875	18.2
Higher savings for crisis situation	27.7	0.108	0.323	0.107*	0.052	40	0.316*	0.000	0.522*	0.000	44.4
Internal sources for debt financing	34.2	0.094	0.502	0.103	0.406	35.3	0.286*	0.000	0.512*	0.000	3.2
Importance of some segment - more	52.5	0.125**	0.064	0.134*	0.010	17.6	0.282*	0.000	0.529*	0.000	-66.5
Higher support of some process	49.8	0.192	0.756	0.254*	0.003	19	0.299*	0.000	0.525*	0.000	-61.8
Lower support of some process	80.1	0.098	0.996	0.147	0.246	5.1	0.293*	0.000	0.509*	0.000	-93.6

Note: CV= Cramer V coefficient. Statistical significance at a value of 0.05 is displayed '*,' and at a value of 0.1 is displayed '**'.
Source: Author´s primary survey data.

The biggest changes in behavior can be observed in *priorities for investments*, where there is a decrease in support for preferred segments (-61.8%) and a decrease in other investments (non-preferred activities, -93.6%). The negative result of the analysis is that the percentage of the reinvested profit group is growing, which in Table 3.4 represents the group investing back to 20% (the increase is 51.7%). The *investments in company development* (+2.5%) and *investments in HR* (-16.4%) suffered the most. Interestingly, there are also differences in the *growth of the amount of savings* (+44.4%) and *internal sources of financing*; the level is with a minimum change (+2.5%).

If we wanted to describe financial behavior in more detail, a scale was used to evaluate the number of investments (0%, 20%, 40%, 60%, 80%, 100%), where the numbers in brackets show the shares for individual segments (phase1/phase2). The rate of investing profits back into the business (40%/20%) dropped by half in the second phase. In the marketing activity segment (20%/20%), the share remained the same, but the share of respondents who reduced these expenses from 42.2% to 53.9% increased. At the same time, the group of those who did not support marketing activities at all during the monitored period decreased from 38.4% to 32.2%, which is contrary to the recommendations of Setiawan, Prastyan & Kijkasiwat (2022). The area of business development was mostly paralyzed (0%/0%), with 40% of the respondents indicating this answer. Only a small group (34% in both observations) indicated investments of up to 20%, which again does not support Clauss et al. (2022), which recommends at least temporary changes. Investments in HR (20%/20%) remained the same; the number increased slightly from 40.6% to 41.7%. In contrast, investments in innovation and technology (40%/40%) remained in the same ratio, and only the group of supporters increased from 26% to 31.6%.

Their lessons learned from the COVID-19 situation, whether they will change their financial strategy and create reserves, turned out positively from their point of view. In the first phase, 38.3% stated that they do not intend to change anything, and only 27.7% will create a higher reserve at the same time, 11.3% stated that they no longer have the funds for investments and reserves in this period (presumption of financial problems). In phase 2, the number of those satisfied with the financial plan decreased to 31.5% and, at the same time, the number of those who will create a reserve increased (40%).

In the second phase, you can see the importance of financial decisions and the dependence on age and business experience, which was not evident in phase 1. As a result, the entrepreneurs had to change their approach and the more successful in solving problems were the older ones in terms of age and experience. This is followed by the expansion of the analysis by future plans in phase 2. Entrepreneurs were offered six types of goals and had to

rank them according to priority from 1 to 6, where 1 meant the main goal and 6 meant the last goal. There was also a musing about how they would like to end their business in case of problems or future plans. The key statistics are summarized in Table 3.5.

Table 3.5. Changes in Goals, Round 2

Future plans	%	Age		Business experience		Evaluation
		CV	Sig.	CV	Sig.	
Strategy change affected by COVID-19	60	0.225*	0.011	0.150	0.156	Strong yes in 60%.
Future goal: successor of the company	25.08	0.131	0.439	0.145	0.215	The priority of this goal is 6, last priority
Future goal: profit maximization	47.12	0.121	0.660	0.150	0.152	Priority to this goal is 1, main goal
Future goal: Long term sustainability	63.39	0.162*	0.040	0.160**	0.064	Priority to this goal is 1, main goal
Future goal: Company value growth	39.66	0.135	0.367	0.133	0.403	Priority to this goal is 1, main goal
Future goal: market share growth	24.75	0.112	0.822	0.145	0.208	Priority to this goal is 3, medium importance
Future goal: selling the company	54.58	0.125	0.571	0.139	0.306	The priority of this goal is 6, last priority
Business environment in future 5 years	57.97	0.127	0.489	0.149	0.106	Positive expectations in 57.97%
Influence of the business environment to entrepreneurship	78.64	0.161	0.180	0.083	0.727	Strongly yes
Sales	77.97	0.168*	0.021	0.190*	0.002	77.97% have sales CZK 49 mil.
Entrepreneurial exit	44.5	0.101	0.871	0.103	0.653	Plan to sell the company, other possibilities 29.5% exit by bankruptcy,26% find the successor of the company.

Note: CV= Cramer V coefficient. Statistical significance at a value of 0.05 is shown as "*"; at value of 0.1 is displayed "**."

Source: Author´s primary survey data.

Thanks to this analysis, we were able to sort out future priorities and the possibility of continuing the business. As confirmed, this crisis situation will further influence their behavior. Therefore, the importance of goals that are linked to financial indicators and a suitable plan can be seen. This confirms the idea of "plan or die." If we analyse the goals, the most important are profit maximization, long-term sustainability, and company value growth, followed by market share growth, and the two exit strategies - selling and handing over the business to a follower from the family or appointing a manager. What is

noticeable here is that the number of sales has a positive tie with the and business experience with an influence on long-term sustainability strategy (Table 3.5).

5. Discussion

Our research findings indicate that the situation was new for entrepreneurs and that they did not expect the restrictions would last so long. Therefore, in the first phase of the research, they were quite optimistic and assumed that they could handle the situation (Table 5.4). We also observe that exit strategies are the last thing entrepreneurs would do in a crisis situation, which does not support Wenzel, Stanske and Lieberman's (2021) proposals (Table 5.5). Furthermore, a situation of "learning by doing" was found when, at the beginning they saw a relatively low value of knowledge of business economics, and it increased substantially in phase 2 (compare Table 3.5). It was also proven that if entrepreneurs did not limit activities towards innovation (meaning profit investments, Table 5.4), they could better cope with the crisis, which is in line with Kang, Diao, and Zanini (2021). The study subsequently established a connection between the influence of age and experience on successfully overcoming the crisis, which is in line with the Fabeil et al. study (2020).

If we return to the original research questions, whether age and length of experience in business are important for an entrepreneur to manage their decision-making or is it enough to have the right goal and a plan subordinated to it? The results show that setting the goal is determined by the age and experience of the entrepreneur. This affects his decisions about the future running of the business. Therefore, we can state that the characteristics of an entrepreneur determine whether he will plan or adapt. The results of the research showed that age and experience influence the reaction to a crisis situation and decisions about the future, which allows the evaluation of two established hypotheses:

- *The age of the respondent will influence the determination of goals in general (H1).* The results presented in Table 3.5 showed that the age of the entrepreneur influences the level of perception in crisis situation and the outlook for the future. It can be derived from a trio of indicators that were statistically significant, such as the strategy change affected by COVID-19 (60%, Cramer V= 0.225, Sig. =0.011); Future goal: Long-term sustainability (63.39%, Cramer V= 0.162, Sig.=0.040) and Sales (77.97% Cramer V= 0.168, Sig. = 0.021) It follows that **we confirm hypothesis H1**.
- *The length of business experience will positively influence the degree of profit from reinvestment in the company (H2).* The

answer to the hypothesis can be found in Table 3.4, where %share of profit reinvestment is statistically significant for age and not for business experience in phase 2. **Hypothesis H2 must be rejected**. The influence of business experience was demonstrated only in the partial decision to increase or decrease the percentage share of the investment (phase 1: Cramer V= 0.144, Sig.= 0.035; phase 2: Cramer V= 0.124; Sig.=0.799).

In summary, we can provide appropriate managerial recommendations on how to overcome a crisis situation. Due to the comparison of the two periods (phases 1 and 2, Table 3.3 to Table 3.5), it is clear that:

1) It is not only necessary to observe the surrounding external environment, but to adapt actively (an increase from 20.7% to 67.5% of positive answers, Table 3.5).
2) It is necessary to strengthen our knowledge of business economics so that we can assess risks (change from 48.6% to 93.2%).
3) It is necessary to have a plan for the future and subordinate investments from profit to different segments like development or innovations. The most important thing should be long-term sustainability, as revealed by the research (to sell a company or give permission to cooperate with other family members). The exit strategy should be the last.
4) They should not underestimate human resources, which are crucial, especially in smaller companies, and if we lose them during a crisis, then we will have a hard time looking for them (meaning of investment in HR, Table 3.4).

These results are valid for the examined sample and may differ when compared with the entire population of entrepreneurs. However, the results are consistent with the literary sources or previous studies. At the same time, the limited sample is a limitation of this case study.

6. Conclusion

Our research provides insight into business behaviour within a crisis environment caused by the COVID-19 pandemic. As stated above, the hypothesis (H1) about the relationship between business experience and profit investment planning was rejected. Further analysis would be necessary to determine how far the result was influenced by the distribution of investments in individual segments or how the attitude changed in the following year when public support was available. A new phenomenon of age appeared in the

study that affected the adaptability of the monitored subjects. The influence of education on financial or strategic goals that went unnoticed, would also be worth a possible analysis.

Lastly, we have identified some limitations in that two-round case study. The study's limitations can be seen in the validation of the results, where they describe each respondent's subjective opinion. This choice was appropriate for the research problem to identify different behavioral models for social group support based on their socioeconomic and sociocultural background (Alaslani & Collins, 2017).

Due to the lack of a uniform definition of crisis situation and non-standardized crisis recommendations across European economies, one should be careful when trying to generalize those findings to other countries as their knowledge and possible resources may not be comparable, as well as the impact of public support. This research focused on the Czech business environment, an economy within the EU area dependent on industry clusters, connected with automotive and IT and public business support. When the economy's structure is different, examined entities react differently due to these preliminary research conditions. Further research would focus on a specific sector and expand the sample size (Fabeil et al.,2020). Moreover, our research findings suggest that the age of the entrepreneur and business experience are factors that may impact crisis survival. This chapter pointed out that proactive entrepreneurs were more successful when they learned to plan from the previous period (Results in Table 3.5).

Acknowledgment

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Biographical notes

Jarmila Duháček Šebestová, Associate Professor, is an experienced researcher focusing on Small Businesses. She has participated in a number of international projects, including IPREG (Innovative Policy Research for Economic Growth) and the E-WORLD project (International Entrepreneurs Network). She is a Vice President of the European Council of Small Businesses for the Czech Republic. Research interests: Small Business Performance, Small Business Dynamics.

Šárka Čemerková, Assistant Professor, graduated from the Faculty of Science, Palacký University in Olomouc, majoring in General Education. Combination of Mathematics - Descriptive Geometry. She completed her doctoral studies

at the Faculty of Economics of the Technical University of Ostrava in 2005 in the field of System Engineering and Informatics. Her research activities are focused on business economics and management, especially in the field of logistics.

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The impact of economic activity zones on local development: The example of Wieliczka Municipality in Poland

Artur Kozioł[1]

Abstract

The purpose of this chapter is to present the impact of economic activity zones (EAZs) on local development and to identify good practices in the management of EAZs, based on the experience of the commune of Wieliczka, Poland. Nevertheless, beyond the theoretical insights, the empirical evidence of effective local development governance in EAZs is still limited, even in metropolitan areas where a range of instruments are provided to support local development. The chapter attempts to provide evidence of the impact of EAZ on local development by indicating the influence of investments located in economic activity zones on the management of local government units in the Krakow metropolitan area. The analysis of the impact of EAZs on local development has led to findings that a valuable tool for the impact of EAZs on local development are the investments located there, which determine the more effective use of local resources. These are challenging resources (including land and infrastructure) and soft, intangible ones (including location, quality of intellectual capital, and entrepreneurship of residents). As a result of the application of good practices in municipal management, they become key determinants that determine the potential of EAZ and increase competitiveness. The example of EAZs shows that their impact on local development can receive significant support from the EU and public authorities. Nevertheless, the development of EAZs is limited to metropolitan areas and tends to limit their development in peripheral areas far from major growth centers. Exploring further options for the impact of EAZ on local development may be an interesting direction to involve external stakeholders in order to enable the incorporation of their skills and resources. The experience of the municipality of Wieliczka is and will be, to a significant extent, a form of more effective use of a variety of local and external resources. The chapter briefly discusses the

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1 Artur Kozioł, Ph.D. in Management and Quality Sciences, Mayor of Wieliczka, Kard. Andrzeja Deskura 20, 32-020 Wieliczka, Poland, e-mail: akoziol@wieliczka.eu.

impact of EAZ on local development and provides practitioners with areas on the potential challenges of using EAZ. Local development carries certain risks, which have implications for EAZ creation efforts.
Keywords: economic activity zones, EAZ, local development, municipal investment, entrepreneurship, innovation, EAZ management.

1. Introduction

Municipal investments efficiency is a challenge for local governments, and at the same time, constitutes a new research area for management and quality sciences, and economic activity zones are an interesting subject of research. The innovative concept of managing economic activity zones opens new possibilities for more effective use of hard local resources which, until now, were agricultural wastelands generating costs for the budget of municipalities, and the activation of soft, non-material resources (e.g., location, quality of intellectual capital, entrepreneurship of residents).

The task of municipal authorities is to create local development by creating organizational and infrastructural conditions, launching promotion mechanisms and supporting local entrepreneurship, absorbing innovative projects, and in particular, creating attractive location conditions for potential investors (Cybulska, 2019; Jaworek, Kuczmarska, & Kuzel, 2017). The implementation of communal investment tasks is defined as development entrepreneurship, characterized by a prominent level of innovation, requiring large expenditure and bringing unlimited results. Innovation is the key to the modern economy, defined as the knowledge-based economy, economy 5.0 that inspires the creation of the information society (Makieła & Stuss, 2018).

Local entrepreneurship, in which the commune self-government is involved, may manifest itself, inter alia, in striving to improve the conditions for business with the use of instruments, such as land gathering, sharing and developing infrastructure, improving local regulations, improving the aesthetics of the local landscape, conditional sale of premises, attracting external business, developing existing business as well as supporting innovation and entrepreneurship, the advance of development incubators, technology and business parks, industrial zones (Climent, & Haftor, 2021).

In contemporary self-government management, managerial skills, understood as the ability to create an atmosphere conducive to creative activity and motivation to achieve specific goals, are gaining increased importance. Commune authorities, as a manager activating the socio-economic development of a commune, take responsibility for creating

entrepreneurship to an extent that goes beyond the current needs, that is, guided by the vision of the commune's development which they previously agreed with the local community in a participatory manner. Thus, one of the areas of entrepreneurial management of a commune is the creation of a climate of entrepreneurship and innovation based on public-private partnership, understood as the commune's cooperation with commercial entities, including external investors (Tavana et al., 2022).

The formulation of the research problem was based on an analysis of the literature on the issue of the management of economic activity zones (EAZs) in the municipality as entities whose task is to make more effective use of local resources, especially rural resources of municipalities. It also provides the key determinants of the potential of EAZs, which result from the income from the commune's location and the quality of intangible resources, the quality of intellectual, relational and innovative capital of residents, the application of good practices in municipal management and the readiness of municipal resources to change in the context of a competitive environment.

The purpose of this chapter is to present the impact of economic activity zones (EAZs) on local development and to identify good practices in EAZ management, based on the experience of the municipality of Wieliczka, Poland. This aim was supplemented with three research goals (RG):

RG1) *Determining the role and significance of selected activities for the possibility of increasing the effect of municipal investments in the field of technical infrastructure.*
RG2) *Indication of the conditions for taking actions conducive to the improvement of the effectiveness of municipal investments, identification of barriers to taking favorable actions improving the effectiveness of investments.*
RG3) *Indication of the possibility of elimination or reduction of the barriers.*

2. Literature background

It is assumed that the source of stimulating the development of systems with various scales (Klasik, 2018) including local development are investments (Harasimowicz, 2022). They shape the labor market (demand for labor, counteracting labor migration), contribute to the transfer of new technical, technological and organizational solutions, influence the work culture and behavior, enforce the increase of employees' competences, motivate local authorities to make infrastructure investments and to improve the quality of service in offices (Wrana, 2018).

There is a surplus of demand over supply in the investment market, which strengthens the position of investors. The competitive struggle between countries, regions, and local structures applying for investors takes place. Investors choose locations that guarantee security for the invested capital and greater opportunities for lasting benefits (Gutowski, 2018). Investments are perceived as an instrument for acquiring innovations, their activity aids the transfer of modern technologies to municipalities and regions and strengthens the competitiveness between local enterprises, becoming a factor of multifaceted changes in the economy (Gorynia, Bartosik-Purgat, & Jankowska, 2006). Diffusion of modern technologies for the modernization of the region, can take place through various channels transmitting ideas and innovations, e.g., import of technologically advanced goods, accumulation of foreign capital, transfer of licenses (Jakubiak, 2018). The starting point for the analysis of the relationship between economic innovation and investment can be taken from Porter, stating that the dynamic model of competition may transform unfavorable factors into a competitive advantage (Makieła & Stuss, 2018).

The economy competitiveness results primarily from the ability of individual entities (especially enterprises) operating in it to create innovations and improvements (new techniques and new ways of proceeding) and the efficiency with which enterprises located in each area can use expenditures to produce valuable goods and services. The impact of investments affects the increase in the value of production factors, changing the strategy of enterprises, creating new demand conditions, creating related and supporting industries, i.e., the four elements that make up the diamond of competitive advantages of Porter (Żmuda & Molendowski, 2016).

A significant element in assessing the importance of investments for increasing the innovation potential of regions is the impact of these investments on the advancement of local research and development activities. The most beneficial for the receiving regions are the investments that lead to developing a network of R&D centers in these countries, raising the demand for services of local R&D centers, and increasing the employment of local staff in internal R&D units (Wierzbicka, 2015).

Technology transfer, modernization, and the introduction to innovation are the most crucial benefits for the region receiving investments. They are valuable, especially in peripheral, underdeveloped regions. Typically, these regions need new development concepts, strategies of action which, using science and technology, will allow the region to be modernized. However, for the development of technology to occur, high financial expenditures are needed, which are often not available in underdeveloped regions. The solutions to this problem are foreign investments that fill this gap (Costa & Matias, 2020).

A special instrument for the development of a region/municipality introduced by the EU is Integrated Territorial Investments (ITI), the aim of which is to support spatial cohesion and affect local and regional economies. The use of this tool, in accordance with the assumptions of the European Commission, is to encourage closer cooperation between units forming the functional urban area and motivate them to jointly solve current problems, as well as enable the use of common values – historical, geographical and natural (Kociuba, 2015).

The main goal of the European Union's regional policy is primarily to increase the economic cohesion of the Member States. By mobilizing subsidies for new instruments that will help less developed regions, the EU aims to reduce the differences in the level of development and life in individual regions of the Member States. The main task of the regional policy is to eliminate the asymmetry in regional development and to promote the rational and controlled by the Union institutions' transfer of funds from the EU budget to regions. At this point, it should be emphasized that this policy significantly affects the scale and pace of development in the spatial structure of the economy from the regional as well as local perspective. It contributes to the improvement of competitiveness and socio-economic development (Świstak, 2018).

A document strongly correlated with the EU regional policy is the National Spatial Development Concept 2030, which defines the spatial order of Poland (National Spatial Development Concept 2030, 2012). The main strategic goal defined in this document is the effective use of the country's space and its various development potentials. They serve to achieve the highest possible state efficiency, increase employment, competitiveness, as well as economic, spatial and social cohesion in the long term. It is worth emphasizing that the document states, inter alia, that a similar set of activities of an integrated nature should be directed to areas that are characterized by common geographic, spatial and socio-economic features, called functional areas.

In the National Spatial Development Concept 2030, urban functional areas are defined as settlement systems, spatially continuous, and composed of administratively separate units. The Concept of National Spatial Development 2030 defines the functional area as "a compact spatial arrangement consisting of functionally related areas, characterized by common conditions and predicted, uniform development goals." The functional urban area comprises a compact urban area and an urbanized zone functionally related to it. The strength of internal connections between the city as a center and its functional area plays a significant role here. Factors, such as the intensity of development, the volume of the flow of goods and services, interrelations between the labor market and the housing market, technical infrastructure and natural structures are taken into account (Kociuba, 2015).

Administratively, Urban Functional Areas may include urban, rural, and urban-rural communes. The National Spatial Development Concept is an important document supporting the development of investments in metropolitan areas, regional and subregional centers, and local centers as functional areas of significant importance for the spatial policy of the commune, designated for cities with less than 50,000 inhabitants (mainly county), which have a chance to concentrate economic functions and serve rural areas with their service facilities (Weresa, 2012).

Investment processes supported by the European Union serve the increased interest in regional issues, and those implemented by the Integrated Territorial Investments, as an effective instrument introduced by the European Union to support spatial cohesion and influence the regional economy. Continued efforts to increase regional competitiveness require the use of increasingly intelligent and innovative tools. The projects implemented under the ITI are aimed primarily at creating a competitive economy through the dynamization of the functioning of enterprises, social capital, educational entities, and the broadly understood research and development area.

3. Methodological approach: Data and information sources[2]

Bearing in mind the fullest possible implementation of the research goals, the study was conducted with the use of both qualitative and quantitative methods. Quantitative methods are characterized by the fact that they allow for obtaining data that can be processed statistically. It it is possible to enlighten, among others, the scale of given phenomena. Qualitative research is used to determine the opinions of respondents who have specialist knowledge on a specific topic. In their course, information is obtained to explain the phenomena and the use of research methods in the described project allowed for obtaining in-depth information (Creswell, 2013).

Given the scope of the study and the goals set for it, methodological triangulation was used. The purpose of such a research approach is the multiplication of research methods and techniques (methodological triangulation), information sources (triangulation of information sources) and research perspectives of people conducting the research (analytical triangulation). It allowed using the strengths of each method while neutralizing their weaknesses. As a consequence, both qualitative and quantitative techniques, expert experience and information obtained from various groups involved in the research process were used during data collection. The

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2   This chapter is only a presentation of condensed research results. Hence, it is rather descriptive and shortened in relation to the original version of the doctoral dissertation.

empirical material gained in this manner made it possible to gather in-depth knowledge of an explanatory nature (Czakon, 2015).

The following methods and techniques of collecting, processing and analyzing existing data (desk research) were used in the work – CAWI, IDI, ITI, and FGI. The source of the data and information came from the survey, which was quantitative in nature and was used to gather information to help formulate recommendations determining the impact of EAZ on changes in the management of local government units. The research tool was a survey questionnaire transmitted to the respondents electronically (Table 4.1).

Table 4.1. Research methods and techniques used with characteristics

Method/Technique	Characteristics
Description of the survey questionnaire	The survey questionnaire was addressed to mayors of municipalities of the Krakow Metropolitan Area. Responses were obtained from 15 municipalities. The questionnaire consisted of the following parts: • informational – the respondents found the purpose of the study, how to answer the question, a guarantee of anonymity of the answers given and the characteristics of the person conducting the survey, • the actual question – a set of questions about the dissertation, • respondent's personal data.
Structured individual in-depth interview. Eight interviews were conducted with:	• Deputy Director of the Department of the Municipality of Lesser Poland • Head of a County • Representatives of the Krakow Metropolis Association • Head of the Krakow Metropolis Team • Director of the Krakow Technology Park Department • Director of the Krakow City Hall • Representative of the County and the City Hall of Bochnia • Representative of the Dobczyce Commune
CAWI Quantitative technique – (Computer Assisted Web Interviews) /18 persons/.	The survey was conducted using a questionnaire made available to respondents via the Internet. The CAWI survey was conducted with the participation of persons employed in Lesser Poland municipalities with knowledge of Economic Activity Zones.
IDI/ITI technique	Purposive sampling was used in the survey conducted with IDI/ITI techniques. Participants included representatives of business environment institutions (N=6), representatives of EAZ managers (N=8), experts (including officials, university employees specializing in economic issues, N=15). The total number of interviews conducted with these techniques is N=29 (N=14 IDI surveys and N=15 ITI surveys).
FGI technique	Experts, practitioners involved in the functioning of EAZ N=5

Another source of data for the EAZ study was a survey of the municipality's potential. The primary issue was the selection of indicators determining the

investment attractiveness of the area, which included indicators of the number of business entities operating in the municipality, an assessment of the labor market, the unemployment rate, an assessment of the education system, the location of the municipality in relation to the main transportation points (travel time), and the state of the municipality's natural environment. The study of the municipality's potential was based on reliable statistical information obtained from local data collection sources. The primary place where the Central Statistical Office publishes statistical data is the Local Data Bank (2021). Other sources of statistical data important for the research on the economic potential of the commune were: The Demographic Database of the Central Statistical Office (2021), Statistical Vademecum of Local Government (2021), Lesser Poland Observatory of Regional Development 2021), and reports of the Institute for Market Economics (2021).

4. Results

4.1. The characteristics of the Municipality of Wieliczka

Wieliczka Economic Activity Zone (WEAZ) is a great example of the impact of investments on the effective use of local resources. It is located on the border of Wieliczka commune with Kraków, south of the A4 motorway. The choice of the area intended for the creation of the zone in the northern part of the commune was determined by the dense area of wasteland, and the proximity of a communication junction: a motorway, railway and an airport of international importance. It is a location in the vicinity of which the motorway (A4 connecting the east and west of the country) intersects with the express road (S7) under construction, connecting the south of Poland with its northern part. There is a network of roads in the vicinity of the zone: national (no. 94 and no. 79), provincial (no. 964 and no. 776) and local. Near WEAZ, there is an active E30 main railway line with numerous stops and sidings. The zone's location enhancement is the proximity to the Balice Airport (approx. 30 km).

A particular advantage of the location of WEAZ is the proximity to the Krakow metropolis. The features of the neighborhood of Krakow include access to the innovative scientific potential of Krakow: intellectual resources of universities, R&D centers, world-class cultural resources, and the possibility of using the network structures of the city's economy.

The establishment of WEAZ was determined by the development barriers of the commune, whereas the possibility of using the existing potential was an opportunity to dynamize economic development. Factors favoring economic development, such as the high investment attractiveness of the commune

expressed by a very large number of business entities operating in the commune (6,567 companies), high level of entrepreneurship (97.2 natural persons running a business per 1,000 inhabitants), average number of active enterprises in the Lesser Poland Voivodeship is 47.3 per 1000 inhabitants (Report on the condition of the small and medium-sized enterprise sector in Poland in 2013–2014) and the potential of human resources (20.5% of the population in pre-working age, 63.7% in working age) together with the favorable geographical location of the commune, influenced the decision of the Wieliczka Town and Commune Office on the creation of the Wieliczka Economic Activity Zone. Significant factors that were also taken into account were local problems, such as unsatisfactory level of accessibility to the sewage disposal system (low percentage of residents using the active sewage network – 40.7%), the unsatisfactory technical condition of roads and road infrastructure as well as insufficient promotion of the Commune (Report on the condition of the small and medium-sized enterprise sector in Poland in 2013–2014).

In the Strategy for the Development of the City and Commune of Wieliczka for 2015-2022 (2014), the domain Wieliczka – an excellent place for business is among the five areas of strategic development. The tasks of one of the strategic goals of this document (Conducting the commune's pro-investment policy ensuring environmentally sustainable economic development) included the preparation of the WEAZ infrastructure. The WEAZ area, based on the local development plan, is divided into three parts, located north of the A4 motorway and the E30 railroad. These are – the western part of Brzegi-Kokotów – with an area of approx. 90 ha, located between the villages of Brzegi and Kokotów, along the Holy Father Francesco's Route (in the place where the World Youth Day took place), the functioning name of this part – Brzegi, the central part – with an area of about 25 ha located within Kolejowa, Łąkowa and Szkolna streets in Węgrzce Wielkie, eastern part – with an area of approx. 50 ha located in the eastern part of Węgrzce Wielkie, under the name – Węgrzce II.

The area located in the village of Brzegi covers over 250 ha (22% of the area is industrial development, 6% is service development, and 31% is a biologically active area (greenery). The remaining 59% is road infrastructure, parking lots, communication routes. The zone consists of three industrial areas divided into four segments (zones). In zones A and B (Kokotów) nearby the Śledziejowice-Brzegi county road, the main functions are services, production and tourism. The area that can be obtained under development for warehouses and depots – is over 25 ha, and 1.5 ha for offices, services and trade. In zone C there are service functions (services, offices, trade) – possible development area – over 7 ha. Zone D is intended for the construction of logistics centers, production and services – over 28 ha.

WEAZ was created as a result of the implementation of the sustainable development policy of the city and the commune and was approved by a number of resolutions of the Commune Council, including the Resolution on the Local Plan of Development from September 29, 2015, defining the present shape of the WEAZ. The areas where WEAZ is located used to be an unproductive wasteland, and inaccessible due to wetlands. The decision to establish WEAZ restored these areas to the commune community as attractive investment plots.

The development of WEAZ primarily takes into account external investments in the logistics industry (storage, packaging, transport), which is confirmed by the presence of already operating investors. Manufacturing companies, which are moving their headquarters from nearby Rybitwy, are also interested in investing. This type of investor responds to the social demand for new jobs, decent earnings, and better quality of life for residents and people commuting to work. Such changes in the labor market may lead to an intensification of the migration process and settlement in the commune. These investments provide the commune funds to the budget from (PIT, CIT tax forms) property taxes or land lease fees.

4.2. The establishment of WEAZ

The development of WSAG was possible thanks to the funds obtained under the Lesser Poland Regional Operational Program. The commune of Wieliczka used the EU funds allocated to the preparation and development of the commune's infrastructure. As part of the Lesser Poland Regional Operational Program for years 2007-2013, action 4.3 Creation and Development of Economic Activity Zones, Scheme B: Economic Activity Zones with an area of more than 20 ha, the local government prepared a project entitled: Creation of the Wieliczka Economic Activity Zone worth PLN 20 million. The project received co-financing in the amount of PLN 12.4 million, which is about 62% of the costs; the remaining part of the costs comes from the commune budget (35%) and the county budget (3%).

The project was aimed at creating the infrastructure of WEAZ on an area of 39.4 hectares, located in the Brzegi-Kokotów zone. Its scope included the development of utilities in the zone, ensuring their functionality. The investment was completed by the end of 2015 and included the construction and modernization of internal roads in the zone, the construction of water and sewage systems, construction and modernization of external roads – a link between the zone and the S7 expressway.

As part of the application the Functional and Utility Program and Feasibility Study were conducted as well. The funds were also used to

promote the project and for the investment supervision. According to the formula "design and build," comprehensive technical documentation was prepared based on the Functional and Utility Program of the project, followed by construction works.

The sum of investments related to WEAZ, which includes investment in factories (PLN 49.55 million), activities attributed to WYD (PLN 10.38 million), and other investments related to the functioning of WEAZ (PLN 40.83 million), is almost PLN 101 million. The expenses incurred for the zone construction were borne by the City and Commune Office in Wieliczka, which is responsible for the zone management. Investments are also financed from external sources – EU funding – the European Regional Development Fund, the County Office in Wieliczka, the Provincial Office in Krakow, and the Marshal's Office of the Lesser Poland Province. The expenses for the construction of the zone from the above-mentioned sources amount to PLN 49.55 million. The City and Commune Office of Wieliczka covered 36% of the costs, 42% of the amount was financed from EU subsidies, 14% of the expenditure was borne by the Voivodship Office, 5% by the County Office in Wieliczka, and 3% by the Marshal's Office in Krakow.

4.3. The impact of WEAZ on local development

There are 22 domestic and foreign companies located in WEAZ, with significant production potential and a recognized brand. They include Teekanne, 7R Solution, Wearco, Brandbq, Iglomen, and Pekaes et al. (Table 4.2).

Table 4.2. Industry specializations of selected enterprises located in the Wieliczka Economic Activity Zone in 2019

Company name	Specialization within the PKD section	Section name	Workers/ quantity /
Wearco and Brandbq	46 - Wholesale trade	H - Transport and warehouse management	250
Iglomen	46 - Wholesale trade	H - Transport and warehouse management	112
Rohlig Suus Logistics S.A.	52 - Warehousing and support activities for transportation	H - Transport and warehouse management	109
Teekanne Polska	10 - Manufacture of food products	C - Manufacturing	102
Pekaes Sp. z o. o.	49 - Land transport and pipeline transport	H - Transport and warehouse management	85
PGD Polska Sp. z o. o.	46 - Wholesale trade, except of motor vehicles	H - Transport and warehouse management	73
PPHU Specjał	51 - Air transport	H - Transport and warehouse management	72

Company name	Specialization within the PKD section	Section name	Workers/ quantity /
7R Solution Sp. z o. o.	49 - Land transport and pipeline transport	H - Transport and warehouse management	**60**
Przedsiębiorstwo Handlowe FAMIX S. i G. Tarnowscy	Wholesale trade, except of motor vehicles	H - Transport and warehouse management	**44**
AUTO Gum	52 - Warehousing and support activities for transportation	H - Transport and warehouse management	**30**

Analyzing the industry and employment structure of the Economic Activity Zones, WEAZ is the only specialized logistic zone in which warehouse management dominates. In 2020, 1,164 employees were employed in the enterprises in the zone. WEAZ will be enlarged by another 50 ha, with land located in Węgrzce Wielkie. 2 km of internal roads, sewage, water and electricity networks, lighting and other infrastructure needed by investors have been designed there.

4.4. Good practices in WEAZ management as well as barriers and impediments to efficient WEAZ management

The SWOT analysis method was used to assess the strengths and weaknesses as well as the opportunities and threats of the pro-investment policy for WEAZ. The analysis uses two basic criteria for the classification of factors influencing the development of the Zone: external factors exerting a positive and negative influence, internal conditions (positive and negative) characterizing the state of the Zone in the cross-section of all the most important groups of resources (Table 4.3).

Table 4.3. SWOT analysis of pro-investment policy in the commune of Wieliczka

Strengths	Weaknesses
EAZ recognition	too late decision to establish EAZ
support from the local government	lack of a professionally prepared offer
existing vacant land in the EAZ	for entrepreneurs
the proximity of the metropolitan center	un-established cooperation with
area connected to the utilities	entrepreneurs in the zone
the proximity of communication hubs	lack of vocational colleges
experience in implementing EU projects	
communication for residents and employees	

Chances	Threats
EAZ management a chance to obtain funds from the EU support for the Association of the Krakow Metropolis increase in the number of inhabitants and employees development of the educational area (for children of EAZ employees) city recognition	- economic changes related to threats (pandemic) - competitiveness of other economic areas with limited investors' interest

The analysis shows that a serious barrier to the development of WEAZ is the lack of a professionally prepared offer for entrepreneurs and the lack of professional investor service. The strengths include large reserves of investment areas and access to the local workforce, technical infrastructure in the Zone and its surroundings, the transport network with its main axis, and the A4 motorway. The creation of the Wieliczka Economic Activity Zone began too late in relation to other communes. However, the strategy, the method of building the brand of the zone through promotion resulting from identifying the location of the global event in this economic area turned out to be effective. Recognition and precise planning of the location and construction of the infrastructure quickly encouraged entrepreneurs to choose the place and invest in this area. The zone has immense potential by indicating further areas in the local plans for the purpose of the EAZ, with the simultaneous acquisition of further funds from the European Union for developing land infrastructure. New jobs were created in the commune, where the number of inhabitants is growing extremely dynamically. Wieliczka Economic Activity Zone is an area characterized by a well-dedicated type of activity, preserving its environmentally friendly character.

5. Conclusion

In order to stimulate the development of EAZs, it was indicated that regions reorient local growth strategies to an increasing extent, intensifying investment processes and building a network economy as an opportunity to use their resources more efficiently. Cluster structures, technology parks, local zones of economic activity cooperating with modern university laboratories and supported by business incubators are generated, bringing transfer to the economy, knowledge and innovations created at universities.

One may formulate a thesis that the most valuable tools and activities that will attract investors and at the same time testify to the potential of a given zone of economic activity include, among others (Salecka, 2019):

- infrastructure preparation – the area intended for EAZ must be equipped with basic utilities, should have access to a public road and be well integrated into the communication network, not only local but also regional and even national;
- legal preparation of the land – a local spatial development plan should be in force in the EAZ area and the legal status of the land should be clarified;
- an appropriate socio-cultural climate, which proves the awareness of the advantages of EAZ among the local community, will result in the acceptance of the investor without any fear.

An essential element in assessing the importance of investments for the increase of the innovation potential of host regions is the impact of these investments on the advancement of local research and development activities. The most beneficial investments are those which lead to the development of a network of R&D centers in the regions. Integrated Territorial Investments are particularly important for economic growth, which, under the EU financial perspective 2014-2020, have become the basic tool for supporting functional areas. They constitute a mechanism for implementing the concept of managing municipalities' development based on the integrated management theory.

The construction and development of the Wieliczka Economic Activity Zone is a very significant strategic goal of the Wieliczka Commune. To achieve this objective, we should consider the following factors:

- social – benefits for residents expressed by the availability of new jobs, the possibility of starting their own business in an above-average favorable environment;
- building the brand/image and promotion of the commune;
- launching urbanization processes, arranging space;
- economic, including an increase in income from (PIT, CIT, VAT tax forms), and real estate tax.

The presented analysis indicated that an increase in employment, increase in budgetary income of communes, the development of entrepreneurship of inhabitants, and innovation of economic entities is possible almost exclusively through investments that can be implemented in Economic Activity Zones.

The review of theories regarding the development of the local economy in terms of the legitimacy of the existence of economic activity zones clearly confirmed the hypothesis that their creation brings positive changes to a given area. The establishment of a local EAZ increases the potential and attractiveness of a given site, which in the light of constant competition between regions contributes to strengthening its position. The creation of the

EAZ is an important activity in the management of the commune, resulting in more effective use of local resources (wasteland, post-industrial areas), which used to be a cost burden. Key advantages of the functioning of the EAZ are the creation of new jobs, diversification of the employment structure, especially in rural areas, promotion of the area, inflow of capital, and a number of other ones indirectly related to the emergence of infrastructure investments in the EAZ.

Local development carries a risk, which has an impact on activities related to the creation of economic activity zones (Limański & Drabik, 2017). However, the market economy is conducive to the development of enterprises of all sizes, with particular emphasis on small and medium-sized ones. Suitable conditions for the development of those entities that act for the benefit of the local economy should be provided. Success may be achieved with the involvement of the investor's resources and capital, and with the financial support of a given territorial unit. The formation of economic activity zones depends on a commune's favorable location and spatial structure, the rich demographic, environmental, financial and socio-cultural resources.

The desired direction of extending the analysis proposed in the chapter is the confirmation of the impact of investments in EAZ, not only the influence of financial resources on the budgets of municipalities but also an increase in the level of innovation and entrepreneurship, as well as a comparison of the effects observed in municipalities with the location of EAZ, and the examination of the dynamics of quantitative and qualitative indicators. It is particularly important to research and conduct in-depth analysis of individual municipalities to assess the impact of EAZ on the development of smart specializations. As the analyzes conducted for the regions show, it was found that the presence of smart specializations translates into stronger regional development. This means that municipalities with EAZ locations are the main drivers of regional development, mainly due to their innovation. Supporting their development, especially innovative activities, should encourage the process of entrepreneurial activity of residents and generate R&D among entrepreneurs as well as stimulate through supply-demand relations the development of other sectors of the region, and thus economic growth.

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Biographical note

Artur Kozioł, Ph.D., local government official, mayor of Wieliczka since 2006. In 2022, he defended his doctoral thesis at the Institute of Economics, Finance, and Management, Faculty of Management and Social Communication of the Jagiellonian University, entitled *„Management in Local Government Units and the Economic Activity Zone in the Krakow Metropolitan Area."* The originator of the creation of the Wieliczka Economic Activity Zone, also a co-organizer on behalf of the Wieliczka commune of the so-called central events during World Youth Day (the largest mass event in the history of the country). Panelist in discussion panels at the Economic Forum in Krynica on innovative management of the municipality, conferences on the organization of World Youth Day, as well as numerous initiatives within the Self-Government Movement. Chairman of the Scientific Council of the Conference „Economic Activity Zones and Management in Local Government" (Niepołomice, 2022). Co-organizer of the 21st edition of the Polish-Peruvian Conference in the series ECONOMY-FINANCE-MANAGEMENT, entitled „Contemporary Challenge in Economic Policy, Business and Management." Initiator of close cooperation between the local government and Kraków's universities (since 2015). He also runs initiatives for students (patronage of student competitions, meetings as part of lectures, coordination of student internships, and support in preparing materials for master's and bachelor's theses).

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A challenge for sustainable public management: Administrative performance measurement and public sector reform

Yuji Sato[1]

Abstract

This chapter proposes a rational approach to administrative performance measurement. As Japan has entered an aged society with a low birthrate, administrative organizations in Japan are required to conduct performance-based public management under tight fiscal conditions. Aiming at efficient management with various schemes for administrative performance measurement based on the theory of New Public Management has been proposed. However, a tangible way of management has not been established due to authoritarianism or political shackles in organizations. In addition, such a performance measurement sometimes involves subjective factors in relation to outcome indices. Therefore, developing a practical evaluation scheme is not straightforward. By applying the Analytic Hierarchy Process, this chapter makes it possible to quantify subjective factors in the evaluation: the degree of contribution of each measure for the achievement of a policy. In order to verify the effectiveness of the application, a case study is performed in a local government in Japan. The proposed approach practically supports public service evaluation based on subjective judgment by executives of administrative organizations in addition to extant project appraisal. The results obtained from the case study show the practical effectiveness of the proposed approach. Based on the evaluation procedure, this chapter further considers a possible scheme of public sector reform in conjunction with a prospective way to transfer authority from an administrative organization to substitutable sectors. The implication of the scheme of reformation illustrates sustainable public management.

Keywords: *public management, sustainability, publicness, analytic hierarchy process, administrative performance measurement, public sector reform.*

1 Yuji Sato, Ph.D., Professor, Graduate School of Management, Chukyo University, 101 Yagotohonmachi, Showa, Nagoya, Aichi 466-8666, Japan, e-mail: ysatoh@1988.jukuin.keio.ac.jp (ORCID: 0000-0002-3317-7350).

1. Introduction

As of 2021, the rate of aging (aged 65 or older) reached 29% in Japan, which is conspicuously high among developed countries. In addition, the year's birth rate is estimated at 1.30%, the lowest among G7countries. According to demographic change, tax revenues decreased, and the fiscal condition of Japan has been declining since the end of the 21st century. As a result, the total gross amount of government exposures increased by a factor of six, from 2.65 (1990) to 12.4 (2020) trillion USD (1$=Ą110) during these 30 years. As a result, the ratio of total governmental debt to GDP reached 256.2%, while in the United States stays at 127.1% as of 2020 (MOF, 2021). Those situations require administrative organizations to enhance the efficiency of public management in conjunction with conducting a proper evaluation of administrative activities. In connection with the passage of the Government Agencies Policy Evaluation Law in 2002, every administrative organization in Japan is obliged to evaluate its policies and announce the results to the public annually. The law has made the evaluation of the achievement of policy goals a critical component of project implementation, which sometimes results in public sector reform (Kudo, 2010; Shiroyama, 2012; Yamamoto, 2003).

The administrative evaluation consists of a series of processes evaluating the adequacy and achievement of policies and measures of public administration against a specific benchmark. In Japan, a prefecture was the first to introduce a rigorous administrative performance measurement system in 1996. The system was developed to reform the prefectural office, which was one reason why the system attracted attention nationwide (Nakamura, 2013). The most noticeable reforms at the time were the introduction of performance management and accrual basis accounting (Aya et al., 2015). Since then, some local governments have begun to introduce a variety of such evaluation systems. As of 2016, 100% of prefectural and 86.7% of city governments, with more than 80% of municipalities, have introduced their original evaluation systems (MIC, 2017).

On the other hand, public sector reform encompasses a spectrum of issues, including civil service reform, performance measurement, and governance regulations. For example, the separation of the implementation of public services from decision-making has been diffused as "gentrification" around the world. The Next Step Agency in the UK is one of the most famous attempts. The central government in Japan has also adopted such reform where the agencies are called "independent administrative institutions" (Yamamoto, 2008). Many local government services, however, have not yet been reformed, even though local public finance is on the verge of a crisis. The index of the fiscal condition is below 0.5 in 53.2% of prefectures as of 2019 (Ministry

of Internal Affairs and Communications, 2020). The main reason for the deadlock in reform is the difficulty in obtaining a rationale for transferring authority from the public sector to other substitutable sectors.

In order to refine administrative evaluation, this chapter proposes an evaluation system using the Analytic Hierarchy Process (AHP). The system quantifies subjective factors in the evaluation; the degree of contribution of measures for the achievement of a policy is quantified. This quantification practically supports public service evaluation by not only extant project appraisal but also subjective judgment by executives of the organizations. Furthermore, this chapter concretely shows how to utilize the evaluation results. Since administrative performance measurement (APM) corresponds to a "Check" phase in PDCA-cycle, it is essential to employ the results of an evaluation in the following phase, "Plan." Administrative organizations, however, sometimes do not utilize the results, such as for budgeting after the evaluation, due to authoritarianism and political shackles. Therefore, such a "negative attitude" toward acting is criticized as evaluation is becoming its goal. As a result, APM is not generally welcomed by administrative organizations because evaluation itself is not a creative activity but a retrospective review of past events.

In addition to the refinement of the evaluation system, this chapter considers a rational approach to public sector reform that is essential for sustainable public management. A prospective way to transfer authority from the public sector to other substitutable sectors is considered. Also, the matching process of public services of a local government with substitutable sectors is proposed. The process quantitatively clarified the property of each public service of a local government and the characteristic of substitutable sectors including the public sector, which can take on the role of implementing such services. Section 2 introduces the framework of a practical APM system, and Section 3 summarizes the results of a case study carried out in a local government in Japan. Section 4 discusses the usage of the evaluation results, and Section 5 proposes a possible scheme of public sector reform. Section 6 concludes this chapter and shows future research.

2. Literature background: A framework of administrative performance measurement system

This section introduces a framework of the APM system. A structure of public administration of administrative organizations can be stratified as a hierarchical structure consisting of philosophies of public administration, subordinating policies, measures, and projects (i.e., public services) from top to bottom. All these public services have been administered by the public

sector so far. Among this structure, this chapter focuses on measures and public services as the objects of evaluation.

Administrative evaluation systems proposed to date have often been criticized as being too qualitative for objective interpretation (Ono and Tabuchi, 2001). Indeed, the ratio of people who were skeptical about the evaluation results was not low (Umeda, 2001). The evaluation system is, therefore, organized into four steps, which clearly evaluate measures and public services of administrative organizations. In Step 1, all public services of an organization are first evaluated based on their output indices. Step 2 then evaluates superordinating measures from the viewpoint of the percentage of completion based on the general plan of an organization. In Step 3, the degree of contribution of measures for the achievement of an administrative policy is evaluated, in which the AHP is applied. Step 4 evaluates the proximity between the policy goal and the current status of management based on the former three steps.

Let P_i ($i=1, \ldots, p$) be an administrative policy of an organization, and M^i_j ($j=1, \ldots, q$) be measures subordinating policy P_i. Now, let S^{ij}_k ($k=1, \ldots, r$) denote a public service based on a measure M^i_j. The APM is then organized following four steps.

• **Step 1:** evaluation of public services
All public services of an organization, S^{ij}_k, are evaluated based on output indices of the services on a scale of 100. The results, $e(S^{ij}_k)$, are aggregated for every measure, M^i_j, by taking simple average of $e(S^{ij}_k)$. The output of this step is denoted by $e(S^{ij})$.

• **Step 2:** evaluation of the percentage of completion of measures
All measures of the organization are evaluated based on the percentage of completion and based on the general plan of the organization on a scale of 100%. Since each measure has some outcome indices, the result of this step, $c(M^i_j)$, is calculated by taking simple average of the percentage of completion of each measure evaluated based on the indices.

• **Step 3:** evaluation of the degree of contribution of measures
The degree of contribution of each measure for the achievement of an administrative policy of the organization is evaluated using the AHP. Practically, evaluators conduct pairwise comparison for the measures based on the relative importance of each measure for the achievement of a policy on a scale of 100%. The degree of contribution of a measure is elicited as a weight vector called *w*-vector, which is normalized by l_1-norm and denoted $w(M^i)=\{$degree of contribution of measures, $w(M^i_j)\}$.

Since each measure is designed to achieve superordinating policy, the degree of contribution of each measure for the achievement needs to be considered in the evaluation of the proximity between the goal of each policy and current status. In calculating the degree of proximity, therefore, a weighted average of $e(S^{ij})$ and $c(M^i_j)$ by the weight of $w(M^i_j)$ is employed.

• **Step 4:** calculation of the proximity to the goal of public management
The proximity between the policy goal and the current status of management is calculated by the summation of the product of $e(S^{ij})*c(M^i_j)*w(M^i)$. The result of this step is denoted by $t(P_i)$.

3. Methodology

In this chapter, the AHP is applied in order to quantify subjective factors in the evaluation: the degree of contribution of each measure for the achievement of a policy. A case study is then carried out in a local government in Japan to verify the effectiveness of the application.

3.1. Outline of the AHP

AHP is developed by T. L. Saaty (1980) as one of the supporting systems for multi-criteria decision-making as well as a tool for analyzing the decision-making process. The AHP has the subjective judgment of each decision maker as input and the quantified weight of each alternative as output. Therefore, not only objective issues but also subjective issues without theoretical values can be easily quantified. The AHP has thus been widely used for decision-making, e.g., economic problems, policy evaluation and urban planning (Vargas, 1990; Saaty, 1994).

The AHP consists of three steps: stratifying the framework of decision making, pairwise comparison, and calculating the weight of each alternative. Let a_{ij} $(i, j = 1,\ldots, n)$ denote the relative weight of alternative i (i for short) to j, and $a_{ji} = 1/a_{ij}$, then the results of all pairwise comparisons can be summarized as an n by n reciprocal matrix (a_{ij}) called a pairwise comparison matrix, where $a_{ii} = 1$ for all $i=1, \ldots, n$.

In cases where a pairwise comparison matrix satisfies transitivity for all pairwise comparisons, i.e., for arbitrary i, j and k, $a_{ik} \cdot a_{kj} = a_{ij}$ $(i, j, k = 1, \ldots, n)$ holds, the rank of such a pairwise comparison matrix equals 1, its Frobenius root is always equal to n, and the remaining eigenvalues are all 0 for any a_{ij}. Thus, the eigenvector corresponding to the Frobenius root is always non-negative, and each element of the eigenvector normalized by l_1-norm can be interpreted as the degree of importance of each alternative.

Decision makers, however, sometimes make judgments inconsistently, in which case the transitivity is not always satisfied. Then the Frobenius root of such an inconsistent pairwise comparison matrix is always greater than n, and the difference between the root and n is equal to the sum of the remaining eigenvalues. Therefore, the smaller the difference, the more consistent the judgment of the decisionmaker would be. In the AHP, the quotient of this difference over n-1 is defined as the Consistency Index, which is the criterion for the consistency of judgments across all pairwise comparisons. Figure 5.1 illustrates the framework of APM based on the AHP architecture.
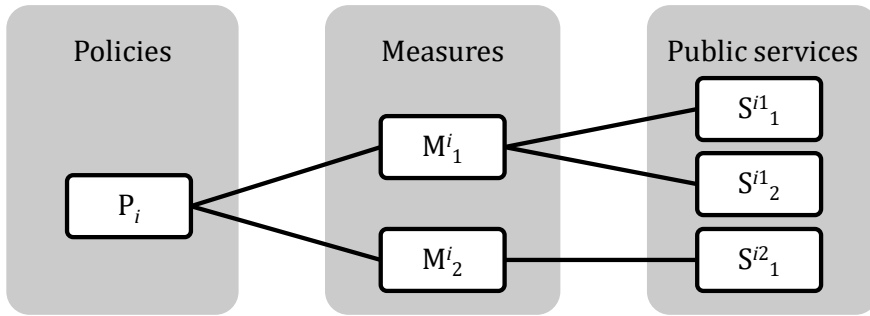
Figure 5.1. Framework of APM (example, partial)

3.2. Outline of the case study

The case study was conducted in an administrative organization in Japan in May 2021, three months prior to the government compilation of the budget. The organization is a local municipality with a population of 170,000, whose public management is carried out based on a general plan consisting of seven policies, 38 measures, and 889 public services. Respondents were executive staff members of the organization: a mayor, two deputy mayors, and 23 chief directors of departments. The purpose of the case study was to identify "the degree of contribution of measures for the achievement of superordinating administrative policy that executives considered when they compiled budget." The case included three questions, each of which asked executives to conduct pairwise comparisons from three perspectives: the need of citizens, immediacy and timeliness, and public utility.

4. Results of the case study

First, all the 889 public services of the municipality were evaluated by 67 section chiefs. They evaluated the achievement of each service based on output indices on a scale of 100. The evaluation results of, $e(S^{ij}_k)$, are aggregated for every measure, M^i_j, by taking the simple average of $e(S^{ij}_k)$. For example, leaving out the details, P_I consists of three measures M^I_1, M^I_2, and M^I_3, and M^I_1 has 50 appendant public services S^{11}_1, S^{11}_2, ..., S^{11}_{50}. Therefore, $e(S^{11})$ is an average of $e(S^{11}_1)$, $e(S^{11}_2)$, ..., $e(S^{11}_{50})$, which resulted in 90.4. Next, the percentage of completion of all 38 measures of the municipality was evaluated by 23 chief directors. They evaluated the percentages based on the general plan on a scale of 100%. For example, P_I consists of three measures, M^I_1, M^I_2, and M^I_3, and each measure has some outcome indices. Therefore, $c(M^I_1)$ is an average of these percentages, which is calculated as 26.7%.

This evaluation was carried out using the AHP, in which they conducted pairwise comparison over measures. They made judgement on the relative importance of each measure to achieve superordinating policy. As shown in the fifth column of Table 5.1, the degree of contribution of each measure is elicited as a weight vector normalized by l_1-norm. For example, $w(M^I)=\{28.3\%, 29.0\%, 42.7\%\}$. Table 4.1 summarizes the results of the case study. Based on these evaluations corresponding to the Steps 1, 2, and 3, Step 4 calculates the proximity between the goal of a policy and the current status as the summation of the product of $e(S^{ij})*c(M^i_j)*w(M^i)$. For example, the proximity to the goal of public management of Policy I, $t(P_I)=52.4$ in this case.

Table 5.1. Results of a case study

Policies	$t(P_i)$	Measures	$w(M^i_j)*c(M^i_j)*e(S^{ij})$	$w(M^i_j)$	$c(M^i_j)$	$e(S^{ij})$
I	52.4	1	6.8	28.3%	26.7%	90.4
		2	21.7	29.0%	80.0%	93.6
		3	23.9	42.7%	57.0%	98.1
II	36.8	1	2.1	8.1%	30.0%	84.4
		2	7.5	32.1%	23.3%	100.0
		3	11.2	21.5%	55.8%	93.2
		4	7.3	26.9%	30.0%	90.5
		5	8.7	11.3%	85.0%	91.1

Policies	$t(P_i)$	Measures	$w(M^i_j)*c(M^i_j)*e(S^{ij})$	$w(M^i_j)$	$c(M^i_j)$	$e(S^{ij})$
III	44.1	1	3.6	6.1%	66.7%	87.1
		2	1.7	4.8%	45.0%	77.8
		3	4.5	7.2%	70.0%	88.6
		4	6.7	17.0%	43.3%	91.3
		5	7.7	12.6%	70.0%	87.5
		6	3.1	23.5%	15.0%	88.8
		7	1.8	5.2%	40.8%	83.6
		8	15.1	23.6%	80.0%	80.0
IV	34.9	1	6.1	12.9%	51.7%	91.4
		2	14.7	18.5%	86.7%	91.5
		3	3.9	7.4%	63.8%	82.9
		4	5.3	20.0%	31.3%	84.8
		5	1.5	13.2%	15.0%	74.8
		6	3.4	28.0%	15.0%	81.0
V	43.8	1	11.4	19.1%	71.7%	83.3
		2	3.1	9.9%	57.5%	54.0
		3	5.6	22.6%	26.3%	95.3
		4	7.1	18.0%	40.8%	97.1
		5	16.6	30.4%	55.0%	99.0
VI	34.7	1	2.1	6.2%	33.8%	98.6
		2	1.3	9.5%	15.0%	93.3
		3	6.1	23.8%	36.7%	70.0
		4	5.5	12.0%	47.5%	96.0
		5	15.7	38.2%	43.3%	94.8
		6	4.0	10.3%	40.0%	98.3
VII	43.3	1	16.3	18.2%	93.3%	95.6
		2	7.0	26.4%	28.8%	92.2
		3	15.6	19.5%	80.0%	100.0
		4	7.9	13.2%	69.0%	86.9
		5	12.2	22.7%	55.0%	97.5

5. Usage of the results

Since APM corresponds to a "Check" phase in the PDCA cycle of public management, the results of the evaluation should refine following the "Plan."

The result of the APM thus needs to be utilized to enhance the efficacy of public management.

5.1. Reflection in budgeting

As noted in the introduction section, tight fiscal conditions of administrative organizations in Japan are required performance-based public management, which means "lax management," is not allowed for organizations. On the other hand, budgeting in an administrative organization is not straightforward because of authoritarianism and political shackles. The executives of organizations need to manage the budget by administering the constraints of the budget. The administrative organization in the case study succeeded in utilizing the results of the evaluation for its budgeting under the mayor's leadership.

Figure 5.2 illustrates the image of the budgeting tactic within the organization. $c(M_j^i)$ is the percentage of completion of a measure M_j^i, and importance of measures are calculated based on the ranking of $e(S^{ij})*c(M_j^i)*w(M_j^i)$ of a measure M_j^i. As shown in Figure 5.2, the organization prioritized its budgeting from the upper left, a measure with a low percentage of completion and a high degree of importance, to the lower right, a measure with a high percentage of completion and a low degree of importance.
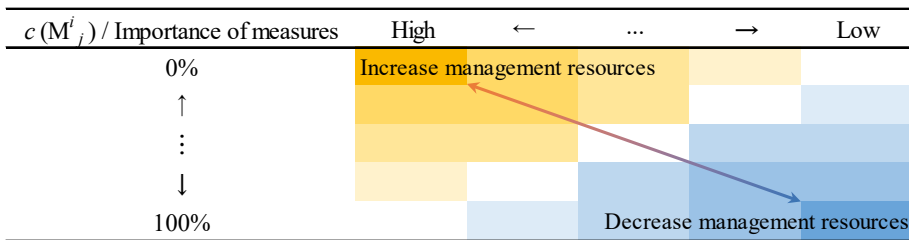
Figure 5.2. Budgeting tactic of the organization

The proposed APM system enables this prioritization as it quantifies the degree of the relative importance of measures. The importance could not have been reflected in budgeting until the degree of contribution of a measure, $w(M^i)$, was quantified because the judgment of the importance heavily relied on evaluators' subjective appraisals. On the other hand, the proposed evaluation system quantifies the importance of using the AHP, which transfer their intangible judgment into concrete number with transparency. As a result, the system succeeds in utilizing the evaluation results to enhance the efficacy of public management in terms of the transparency of budgeting.

The organization in the case study is the first local government in Japan that reflects APM in budgeting.

5.2. Improvement of accountability

Administrative organizations are responsible for their decision-making on public management. The organizations thus sometimes conduct a survey based on public opinion in order to clarify what citizens think about public management. In such a survey, the degree of citizens' satisfaction with public management is a frequently asked question, the result of which needs to be taken care of in improving the accountability of an organization. The degree is, however, rarely reflected in public management regardless of the priority of measures because simply increasing management resources for measures with low satisfaction is nothing more than populism. Public management should take both the degree of importance of a measure as well as the index of satisfaction into account in decision-making. Therefore, the administrative organization in the case study combined the results of the evaluation with the index of citizens' satisfaction obtained from its public survey.

The outline of the prioritization of measures is shown in Figure 5.3 below. The X-axis represents the degree of satisfaction for measures obtained from the survey. Y-axis indicates the degree of contribution of measures for the achievement of an administration policy of the organization, $w(M_j^i)$ derived from the APM. The organization prioritized measures from the most important, A, to the least, D. Measures plotted in the area of A, high degree of contribution and low degree of satisfaction, are the top priority measures for the organization, for which the organization must increase management resources. Measures in area B, a high degree of contribution and a high degree of satisfaction, need to be carried out continuously, which are of secondary importance. Measures plotted in the area of C, a low degree of contribution and a high degree of satisfaction, need to be carried out with careful consideration and might be refined its contents in the future. Measures in the area of D, a low degree of contribution and a low degree of satisfaction, must be refined contents or abolished its activities.

The logic of prioritization improves the accountability of administrative organizations in refining public management. Every administrative activity has a public beneficiary; organizations, therefore, face difficulties in explaining the reason for the revision or abolition of activities. On the other hand, the proposed evaluation system calculates the degree of contribution of measures for the achievement of an administrative policy of the organization using the AHP.
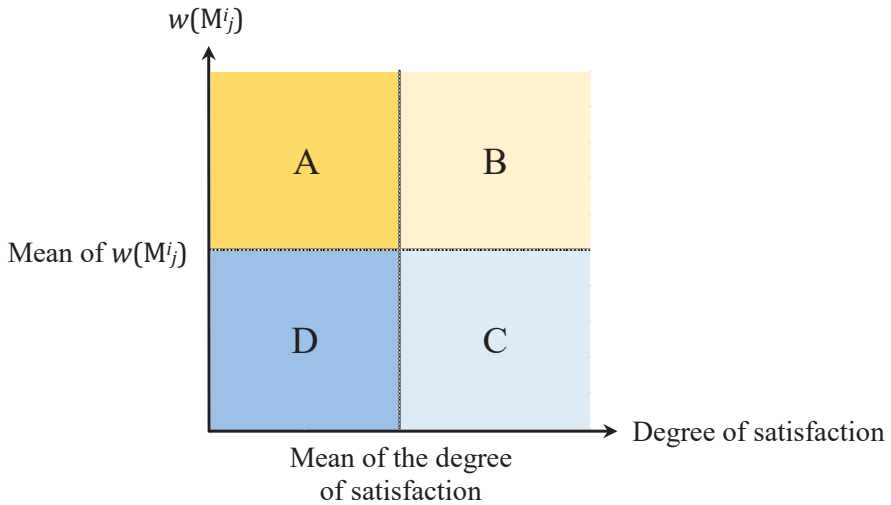
$w(\mathrm{M}^i_j)$

A B

Mean of $w(\mathrm{M}^i_j)$

D C

Degree of satisfaction

Mean of the degree
of satisfaction

Figure 5.3. Prioritization of measures

The system, therefore, enables organizations to anticipate the degree of importance and satisfaction. As a result, the system succeeds in utilizing the evaluation results to enhance the efficacy of public management in terms of the improvement of its accountability.

6. Future application

The proposed APM system is able to clarify the subjective judgment of evaluators in appraisals, such as the relative importance of a measure to others. Hence, further application of the system for sustainable public management can be considered: proposal of the scheme of public sector reform. Based on the procedure of the system, this section considers how to reform the public sector in conjunction with a prospective way to transfer authority from the public sector to substitutable sectors.

In the context of public sector reform, assuming that the public sector would specialize in decision-making and ruling, the Joint Research Group of prefectures in Japan (JRG) clarified that the size and the legal power of administrative organizations should be reduced. JRG also suggested that alternative sectors, such as the network sector and private sector, would then take on an important role, particularly in executing services. Tomino (2009) also assumed the function of the public sector to be limited and that the size and the legal power of administrative organizations should be downsized

insisted, where the abovementioned alternative sectors should take on the role of implementing services.

The framework of public sector reform proposed by the JRG (2003) can be considered as the refinement of New Public Management. The current public sector needs to be decomposed into two parts: one is the organization specialized in decision-making and ruling, which contributes to public welfare with authority and legal power, called "refined public." The other is collective entities that productively cover social issues, such as the next step agency or a non-profit organization called the "intermediate sector." Thus, the research concluded that the current public-private binary social structure needs to change and improve to a ternary structure consisting of a refined public sector, intermediate sector, and private sector. On the other hand, one executive personnel in the case study in this chapter responded in the interview, "Evaluating public services is one thing; implementing reformation is another." "Criticisms to the evaluation reports from anti-reformers always gnawed at us," he said. Therefore, a rational approach for transferring authority is the issue to be concerned.

Based on the research, this chapter proposes the scheme of public sector reform as follows. The process of reformation consists of three phases. Phase 1 evaluates public services of an administrative organization based on properties that define the publicness listed below. In phase 2, substitutable sectors are characterized from the viewpoint of the properties. Phase 3 derives overall judgments concerning which service should be administered by which sector by taking the weighted average of phases 1 and 2.

The properties listed below characterize the features of "public," such as public activity, public entity, and public opinion. The properties defining publicness are obtained from the brainstorming by the executives of the administrative organization in the case study.

- *Authority*: the power or right to give orders or make decisions.
- *Efficiency*: skill in avoiding wasted time and effort.
- *Productivity*: working with others for a common purpose or benefit.
- *Publicity*: affecting the people or community as a whole.
- *Fairness*: ability to make judgments free from discrimination or dishonesty.
- *Profitability*: the quality of affording gain, benefit, or profit.
- *Disciplinary*: having quality relating to a specific field.

• Phase 1: characterization of public services

All *n* public services of an organization are characterized based on the properties listed above using the AHP. Practically, services are paired wisely

compared to the viewpoint of the properties. The characterization of each service is then derived as a weight vector called p-vector, which is normalized by l_1-norm and denoted $\boldsymbol{p}_q$={weight of property r}, (q=1, …, n; r=Authority, Efficiency, Coproductivity, Publicity, Fairness, Profitability, Disciplinary).

• Phase 2: characterization of substitutable sectors

All m substitutable sectors are characterized by the viewpoint properties that are the same as those employed in Phase 1. In this phase, substitutable sectors, such as the network sector and private sector, are characterized using the AHP. In concrete, sectors are paired wisely compared from the viewpoint of the properties. This phase may be conducted by several experts. In such a case, based on their pairwise-comparison matrices, the geometric mean of each element of the matrices is calculated, and one pairwise comparison matrix is generated as a consensus-based matrix. The characteristic of each sector is then elicited as a weight vector called u-vector, which is normalized by l_1-norm and denoted $\boldsymbol{u}_r$={weight of sector s}, (r=Authority, Efficiency, Coproductivity, Publicity, Fairness, Profitability, Disciplinary; s=1, ..., m). Furthermore, the matrix ($\boldsymbol{u}_r^{\mathrm{T}}$) is defined as U-matrix and denoted $\mathbf{U}$, which represents the characteristic of each sector.

• Phase 3: overall judgement

An overall judgment concerning the matching of public services with substitutable sectors is derived by taking the weighted average of the evaluations of each service and the characteristics of sectors. Practically, $\mathbf{U} \cdot \boldsymbol{p}_q^{\mathrm{T}}$ is defined as the overall judgment for service q (q=1, …, n). An alternative sector, s, with the highest score can be considered as the most compatible sector with service, q.

These phases clarify the features of public services and their responsible sectors quantitatively, which makes the process of transferring authority clear. The results thus give quantitative outputs to public service analysis, by which rationale for public sector reform can be obtained. The public sector reform provides more room for administrative organizations to promote efficient management. By outsourcing appropriate public services that are currently maintained by administrative organizations, the room leads to sustainable public management.

7. Concluding remarks

Even though almost all government offices in Japan have introduced the APM system and evaluated their services to a greater or lesser degree, the

results have not been utilized practically thus far. One of the reasons for not utilizing the results of the evaluation is considered to stem from the style of the evaluation report, *not quantitative*. As a result, such an evaluation is often criticized as "subjective." Even worse, evaluations are often carried out as self-appraisals, resulting in further criticism about their leniency to themselves. Therefore, the employment of objective criteria and the introduction of external evaluations are necessary steps for enhancing the reliability of evaluation systems (Mori, 2003).

In addition, taking both the tight fiscal conditions of local governments and citizens' claims for clarifying administrative responsibility into account, public sector reform has been one of the most pressing issues for administrative organizations. Most services, however, have not yet been reformed, which is criticized as "turning an evaluation itself into an end." The gap between introducing APM and the deadlock in reform is considered to arise from the difficulty in obtaining consensus for transferring authority. Authoritarianism or political shackles may be behind the difficulties.

This chapter proposes a rational approach to the APM by applying the AHP and considers a possible scheme of public sector reform based on the evaluation results. The application of the AHP quantifies not only the subjective judgment of evaluators in appraisals but also the achievement of public services based on outcome indices. This quantification enables an administrative organization to utilize the results of the evaluation in a practical way: such as the reflection of the results to budgeting, as shown in Figure 5.2, and the fulfillment of administrative management accountability referred to in a survey on public opinion as illustrated in Figure 5.3. In addition, the proposed scheme of public sector reform clarifies the transparent matching process of public services of a local government with substitutable sectors. This process gives rationale to transferring authority from the public sector to other substitutable sectors, the results of which suggest sustainable public management.

On the other hand, this chapter has some limitations. First, the proposed APM system might not function well in some cases. If members of an organization share values and have a common objective, the system will work because it promotes understanding of issues and derives convincing results for every member. However, in case they have diverse backgrounds or there exist political shackles in the organization, the system might not function because the solid framework of the system may not fit every member. If an administrative organization corresponds to the latter type, the proposed APM system will not work well. In such a case, further modification of the framework of the system needs to be explored.

Second, the proposed APM system might not be successively operated without legal support. Public administration is led by the head of local

government, such as a mayor or a governor, elected through an election. The operation of the APM system and the treatment of its results are, therefore, sometimes affected by their campaign promises. In order to continuously carry out APM and utilize its results, establishing a bylaw is necessary. Although the legal support for the APM is not in the scope of this chapter, we need to consider this issue in the future.

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Biographical note

Yuji SATO received a Ph.D. degree in Engineering from the Graduate School of Science and Technology, Keio University, Tokyo, Japan, in 1999. He works in the Graduate School of Management, Chukyo University as a full professor. He was the dean of the school from 2017 to 2019. He published chapters from prestigious journals such as the International Journal of Production Economics, Annals of Operations Research, and Industrial Management & Data Systems. He is also the editorial board member of the International Journal of the Analytic Hierarchy Process. In addition to the efforts of his academic pursuit, he is eager to train young researchers and establish their academic research environment.

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Hydraulic supplier selection: An Analytic Hierarchy Process approach

Nuno Torre[1], Valério Salomon[2]

Abstract

In industrial environments, hydraulic systems work in continuous operation, for several applications that may demand control of large loads and high-power density. The inputs used in the maintenance of this type of equipment should follow the policies and procedures established by ISO standards, which may guarantee safety and operational reliability. The supplier selection for hydraulic components is a subject that involves several factors with complex decisions. Efficient and reliable suppliers can be decisive for the company's success. The aim of this study is to propose an evaluation framework for supplier selection of hydraulic equipment in the steel industry. The methods of multi-criteria decision analysis (MCDA) facilitate the decision-making, including the supplier selection strategies for hydraulic equipment. The Analytic Hierarchy Process (AHP) is the MCDA method applied to select suppliers by a Brazilian industrial plant. This chapter presents a case of supplier selection of hydraulic equipment, with four suppliers evaluated regarding five criteria and more than 20 sub-criteria, according to three experts. The AHP, the most widely used MCDA method, proved to be a reliable and useful MCDA method even in a case of more than nine criteria. In this case, Quality was the most important criterion, and Price was the less important. The main contribution of this study is to prove that a simple MCDA model, with the AHP application alone, may be enough to solve a practical decision problem, without increasing its complexity with hybridism.

Keywords: *Analytic Hierarchy Process, multi-criteria decision analysis, hydraulic systems, supplier selection.*

1 Nuno Torre, Engineer, Student, Department of Production, Sao Paulo State University, Av. Ariberto P. Cunha 333, Guaratingueta, SP 12516-410, Brazil, e-mail: nuno_torre@hotmail.com (ORCID: 0000-0003-4260-2686).
2 Valerio Salomon, Ph.D., Professor, Department of Production, Sao Paulo State University, Av. Ariberto P. Cunha 333, Guaratingueta, SP 12516-410, Brazil, e-mail: valerio.salomon@unesp.br (ORCID: 0000-0002-5619-5076).

1. Introduction

For companies that want to be competitive in an increasingly globalized market, partners in their business operations and in the supply chains become crucial. Supplier selection is one of the most important decisions in the purchasing process of an organization, aiming to increase competitiveness and customer satisfaction (Wang, Nguyen, & Dang, 2021). After all, suppliers impact the entire supply chain and the performance and sustainability of an organization. The supplier selection process must be structured including several criteria, often conflicting criteria. Multi-criteria decision analysis (MCDA) methods may contribute to managers' decision-making (Ortiz et al., 2021; Depczynski, 2021).

According to Ohta, Salomon, and Silva (2020), the concept of industrial maintenance is not at the top of an organization's business, however, maintenance costs can represent more than 50% of production costs. The main role of managers in an organization is to keep the operating system always active, adopting appropriate maintenance methods for each type of equipment (Baidya et al., 2018).

Nowadays, industrial assets are extensively equipped with hydraulic systems for various process purposes. However, the operational performance of these systems requires a high level of reliability, which can be achieved through appropriate preventive measures (Pavlov, Polyanin & Kozlov, 2017).

A breakdown of hydraulic equipment in an organization or linked processes to them may result in costs associated with lost production as penalties, lower availability, or increased operational risks. Therefore, the suppliers' selection for hydraulic systems needs proper treatment, where multi-criteria decision techniques can help with fundamental decisions according to the desired level of service with the lowest possible risk. Our main goal is to propose an evaluation framework that allows optimizing the trade-off between risks and service levels, guaranteeing a business improvement quality of the suppliers' selection for hydraulic systems, in steel industries. The problem is structured by identifying the criteria and sub-criteria that meet the needs of suitable choices for suppliers, which can be solved by MCDA. MCDA methods have been applied to several problems, where we can highlight the Analytic Hierarchy Process (AHP), developed by Saaty (1974) and Saaty (1980). AHP may be of great value due to its efficiency and flexibility in assisting decision-making. AHP, one of the most popular and widely applied MCDA methods, is easy to understand and apply (Canco, Kruja & Iancu, 2021). Our research question (RQ) is:

RQ) How to use an AHP approach to develop an evaluation framework for supplier selection for hydraulic systems in the steel industry?

This chapter has five more sections: a short literature background, methodology, results, discussions, and conclusion.

2. Literature background

This study consists of four phases. First, the key search terms were selected in the Scopus database from 2018 to 2022 in order to summarize the findings, with the combination of the words: "Suppliers Selection" and "AHP" (291), "Hydraulic systems" and "AHP" (4), "Maintenance" and "AHP" (532), and "Steel industry" and "AHP" (23), totaling 850 scientific articles. Table 6.1 shows the evolution of publications from 2018 to 2022.

Table 6.1. Publications from 2018 to 2022

Year	Suppliers Selection + AHP	Hydraulic systems + AHP	Steel industry + AHP	Maintenance + AHP
2022 *	30	0	1	43
2021	61	1	8	150
2020	64	1	5	126
2019	73	0	3	121
2018	63	2	6	92

Note: (*) Only the first semester.
Source: Scopus (2022).

In the second phase, 50 articles relevant were selected based on the areas of knowledge: engineering, economics, management and accounting, computer science, decision sciences, mathematics, energy, environmental management, material sciences and social sciences. The selection was limited to articles/reviews, conference articles/reviews, and open-access articles, with publications in English. The list of articles by research area is illustrated in Figure 6.1, where Engineering is the dominant area.

In the third phase, the VOSviewer software was used to support the analysis of co-occurrence keywords. Figure 6.3 shows the network of 337 keywords, with at least three occurrences, using the full counting method. Nodes and larger words reflect their highest occurrence, colors indicate clustering, which in this case are present 3 clusters - supplier selection, AHP, and decision making.
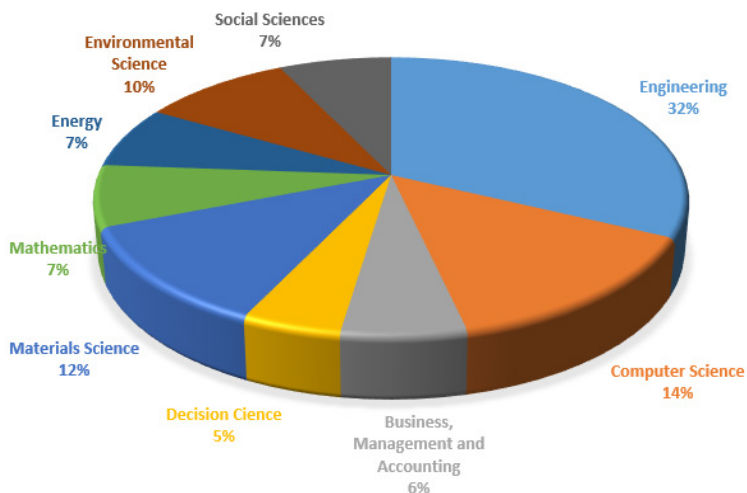
Figure 6.1. Articles distribution by research area

Source: Scopus (2022).

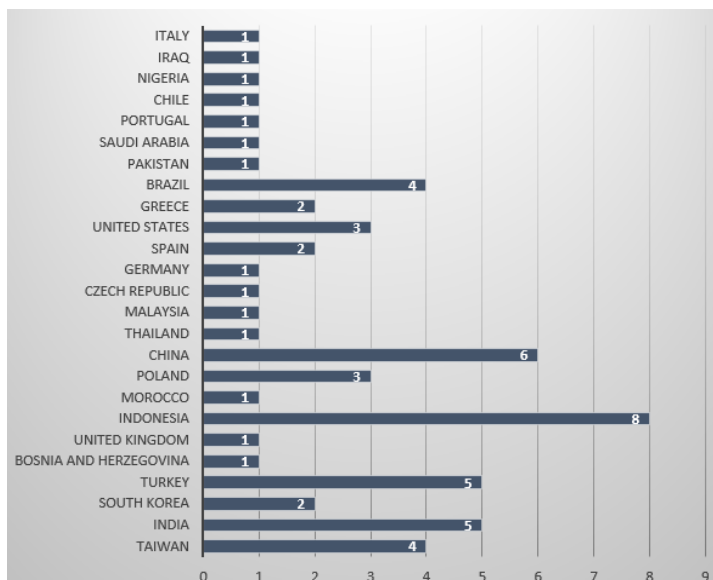The country distribution is represented in Figure 6.2. Indonesia and China are the leading countries in publications.

Figure 6.2. Country distribution

Source: Scopus (2022).

Figure 6.3. Articles distribution by research area

Source: VOSviewer.

Supplier selection

In search of continuous improvement in their processes and the optimization of the supply chain, the steel industry is seeking to introduce new management concepts with wiser insights to guarantee the quality of their products. The evaluation and selection of suppliers is a process that must supply the customer with quality and services of products at the correct market price, in the right quantities and times. In this context, evaluating and selecting suppliers in an organization takes a fundamental rule, which must be carried out appropriately to obtain the best possible results. To achieve the stipulated production goals in an increasingly competitive market, organizations need to choose their partners and establish strategies that optimize their results (Deshmukh & Vasudevan, 2018; Ulutas, 2019).

A comparison between qualified suppliers is made by means of criteria and subcriteria, which are stipulated according to the organization's needs (Kumar, Padhi, & Sarkar, 2019; Depczyński, 2019). According to Depczyński (2019), a supplier does not have optimal qualifications for all criteria. There is no precise method for evaluating a particular supplier: it changes from organization to organization (Kannan, Balamurugan, & Sasikala, 2021).

Supplier selection for hydraulic systems has crucial importance in the steel industry since these systems are associated with equipment that can generate risks for personal safety and the environment, which can compromise the operational reliability significantly of an organization. If the selection process of suppliers is inadequate, equipment without quality may be acquired, which

can cause severe problems in the operational activities of the companies. For instance, Kumar, Padhi and Sarkar (2019) suggest that a subjective evaluation of suppliers depends not only on stipulated criteria but also on how these criteria should be evaluated by experts, as well as the methodology used for this purpose. Therefore, the qualification of suppliers for hydraulic systems in the steel industry needs proper treatment. Multi-criteria decision techniques may substantiate the decisions according to the desired level of service with the best possible assertiveness.

3. Methodology

3.1. Research subject

This study was carried out by a specialist's judgment using questionnaires and interviews in a steel industry located in the southeast region of Brazil with over 10,000 employees, which operates large equipment, such as hot strip mills, sintering processes, picking lines, blast furnaces, among others. A group consisting of three experts was selected as follows; a production engineer with 44 years of experience in the industrial area; a marine engineer with 24 years of experience in the maritime and industrial area; and a mechanical engineer with 15 years of experience in the industrial area. Though they performed different functions, their opinions were equally considered since all the experts are directly involved in maintenance management.

3.2. Method

Analytic Hierarchy Process (AHP), developed by Saaty (1974, 1980, and 2013), is one of the most applied MCDA methods for decision-making problems in several fields such as engineering, computer science, mathematics, logistics, health, industry, and education (Martino et al., 2022).

The AHP can be applied in a few steps, such as hierarchy building, criteria comparison, consistency checking, and analysis of results (Tramarico et al., 2019; Martino Neto et al., 2022). The adopted flow chart is presented in Figure 6.4.

According to Saaty (1977), AHP has a hierarchy structure where criteria, subcriteria, and alternatives are selected. In this model, the elements are presented in levels where the lower level needs to be evaluated at the higher level. Table 6.2 presents the Saaty Scale, a linear scale for pairwise comparisons by experts (Kannan et al., 2021; Martino Neto et al., 2022; Özcana, Yumusak, & Eren, 2021).
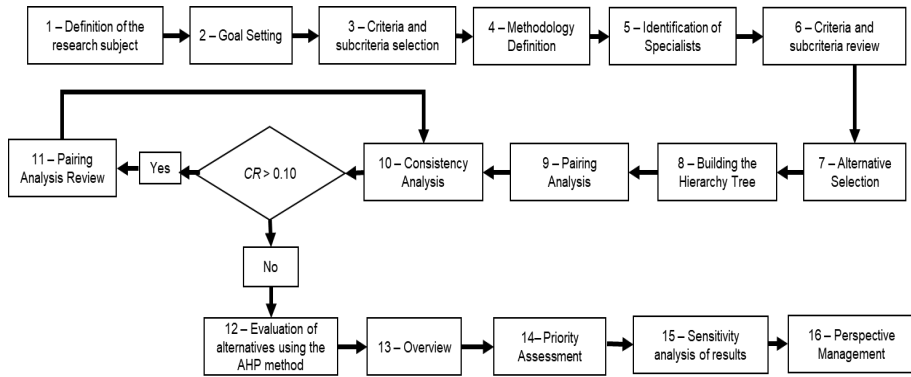
Figure 6.4. Flowchart of the methodological approach

Source: Tramarico et al. (2019).

Each expert uses Table 6.2 to establish a comparison matrix. The weights for the attributes, usually referred to as criteria priorities, are obtained by normalizing the direct eigenvector w of A, according to Equation 1, where l_{max} is the maximum eigenvalue of A.

$$A\ w = \lambda_{\max}\ w \tag{1}$$

The consistency check is one of the great advantages of the AHP over other MCDA methods. When $a_{ij} = a_{ik}\ a_{kj}$ resulting for all $i=1,2,3\ldots n$, $j=1,2,3\ldots n$, and $k=1,2,3\ldots n$, $\lambda max = n$, where n is the number of comparing elements, alternatives or criteria (Saaty, 1977). If A is not consistent, then $\lambda max > n$. The closer λmax reaches n, the more A can be considered consistent. CI is the consistency index and can be calculated according to Equation 2:

$$CI = \frac{(\lambda_{\max}-n)}{(n-1)} \tag{2}$$

The consistency ratio (CR) is associated with a random consistency index (RI) according to Equation 3.

$$CR = \frac{CI}{RI} \tag{3}$$

Table 6.2. Saaty scale

Numeric Scale	Conceptual Scale	Description
1	Equal	The two compared elements contribute equally to the objective
3	Moderate	The compared element slightly favor one activity over the other.
5	Strong	Experience and judgment strongly favor one activity over the other.
7	Very Strong	An activity is favored very stronger in relation to the other, and such importance can be observed in practice.
9	Absolute	The evidence favoring one activity in relation to other presents the highest possible level of evidence in its favor.
2,4,6 and 8	Intermediate values between two judgments are used when the decision-maker has difficulty choosing between two adjacent degrees of importance.	

Source: Saaty (1990).

Table 6.3 presents *RI* for n from 1 to 10. The value of *CR* should not be greater than 0.1. if it occurs, a review of the judgments will be necessary.

Table 6.3. Random consistency index

n	*RI*
1	0
2	0
3	0.58
4	0.9
5	1.12
6	1.24
7	1.32
8	1.41
9	1.45
10	1.49

Source: Saaty (1980).

According to Lin et al. (2008), the comparisons provided by experts can be aggregated in several ways, with the aggregation of individual judgments (AIJ) and Individual priorities (AIP) being the most effective approaches. In this chapter, AIJ will be adopted, because the experts are from the same company and share common interests (Saaty & Peniwati, 2008).

Taherdoost (2019) cites that although in the literature exists a lot of supplier selection criteria, each company should choose the criteria that fit its expectations about the supplier. Also, it refers to the importance of structuring the problem and choosing the pertinent criteria to find the best supplier. The supplier criteria are divided into quantitative and qualitative attributes.

The study was conducted qualitatively through data collected from the maintenance department and through bibliographic research. Initially, a criticality analysis aiming to provide the criteria for supplier selection was carried out (Table 6.4). The following criteria were identified in the literature and approved by the review committee of this study:

- Quality: The ability to consistently meet the specifications including materials, dimensions, design, durability, variety, and production items.
- Delivery: The ability to meet specified delivery schedules which, include lead-time, on-time, transportation, incoterms, location, fill rate, performance, and returns management.
- Warranty and Claims Policy: A way of providing a warranty, which provides the repair or replacement of a product within a stipulated period.
- Price: This item includes unit price, pricing terms, exchange rates, taxes, and discounts.
- Capacity & Technology: The capability and ability to acquire new technologies and technical resources for research and development processes.

Cost, Quality, and Delivery fit the criteria for supplier selection as the most prominent in the manufacturing industry (Depczynski, 2021). The selected subcriteria were coming through an adaptation of the QS 9000 standard for supplier selection and were approved by the experts consulted in this study (Table 6.4). The suppliers of hydraulic systems fall under premium brands, which are widely referred to in the steel industry.

Table 6.4. Selected criteria and sub-criteria

Criteria	Sub-Criteria
Quality (C1)	Structured Metrology (C11) Process Inspection (C12) Administrative Management (C13) Organization / Manufacturing Capacity (C14) Homologation / Acquisition (C15)
Delivery (C2)	Capacity (C21) Planning (C22) Logistics (C23) Stock Control (C24)
Warranty and Claims Policy (C3)	Proactivity (C31) Communication (C32) Replacement Time (C33) Corrective Actions (C34)
Price (C4)	Cost (C41) Forms of Payment (C42) Negotiation Skills (C43)
Capacity & Technology (C5)	Experience (C51) Qualified Professionals (C52) Design (C53) Innovation (C54) Training (C55)

Data were collected to define the priority strategy for suitable supplier selection of hydraulic systems in a production line in the steel industry. For the AHP application, was developed the hierarchy tree shown in Figure 6.5.

4. Results

Three experts were interviewed and assigned values for each defined criteria and sub-criteria concerning the application of the AHP method. Each expert has assigned values according to the following: one matrix concerning the objective, five matrices for the criteria, and twenty-one matrices for the supplier alternatives. Initially, the experts compared the criteria regarding their relative importance to the goal, as shown in Tables 6.5, 6.6, and 6.7, respectively, for Experts 1, 2, and 3.

Table 6.5. Priority of criteria according to Expert 1

Criterion	C1	C2	C3	C4	C5
Quality (C1)	1	3	5	7	1
Delivery (C2)	1/3	1	3	5	1/3
Warranty & Claims Policy (C3)	1/3	1/3	1	3	1/5
Price (C4)	1/7	1/5	1/3	1	1/5
Capacity & Technology (C5)	1	3	5	5	1
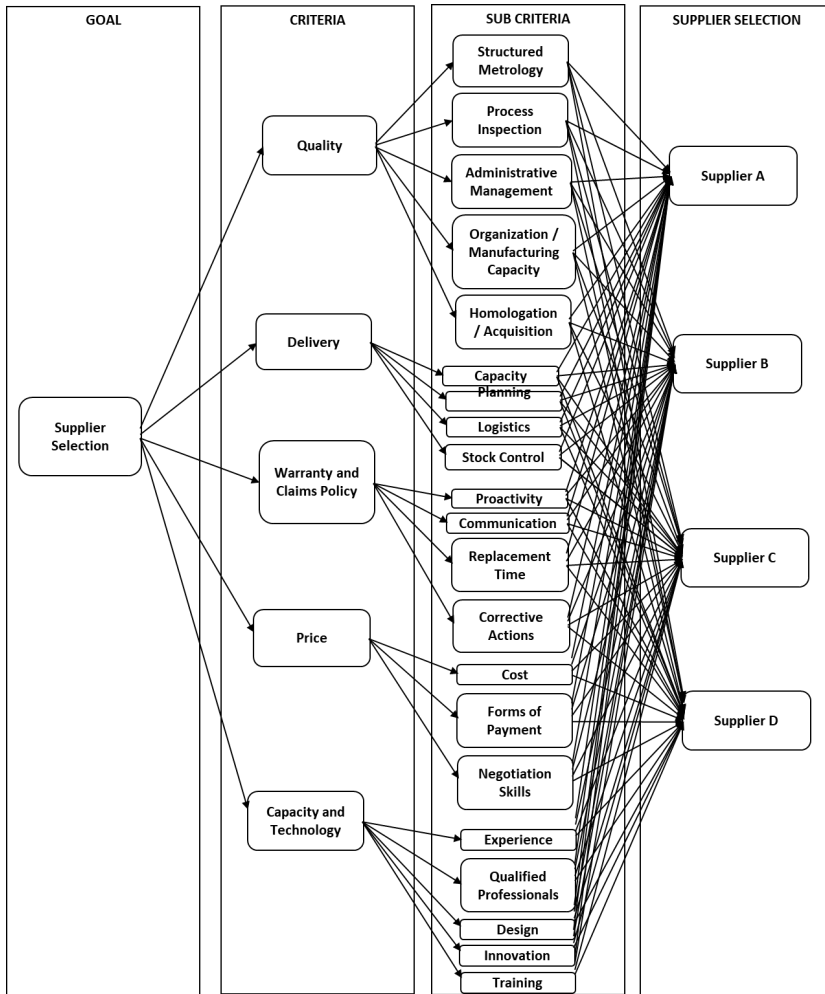
Figure 6.5. Hierarchy for AHP application

Table 6.6 Priority of criteria according to Expert 2

Criterion	C1	C2	C3	C4	C5
Quality (C1)	1	3	3	5	5
Delivery (C2)	1/3	1	1/3	5	3
Warranty & Claims Policy (C3)	1/3	3	1	5	3
Price (C4)	1/5	1/5	1/5	1	1/3
Capacity & Technology (C5)	1/5	1/3	1/3	3	1

Table 6.7. Priority of criteria according to Expert 3

Criterion	C1	C2	C3	C4	C5
Quality (C1)	1	3	5	5	3
Delivery (C2)	1/3	1	3	5	1/3
Warranty & Claims Policy (C3)	1/5	1/3	1	3	1/5
Price (C4)	1/5	1/5	1/3	1	1/5
Capacity & Technology (C5)	1/3	3	5	5	1

CR for each expert is presented in Table 6.8. A consistent comparison matrix results in a *CR* close to zero, thus validating the expert's comparisons. Then, revision of the matrices will not be necessary.

Table 6.8. Consistency ratios for Tables 6.5 to 6.7

Expert	CR
1	0.060
2	0.082
3	0.092

The aggregated comparisons of the three experts, by geometrical mean, as in AIJ (Saaty & Peniwati, 2008), are presented in Table 6.9. Quality (C1) and Capacity & Technology (C5) have top-two priorities. Price has the lowest priority. The aggregate priorities of criteria correspond to the requirement of operational reliability, as demanded by hydraulic systems in the steel industry.

Table 6.9. Priority of criteria according to Expert 3

Criterion	C1	C2	C3	C4	C5	Priority
Quality (C1)	1	3	4.22	5.59	2.47	44%
Delivery (C2)	0.33	1	1.44	5	0.69	17%
Warranty & Claims Policy (C3)	0.28	0.69	1	3.56	0.-49	13%
Price (C4)	0.18	0.20	0.28	1	0.24	5%
Capacity & Technology (C5)	0.41	3	5	5	1	21%

Afterward, the experts compared the sub-criteria regarding their relative importance for their criterion. Table 6.10 presents the aggregated priorities. Sub-criteria Process Inspection, Planning, Proactivity, Cost, and Qualified Professionals have higher priorities. These sub-criteria indicate the most influential characteristics of the equipment for hydraulic systems in the steel industry.

Table 6.10. Priorities of the criteria and sub-criteria

Criterion (overall priority)	Sub-Criterion (local priority, overall priority)
Quality (44%)	Structured Metrology (31%, 14%) Process Inspection (41%, 18%) Administrative Management (14%, 6%) Organization / Manufacturing Capacity (8%, 3.5%) Homologation / Acquisition (6%, 2.5%)
Delivery (17%)	Capacity (38%, 6.5%) Planning (40%, 7%) Logistics (14%, 2.5%) Stock Control (8%, 1%)
Warranty and Claims Policy (13%)	Proactivity (43%, 5.5%) Communication (7%, 1%) Replacement Time (12%, 1.5%) Corrective Actions (38%, 5%)
Price (5%)	Cost (49%, 2.5%) Forms of Payment (20%, 1%) Negotiation Skills (31%, 1.5%)
Capacity & Technology (21%)	Experience (20%, 4%) Qualified Professionals (36%, 7.5%) Design (27%, 5.5%) Innovation (8%, 2%) Training (9%, 2%)

Finally, the experts compared Suppliers A to C regarding their relative performance on the sub-criteria. Table 6.11 presents the priorities resulting in a decision matrix.

Table 6.11. Local priorities of suppliers

Supplier	C11	C12	C13	C14	C15	C21	C22	C23	C24	C31	C32	C33	C34	C41	C42	C43	C51	C52	C53	C54	C55
A	42%	49%	45%	43%	36%	42%	48%	44%	44%	49%	48%	42%	38%	17%	25%	51%	43%	46%	55%	58%	55%
B	21%	14%	26%	24%	29%	21%	18%	22%	24%	26%	31%	37%	34%	23%	25%	6%	15%	17%	12%	19%	21%
C	12%	12%	11%	11%	12%	10%	10%	9%	11%	7%	7%	8%	10%	34%	25%	11%	17%	14%	10%	9%	10%
D	25%	25%	18%	22%	23%	26%	23%	25%	21%	18%	14%	13%	18%	26%	25%	32%	25%	23%	23%	14%	14%

Table 6.12 presents the overall priorities of the suppliers, obtained by weighting the local priorities of the suppliers by the overall priorities of the sub-criteria, and adding them.

Table 6.12. Overall priorities of suppliers

Supplier	Priority	Rank
A	45%	1
B	22%	2
C	12%	4
D	22%	2

Supplier A has the highest priority, and Supplier C has the lowest priority. Suppliers B and D are tied in second place. This tie brings uncertainty if some problem occurs with Supplier A. The selection of Supplier A is in accordance with the company's engineering manager, including the tie between Suppliers B and D.

5. Discussion

Through the framework proposed and the methodology of the AHP, it's possible to identify which criteria or sub-criteria have more influence on assertive decision-making of supplier selection for hydraulic systems in the steel industry. The criteria with the highest priority were Quality (C1) and Capacity & Technology (C5). Furthermore, Price (C4) was the criterion with the lowest priority. These priorities correspond to the operational reliability demanded by hydraulic systems in the steel industry, which requires high performance and operational safety. The sub-criteria Process Inspection (C1), Planning, Proactivity, Cost, and Qualified Professionals presented a higher priority. Thus, these factors became relevant for suppliers of hydraulic systems in the steel industry. The ranking order of the suppliers was as follows: Supplier A in the first place, Supplier B and D in the second place with similar values, and Supplier D in the last place. If supplier A is not available, managers must choose between supplier B or D, which have shown tied results. This study can also be used in other types of maintenance assets, however, could be necessary to review the defined criteria/sub-criteria.

6. Conclusion

The steel industry faces an extremely competitive and globalized market, in which the improvement of quality, customer service, reducing costs as well as optimizing assets became essential on production lines. Literature research was performed concerning the main multi-criteria decision methods for solving problems with uncertainty, where the AHP method was chosen due to being the most widely used method worldwide. The AHP methodology seems

to be trivial for this decision-making problem, which in this case, presents four suppliers associated with several criteria and sub-criteria disposed of in a hierarchy tree. The simple methodology of this method makes it easier to identify the most relevant criteria and sub-criteria, which proves to be a useful tool for helping maintenance managers with decision-making problems.

In the steel industry, it is necessary to maintain a commercial relationship with a set of suppliers for hydraulic systems since there may be the possibility of insolvency of one of them or the practice of abusive prices. Moreover, competition among suppliers favors the rivalry between them, benefiting the final client. After conducting this study, several lessons were identified through discussions with some managers of the steel industry. These lessons are associated with the main concerns of managing the maintenance of hydraulic systems, such as the quality of the spares provided by suppliers, lead time for receiving the spares, and associated costs. The proposed framework for supplier selection with the application of the AHP method provides a perspective to the users with valuable guidelines for future applications. However, in some instances, the AHP method needs a review of the judgments once the CR value reached values higher than 0.1.

For future studies, the Fuzzy AHP method can be applied to discriminate the results between Suppliers B and D, or other decision MCDA techniques such as the Multi-Attribute Utility Theory. Another option might be applying the same methodology to other business segments, such as the production sector, financial area, human resources, and so on.

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Biographical notes

Nuno M. M. Torre received his bachelor's degree in Marine Engineering from the Nautical School Infante Dom Henrique of Lisbon, Portugal, in 1999. Currently, he is working as a Specialist Engineer at the Companhia Siderurgica Nacional (CSN), Brazil.

Valerio A.P. Salomon received his bachelor's and MSc in Industrial Engineering from the Federal University of Itajuba, Brazil, in 1994 and 1998. Subsequently, he obtained his Ph.D. in Engineering from the University of Sao Paulo in 2004 and developed post-doctoral research at the University of Pittsburgh, USA, in 2007. Currently, he is working as an Associate Professor in the Department of Production at the Sao Paulo State University. His works have appeared in the International Journal of Analytic Hierarchy Process, the International Journal of Production Research, the International Journal of Project Management, the International Journal of Quality and Reliability Management, and several Brazilian journals on industrial engineering. His

research area includes multi-criteria decision analysis, operations management, and quality management.

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Strategic business planning technology for weakly-structured subject domains

Vitaliy Tsyganok[123]

Abstract

The purpose of this study is to create a technology and respective software tools for collegial (group) development of strategic plans for businesses in weakly structured domains. Strategic planning in such domains is an often challenging task, as quantitative (or even quantifiable) deterministic data is scarce or unavailable, uncertainty levels are high, and expert knowledge often represents the key information source (potentially, alongside open data). The technology is intended to overcome these challenges. It is based on group construction of a goal-oriented model of the system (subject domain), which is built through the decomposition of the main strategic goal and considers the terminal and resource properties of the system's components, as well as mutual connections between them. The software toolkit allows knowledge engineers and their invited experts to remotely provide knowledge for building the system model. Then, based on the developed model, using the method of target-oriented dynamic estimation of alternatives and evolutionary methods of optimization, a set of measures (projects) is selected, complete with suggested funding allocated to them within the limited resource volume during the specific planning period. The selected set of measures guarantees the maximum level of achievement of the strategic goal within a given time perspective under limited funding and become the basis of the strategic plan. Methods of group knowledge acquisition and processing have been developed. They became the basis for the development of the original technology and software tools for strategic business planning. Theoretical foundations and methods for reliable obtaining of (thorough and undistorted) collective knowledge in a subject domain, ensuring their concordance and aggregation

1 Vitaliy Tsyganok, Dr.Eng., Head of Department, Dep. for Intelligent Technologies of Decision-Making Support, Institute for Information Recording of National Academy of Sciences of Ukraine, M.Shpak str., 2, Kyiv, Ukraine;

2 Professor, Faculty of Information Technology, Taras Shevchenko National University of Kyiv, B.Havrylyshyn str., 24, Kyiv, Ukraine.

3 Professor, Institute of Special Communication and Information Protection, National Technical University of Ukraine „Igor Sikorsky Kyiv Polytechnic Institute", Verkhnjokljuchova str., 4, Kyiv, Ukraine, e-mail: vitaliy.tsyganok@gmail.com (ORCID: 0000-0002-0821-4877).

for further application in various areas, have been suggested. This research aims to solve a global problem of knowledge transfer from people with expertise (experience, intuition) in a certain field to people who need this knowledge to solve practical problems. This theoretical basis is intended for strategic planning practice in various areas, including business. An original way of automating the process of group subject domain model construction and the suggested application of existing and newly developed knowledge-oriented methods to strategic planning are proposed. All material presented in the chapter, is the result of ongoing original research led by the author.

Keywords: strategic business-analysis, knowledge transfer, goal dynamic estimating of alternatives, rational distribution of resources, genetic algorithm, technology, subject domains

1. Introduction

The relevance of accurate and scientifically substantiated strategic planning mechanism and the availability of a reasonable enterprise (industry, region, state) development strategy is hard to overestimate. After all, in any field of human activity, it is desirable for a person to know what needs to be done to achieve a certain goal. In addition, success directly depends on choosing the most effective way to achieve the desired result.

Thesaurus dictionaries explain the term "Strategy" (Ancient Greek: στρατηγία, the art of a commander) as a general, non-detailed plan of a certain activity that covers a long period, a way to achieve a complex goal. Here we can observe an analogy with the definition of a system in System Analysis (Zgurovsky & Pankratova, 2011): a system is a set of components interconnected to achieve a goal. As we can see from the definitions, both terms are associated with the presence of a goal. In fact, a system, as an abstraction, cannot exist without a goal for its functioning, and a strategy is a way to achieve the goal of this system. So, in terms of System Analysis, the term strategy can be defined as the most effective way to achieve the optimum (maximum) of the goal function of the system.

Modern specialists who have successful experience building long-term plans in entrepreneurship (business strategists) claim that strategy development is a creative rather than an analytical process (Roger, 2014). Thereby, they indirectly confirm the insufficiency of the current formalization levels and the study of this problem. Moreover, they, thus, confirm the impossibility of analytical presentation of the goal of functioning in the areas of application of strategic plans, such as business, economy, sustainable development,

military sphere, public administration, etc. It is, after all, the impossibility of analytically setting the goal of functioning that is considered the main property that classifies systems as weakly structured.

The need to build strategies often emerges in management problems. Any strategy can be considered a long-term, consistent, constructive, rational, ideologically supported plan that is resistant to the uncertainty of environmental conditions. This plan should be accompanied by constant analysis and monitoring during its implementation and aimed at a certain goal of achieving success in the final outcome. The strategy has the ability to move from abstraction to concreteness in the form of plans for functional units.

As we choose the methods for building strategies, we can argue that the methods of economic analysis do not fully satisfy the requirements set. For example, from a purely economic standpoint, space program projects related to commercial launches and telecommunications always prevail over any scientific, innovative projects in the short term. However, when it comes to the project's evaluation from a long-term perspective, economic analysis is usually unable to give reliable conclusions. At the same time, the experience of leading space states in the USA suggests that long term innovative research projects provide economic profit (Fedorov, 2011). For instance, according to the US National Aeronautics and Space Administration (NASA) statement, the projects of the Apollo space mission paid off after about 30 years, due to the widespread introduction into the economy of innovations that were first proposed during the preparation of these space projects. Such innovations included a whole range of products and services that gave a significant impetus to the development of the economy (from household water filters to sports shoes, initially designed as shoes for astronauts).

The first corporation that began to engage in research in the field of development strategies was the RAND (Research AND Development) corporation created in 1948 in the USA is considered a pioneer in System Analysis. In the 1950s and 1970s, famous theories were created: The Game Theory by Neumann and Morgenstern (von Neumann & Morgenstern, 2007), and the Theory of "Conflicting Structures" by Lefebvre (1973). And from those times to the present day, the relevance and popularity of this topic are only increasing (it is worth at least mentioning the work of professor Schelling, recently awarded the Nobel Prize, and his book, which has become a classic, "The strategy of conflict" (Schelling, 1990). Among modern theories related to strategic plans, the construction and analysis of military strategies by Boyd (1986) have a special place. In addition, a number of approaches to strategic planning deserve attention (Henderson, 1970; Andrews, 1971; Ansoff, 1979; Abell, & Hammond, 1979; Mintzberg, Quinn, & Ghoshal, 1998; Szabo et al., 2021; McKinsey & Company, 2008).

A lack of deterministic information and knowledge about the subject domain often characterizes the construction of strategies. Under such conditions, experts are often the only available source of information for an adequate description of this subject domain (Glushkov, 1969). And methods of expert decision-making support are a tool that allows us to build a knowledge base of the subject domain and perform the evaluation of projects.

In the past, the construction of strategies started with attempts to evaluate alternative scenarios formulated by experts in a certain field. Later, these attempts had to be abandoned due to a considerable number of scenarios to be considered and the task irrelevance of delegating the resource distribution between projects, featured in a specific scenario, and the experts. In fact, a strategy is a defined set of projects for which specific funding has been allocated with a distant perspective (for example, 15-20 years) in mind.

Therefore, we will consider strategy building as the allocation of resources to projects over a period. It is advisable to determine the distribution at the beginning of each stage of the implementation of the strategic plan. When the allocating resources for the next stage encounter unexpected changes in the field of planning, they cannot be built while modeling the subject domain.

The chapter offers a description of a toolkit that allows decision-makers (DMs) to build long-term plans to achieve strategic goals. The present-day lack of such tools further confirms the relevance of this research. Target users of the toolkit and the whole respective methodology include government and self-government bodies, NGOs, intelligence specialists, large corporate and organizational structures, and other entities operating in weakly-structured subject domains. The research results would allow them to make the decision-making process more systematic, structured, and universal, replacing the "permanent ad hoc" approach.

The main drivers that allow us to hope for the creation of such an effective toolkit for DM include the usage of a) a system approach to solving a set of research tasks and b) developed methods of analysis and application of all available knowledge about the system.

Further analysis also indicates that most of the requirements for strategic planning tools are satisfied by the decision support systems (DSS) of the Solon family, thanks to the appropriate set of tools. As for the requirement to take risks and threats into account, it is considered quite realistic to satisfy it without going beyond the scope of this particular DSS.

2. Literature background: Analysis of some available approaches to strategy development

One approach to building a strategy is the evaluation of existing options for strategies and choosing the best option in the context of its impact on the achievement of a global goal. DSS "Solon" has all the necessary tools for the implementation of this approach, including:

- means of expert construction of the model of the subject domain, which are based on the principle of hierarchical decomposition of goals;
- tools for conducting group and individual expert estimations (expert assessments);
- software-implemented methods of evaluating alternatives based on the constructed subject domain model, which makes it possible to evaluate solution options by taking into account the dynamics of their changes over a period; and
- implemented methods of calculating the degree of goal achievement, taking into account the current percentage of project realization (including complex projects).

It is advisable to apply such an approach to the development of strategies where variants for strategic plans have already developed apriority, or such plans (permissible sequences of actions) have been determined and cannot be changed. The disadvantages of this approach include the possibility of a significant increase in the total number of variants for strategic plans. Even at the time of their preliminary selection, the impossibility of guaranteeing the optimality of the chosen strategic plan by at least one of the criteria and the fact that the resource allocation function, in this case, is entirely dependent on DMs or experts.

Another proposed approach is devoid of the above-mentioned disadvantages. According to this approach, a strategy is a defined set of projects for which specific funding is allocated, with a definite long-term period in mind. Therefore, in this context, strategy building is the allocation of resources to projects over a period. It is advisable to determine this distribution at the beginning of the implementation of the strategic plan before allocating resources for the next stage. Redistribution should be conducted in the event of unplanned significant changes in the planning sphere, which were not foreseen during the modeling of this subject domain.

Besides tools for collaborating with experts when building a subject domain model and the implemented methods for dynamic evaluation of alternatives, software tools for distributing limited resources among projects

are additionally included in "Solon" DSS (Solon3 Certificate, 2003), in order to fully implement the described approach (Tsyganok, 2010). Resources are distributed among a given (formulated) set of projects, considering their contribution to the achievement of a strategic goal during a defined period (planning period).

The contribution of each project to the achievement of the strategic goal is calculated considering the risks and threats. These are modeled as projects with negative influences, each characterized by the probability of the occurrence of the specific threat to the implementation of the project and an expert estimate of the potential damage that might be caused by the negative event. When the subject domain model is built, the distribution of resources depends on the chosen term of the long-term plan and the total amount of allocated resources (funding).

Summarizing the above, we can formulate the following requirements for creating strategies:

- focus on the achievement of a certain goal (the main goal of the problem);
- calculation (evaluation) of action variants in the long-term perspective taking into account the duration of project implementation and delays of influences between goals);
- taking into account the amount of funding necessary to perform certain tasks;
- the expediency of using expert estimation along with quantitative objective information;
- taking into account the risks and threats that arise when performing tasks.

3. Methodological approach

Since the concept of strategy is, in fact, a way to achieve a goal, the concept of strategy and goals are inseparable. Therefore, within the strategic plan building technology, it has been proposed to use the so-called goal-oriented approach. This approach involves modeling the subject domain as a complex weakly-structured system in the form of interconnected components, i.e., goals that influence each other. The key methodological steps are as follows:

3.1. Define the main strategic goal.
3.2. Decompose it into sub-goals that influence this goal within the given subject domain.

3.3. Define "atomic" (non-decomposable) goals, which can be accomplished within the DM's competencies.

3.4. Define the resource volumes required to implement each project.

3.5. Define durations and delays in each project's implementation.

3.6. Define the best resource allocation between given projects, allowing to maximize the efficiency of the main goal's achievement under given funding volumes; this allocation (or distribution) would be the strategy (i.e., plan of action) for the given time period.

3.7. Ensure the opportunity for strategic plan correction during the next periods.

Let us address each of the listed steps in greater detail.

3.1. Goal-oriented approach and main goal

When applying the goal-oriented approach, first of all, it is necessary to formulate the main goal that must be achieved during the implementation of the strategy. This strategic goal is usually formulated by DMs, which include top state leaders, politicians, and business people.

The main goal for strategic planning should be formulated in such a way that the following requirements are met:

- the goal should be general enough, and the degree of its achievement may change over time. This requirement is related to the features of strategy construction, which allow us to consider the goal achievement plan depending on the given time prospect (for example, 3, 5, 10 years, etc.);
- it is desirable that the achievement of the goal does not depend on and does not come into confrontation with the achievement of goals by other players on the market. Thus, such a goal as "Being first in the region in terms of sales" is not formulated well enough because it can be achieved not only by expanding the market and increasing sales but also by counteracting the players currently occupying leading positions at the market;
- basically, the degree of achievement of the main goal cannot be determined by measuring a single value (that is, the nature of the goal is qualitative rather than quantitative). Otherwise, the task of building a strategy is greatly simplified and deserves less attention.

All the above-mentioned requirements for the main strategic goal are interrelated. It is worth noting that within the goal-oriented approach, characteristics of the main goal are determined through characteristics of other

components of the system, i.e., goals that have a direct or indirect influence upon the achievement of the main goal. Such components, formulated at the end of the decomposition process and indirectly affecting the main goal, include specific goals that are not subject to further decomposition and represent decision variants /measures/projects.

3.2. Subject domain model

When building a strategy, it is important to be able to define the degree of achievement of a strategic goal over time. Therefore, the subject domain model is created with this opportunity taken into account.

The subject domain model is a directed graph of a hierarchy of goals formed as a result of the main goal's decomposition. To increase the adequacy of the model, in addition to the influences corresponding to the arcs of the "tree" type graph added during the decomposition, arbitrary influences/connections between goals are added to the graph model. Although the resulting graph has a tree-like hierarchical structure, in the general case, it represents a network.

It is appropriate to single out the following components of the model (hierarchy of goals): goals – vertices/nodes of the graph, projects/measures – vertices corresponding to the leaves of the tree, and influences – arcs of the directed graph. All the listed components can be of different types and have different properties. It is this system that belongs to the category of complex systems.

3.2.1. Goal model

The main component in the system model is the goal. Goals in the general model of a system are presented as graph vertices. Goals are formed as a result of the decomposition of the main goal and are essentially its components. The main properties characterizing the goal are its formulation (description of what should be achieved).

Besides that, goal modeling envisions two kinds of processes for goal achievement. In the first case, any progress in achieving the goal causes a change in the influence of this goal upon other goals that it directly affects (linear goal). Otherwise, the goal has no influence until the degree of its achievement exceeds a certain threshold – a value is set as a percentage that increases until the goal is fully achieved (threshold goal).

Depending on available specific knowledge about goal achievement degree evaluation, the goal can be presented as quantitative (when the degree of achievement can be defined in units of measurement) or qualitative (in the opposite case). Quantitative goals can be defined (quantitative-defined) if

the effect of achieving the goal, measured in units, is known for sure. In the opposing case, when the effect of achieving the goal can be measured in units, but the value of this effect is not reliably known, it is quantitatively uncertain.

As we have noted earlier, it is advisable to define the main goal of strategic planning as a qualitative, linear-type goal.

3.2.2. Project model

Within this study's terminology, a project (decision variant, measure) is a goal, the achievement of which is connected with the implementation of defined actions. The main characteristic property of such system components is the possibility of estimating (analytically or through expert evaluation): the duration of realization/implementation (time) and resources (finances) required to achieve the project goal. It is these two properties that distinguish projects from goals, and also signify the termination of the process of further decomposition of goals during modeling because projects, unlike goals, are not subject to decomposition.

In order to increase the adequacy of the system's model and to enable the rational distribution of available financial resources, the project model takes into account the dependence of the degree of project implementation on its financing. A piecewise continuous linear function is used (such as the one shown in Figure 7.1).
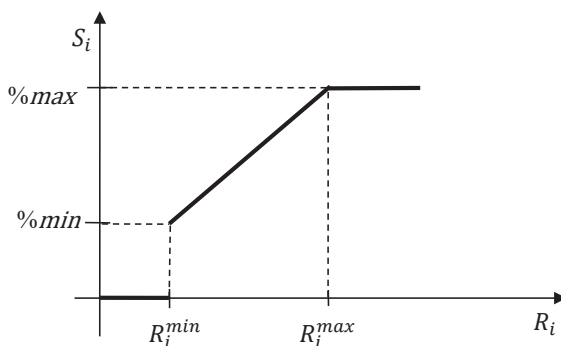

Figure 7.1. Dependence of the degree of implementation of the i-th project on its funding

In Figure 7.1 R_i^{max} is the amount of financial resources required for the full implementation of the i-th project, R_i^{min} is the minimum amount of resources, without allocation of which the project cannot be implemented

even in part (that is, when these resources are allocated, the degree of project implementation will be *%min*).

3.2.3. Properties of influences

Goals, as components of a system, are interconnected: within the model, goals influence other goals. Influences are established during the decomposition of a goal and simultaneously with the formulation of components of this goal. The components that affect the goal are usually called sub-goals, while the goal affected by the sub-goals is sometimes called the over-goal of those sub-goals.

In a goal-oriented model, the influences between goals correspond to arcs in a directed graph. If a goal directly affects another, then there is an arc leading from the respective vertex of the graph (corresponding to the first goal) to the second vertex.

Influences have a number of properties, and one of the most important is the relative indicator/index, the so-called partial coefficient of influence (PCI). PCI is defined as an indicator of the direct influence of a sub-goal upon its over-goal. These coefficients show the relative magnitude of the influence of a specific sub-goal on a given goal in comparison with other sub-goals of this goal.

Note that when building the model, it is possible to take into account the existence of alternative variants (paths) for each goal. Each variant of achieving this goal is represented by a set of sub-goals that are compatible with each other. In this context, sub-goals are compatible if the achievement of a certain sub-goal does not prevent the achievement of another (incompatible sub-goals cannot be achieved simultaneously). Such groups of mutually compatible goals are determined during the decomposition process when information about the compatibility of each pair of sub-goals is provided.

PCIs are normalized, and for each *k*-th group of compatible sub-goals the following equality holds:

$$\sum_{j=1}^{K}\left|w_{ij}^{(k)}\right| = 1, \tag{1}$$

where $w_{ij}^{(k)}$ is the PCI of the *j*-th sub-goal upon the *i*-th goal within the *k*-th group of compatible sub-goals; K is the number of compatible sub-goals in the *k*-th group.

The expediency of using the module (absolute value) under the sum sign in formula (1) is explained by the fact that the influences can be either positive

or negative. That is, a sub-goal within this model can exert either contributing or depressing influence upon the achievement of its immediate over-goal.

The value of PCI before normalization (1) is defined as the relative contribution of a sub-goal upon achieving a goal in two ways, depending on the available knowledge, during modeling. If such knowledge (reliable information about the effect of achieving a sub-goal) is available, the value of PCI is calculated as the ratio between the effect of achieving the sub-goal and the resource required to achieve the over-goal, measured in the same units as the effect. In the opposite case (when there is no reliable information about the effect of achieving the sub-goal or when the sub-goal is qualitative), expert evaluation methods (Saaty, 1996; Totsenko, 2002; Bozóki, Fülöp, & Rónyai, 2010; Hnatiienko, Snytyuk, & Suprun, 2018; Kadenko, et al., 2021; Szádoczki, et al., 2022), in particular, group expert evaluation methods (Zgurovsky, Totsenko, & Tsyganok, 2004; Tsyganok, Kadenko, Andriichuk, & Roik, 2018), are used to determine PCI.

Pairwise comparison methods using verbal scales with different degree of detail are effective and highly reliable, especially when conducting group evaluations (Tsyganok, Kadenko, & Andriichuk, 2015). It is advisable to apply methods with feedback from experts (Totsenko &Tsyganok, 1999), which allow us to achieve a level of consistency of expert estimates sufficient to justify their aggregation (Totsenko, 2002; Tsyganok, 2013a).

Before applying expert evaluation methods to determine PCI in each of the groups of mutually compatible goals, the formulation of sub-goals that have a negative influence is replaced by a formulation with their logical negation. As a result, absolute values of PCI are obtained, regardless of the nature of the influence (positive or negative).

Another property of influence is related to the requirement to model the system in dynamics on a given time interval during strategic planning. In order to realize such opportunities, each influence is characterized by a time delay in its propagation. In the field of strategic planning, such delay is determined by an expert and measured in days. Thanks to the information about delays in the impact propagation, as well as the terms of project implementation, it is possible to predict the values of the goal achievement degree for prospects of varying lengths.

3.3. Group decomposition

According to the system approach, the idea of modeling is based on the division (decomposition) of a complex problem into less complex ones, followed by the solution (analysis) of these simpler problems and subsequent synthesis of a solution of the general problem based on the solutions to partial problems.

In the context of the goal-oriented approach, it is the main goal of a problem (a strategic goal) that is decomposed.

3.3.1. Principles of decomposition during modeling

Any modeling involves simplification and neglecting (ignoring/not considering) properties of the modeled object. Within the goal-oriented approach, this simplification envisions neglecting insignificant connections between the components of the system. That is, when decomposing a goal, only goals that exert significant influence upon the achievement of the decomposed goal are taken into account.

So, which influences should be considered significant enough to be taken into account when building a model? For this type of modeling, the rule of thumb is as follows: influences of goals, the relative value of which for achieving a goal, does not exceed 1/10 (10%) of the total amount of influences, are considered negligible. If you follow this non-strict rule, the requirements for reliability level of the results of pairwise expert comparisons will be satisfied, namely: the weights of compared alternatives in a pair should belong to the same order of magnitude (Saaty & Shang, 2011), and the number of alternatives for comparison should not exceed 7 ± 2 (Miller, 1956).

3.3.2. Group decomposition technology

There is probably no doubt that, it is worth using all available knowledge to build a domain model. Since knowledge cannot belong to a single person (even a highly qualified one), it is advisable to use group expert sessions for building models. Such sessions allow you to obtain knowledge from an expert group.

Group decomposition is the process of building a model of a subject domain. It allows a group of people endowed with knowledge on the subject domain, to perform decomposition of a goal, agreeing on their notions/ preferences about the necessary conditions for its achievement (influences of sub-goals) to reach a consensus. The decision about the need for such collective work is usually made by the knowledge engineer in the case of a lack of available knowledge about the conditions for achieving the goal that is decomposed.

The knowledge engineer manages the process of decomposition, s/ he forms an expert group of specialists, knowledgeable in the object of decomposition. It is appropriate to highlight the following main stages of group decomposition:

1) Formation of a list of sub-goals by an expert. At this stage, each of the involved experts forms a list of goals that, in his/her opinion, directly influence the goal to be decomposed. This list includes goals (sub-goals) that have a significant influence on the goal (significant in the sense described above). When forming this list, the expert first analyzes the list of currently available hierarchy goals as to their inclusion in the list. With this inclusion, the expert proposes to confirm the presence of a significant influence of the goal included in the list upon the decomposing goal (proposes establishing a corresponding connection/arc in the graph of the goal hierarchy). Next, the expert formulates and adds to the list the remaining goals that, in his opinion, have a significant influence on the decomposed goal. This process ends (terminates) at the suggestion of the knowledge engineer when sufficient number of experts have formed their lists of sub-goals.

2) Formation of formulations identical in content in groups under the guidance of a knowledge engineer. This stage is performed in a semi-automatic mode using Natural Language Processing tools under the control of a knowledge engineer. The result of this stage is groups/lists of goal formulations with identical content (a list/group can also include one single, unique formulation).

3) Group consensus on decomposition. Experts involved in the decomposition process are asked to choose the best formulation among formulations presented in each group with identical content. At the initiative (choice) of the knowledge engineer, one of the available methods group choice may be applied. The option "None" (none of the formulations) is included in the list of formulations, among which the expert must choose the best one in each group. When choosing "None," the expert proposes not to include a sub-goal with such content in the hierarchy and/or not to establish an influence arc leading from an existing goal to the decomposed one due to its insignificance. Termination of the experts' work on the choice of wording occurs at the initiative of the knowledge engineer when their estimates are sufficiently consistent in reaching a consensus. After that, the experts' preferences are aggregated. The result is the decomposition of the goal into a list of sub-goals with established influences upon the goal.

The decomposition carried out by an expert group is presented graphically as a subgraph within the general graph of the goal hierarchy.

3.4. Formation of the general structure of the subject domain model

The structure of the domain model is formed by successive decompositions performed under the guidance of a knowledge engineer. Such a process begins with the decomposition of the main strategic goal and continues with the decomposition of sub-goals until there are no goals left that should be decomposed. This process is called top-to-bottom passage, meaning that the root vertex of the goal hierarchy graph is depicted from above. Non-decomposable (undisclosed) goals become projects, along with others that can be added as variants for possible decisions or actions.

At the end of this process of model structure building, the entire hierarchy of goals is presented to the knowledge engineer in the form of a graph (see Figure 7.2).
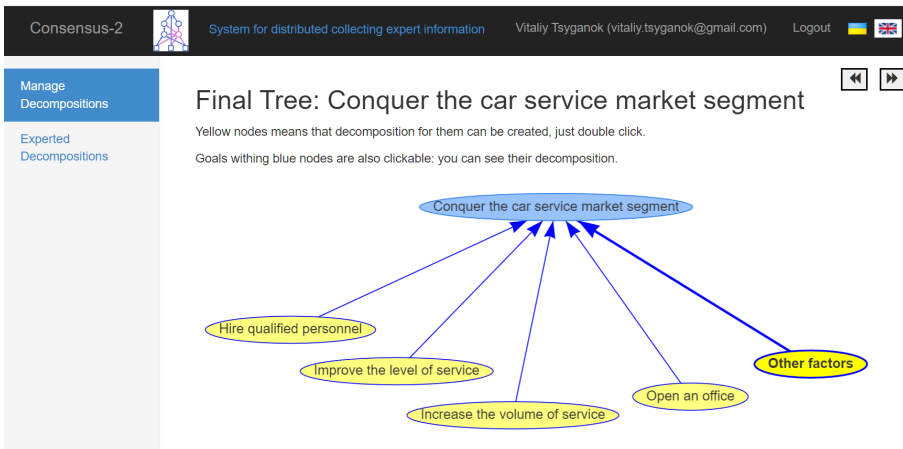

Figure 7.2. Screenshot of the software system "Consensus-2" with a goal hierarchy image example

3.5. Model parameters determination

After the structure of the model is built, it is necessary to determine its parameters. Some of the parameters are determined by the knowledge engineer since their values are known and not subject to doubt. The rest are determined by the group of experts at the initiative of the knowledge engineer.

The knowledge engineer determines whether a goal is quantitative or qualitative, linear or threshold, whether sub-goals are compatible, whether a goal's impact is positive or negative. As for other parameters: PCIs and time delays of influences are determined as a result of group expert sessions,

involving the same experts who performed the group decomposition of the respective goals.

Within the technology of strategic planning based on group expert sessions, in order to determine previously unknown parameters of the model, the following tools are used:

- methods of obtaining and processing of expert estimates using pairwise comparisons;
- verbal scales of various degrees of detail;
- feedback with experts.

This whole toolkit was developed to increase the reliability of expert session results and, thereby, to increase the adequacy of the models, providing the basis for strategic planning.

Technology of group construction of the domain model is implemented in a web-oriented software system for distributed group expert sessions "Consensus2" (Consensus2 Certificate, 2017). Now that the model of the subject area is built, it can be used as basis for solving a whole set of problems related to decision support, forecasting, and analytics. The decision support system "Solon3" (Solon-3 Certificate, 2003) is capable of solving a wide range of tasks, including strategic plan construction.

3.6. The Method of Goal Dynamic Evaluation of Alternatives

The Method of Goal Dynamic Evaluation of Alternatives (MGDEA) was developed for the evaluation of decision alternatives based on a goal-oriented hierarchical model (Totsenko, 2001). And to improve and provide the opportunity of evaluating alternatives (projects, measures, decision variants) when building strategic plans (Tsyganok, 2013b). MGDEA is primarily intended for the evaluation of alternatives (decision variants, projects, measures) on a time interval in DSSs. Evaluation is carried out based on an expert-constructed subject domain model. The method makes it possible to use the most general models of weakly structured subject domains, which fully and adequately reflect the peculiarities of one or another subject domain.

In contrast to other existing methods, for example, multi-criteria ones (Figueira, Salvatore, & Ehrgott, 2005), where appropriate optimization methods are used (Steuer, 1992), MGDEA allows for the evaluation of heterogeneous projects, for which it is difficult or impossible to formulate a single set of criteria. In addition, MGDEA does not require an expert to master the entire problem as a whole, but instead allows decision-makers to involve expert groups. During the model construction, each expert only has full knowledge of some part of

the subject domain. Due to the aforementioned properties, MGDEA can be considered one of the fundamental methods in the field of expert decision-making support. The method makes it possible to calculate ratings (estimates) of decision variants (actions, measures, projects) based on KB.

The basis of MGDEA is a generalized procedure for determining the achievement degree of any goal in a hierarchy at a given moment in time t. As stated in Totsenko (2001), when determining the degree of achievement of a goal, it is necessary to analyze the degree of achievement of its immediate sub-goals (for each alternative subset of compatible sub-goals). So, $d_i(t)$, that is the degree of achievement of the i-th goal at the moment of time t, is determined by the following expression:

$$d_i(t) = \begin{cases} 0, & \text{if} & D_i(t) < T_i \\ T_i, & \text{if} & D_i(t) = T_i \\ f(D_i(t)), & \text{if} & T_i < D_i(t) < 1 - \sum_j \left| w_{ij}^{(k-)} \right|, \\ 1, & \text{if} & 1 - \sum_i \left| w_{ij}^{(k-)} \right| \le D_i(t) \le 1 \end{cases} \tag{2}$$

where $D_i(t) = \sup_k \sum_j w_{ij}^{(k)} d_j(t)$; T_i is the threshold for achieving the i-th goal; $f(D_i(t))$ is a function of achievement degree of the i-th goal at moment t; $w_{ij}^{(k-)}$ is the PCI of the j-th goal in the k-th group of compatible goals, which has a negative influence on the i-th goal.

Calculation (by means of MGDEA) of the rating (relative estimation) of the decision variant corresponding to the l-th goal of the hierarchy at a certain moment of time t is, in essence, the determination of the difference between achievement degrees of the main goal $d_0(t)$ under the condition of full achievement of all goals that correspond to decision variants intended for comparison $d_i(t) = 1$, $i \in L$, $L = \{m..n\}$, and under the condition $d_i(t) = 1$, $i \in L \backslash \{l\}$, $d_l(t) = 0$. That is, the rating of this or that alternative (decision variant) is the difference between the degree of achievement of the main goal in the presence of the influence of this alternative upon the main goal and without it.

In order to expand the MGDEA functionality, it has been proposed to improve the method with the possibility to calculate the rating of alternatives not only in relation to the contribution to the achievement of the main goal of the hierarchy but also in relation to any chosen goal. This allows us to compare the influence of alternative decision variants on intermediate goals in the general domain model.

The process of calculating $d_i(t)$ – the degree of achievement of the chosen *i*-th goal at the moment of time *t* – can be described as follows. In the goal hierarchy graph, we search for goals that do not influence other goals of this hierarchy, that is, a set of vertices is selected which do not have any incoming arcs in the graph. The calculation of goal achievement degrees begins from this set of goals (usually projects). Initial values of achievement degrees of goals from this set are assigned (as was noted above) equal to 1 or 0. Intermediate values from interval [0,1] are also allowed to consider the incomplete implementation of the project at a given time. It is advisable to take into account the expert estimation of project implementation degree when analyzing the intermediate states of the system model, and in case of partial allocation of resources (funding), to projects.

It should be noted that, in general, the graph may not have any vertices, which do not have any incoming arcs. However, according to the logic of model building, this is unlikely, and such a scenario was not considered (Totsenko, 2001). It is advisable to include the goal "Other factors" when building the hierarchy. It influences all those goals of the hierarchy, whose achievement is insufficiently determined by the available goals. If this recommendation is followed, the initial set of goals, when determining the goal achievement degrees, will not be empty because it will include the goal "Other factors," which has no influences.

Subsequently, a set of goals can be achieved by the direct influence of goals belonging to set formed at the previous step. This set is formed because all goals (graph vertices) are directly influenced by the goals from the previous set (vertices that have incoming arcs leading from the vertices of the pre-formed set). Goals belonging to a previously formed set can also be included in this set.

For each goal from the formed set, the degree of its achievement at the moment of time *t* is determined. In fact, in the process of determining the degrees of achievement of goals, there is a propagation along the hierarchy graph from the goals of the lower level to the upper levels and, finally, to the main goal. Suppose there is feedback in the graph (arcs leading from vertices of higher levels to vertices of lower levels). In that case, the iterative process of determining the goal achievement degree is terminated when the modulus (absolute value) of the difference between the calculated achievement degree values of the selected goal in consecutive iterations (*x*) and (*x*+1) does not exceed the specified accuracy ε:

$$\left| d_i(t)^{(x)} - d_i(t)^{(x+1)} \right| \le \varepsilon. \qquad (3)$$

The accuracy of calculations ε, as well as the planning period, are set as input parameters. Based on the specifics of the tasks solved with the help of this DSS, the minimum unit of measurement of time intervals is performed with one day accuracy. By default, the recommended planning period (preset in the form) is the time interval within which the relative ratings of the selected projects are calculated. This value (in days) is calculated according to the goal hierarchy graph while moving from lower-level vertices to the upper level, similarly to the process of determining the goal achievement degrees. However, in this case, the value of the maximum duration of the time period is calculated during this process. This value is the sum of the delays of the influences propagation, the time interval beyond which changes in the relative project rating calculation results no longer occur.

The MGDEA allows us to calculate the relative ratings of projects for any point in time from the start of their implementation. However, the calculated values of the ratings change only in the so-called reference points of the time axis. So, we propose to determine these points a priori (in advance), just once, and not before each iteration. In contrast to the iterative method proposed in (Totsenko, 2001) for determining the next $t^{(i+1)}$ moment of time for calculating the goal achievement degrees:

$$t^{(i+1)} = \inf_{k,\, \tau_k \geq t^{(i)}} (\tau_k), k \in \{1, 2, \ldots, n-1\}, \tag{4}$$

where τ_k is the value of the delays of the influences of the goals in the hierarchy, which contains n goals. It is currently proposed to move from lower-level goals to upper level while calculating and adding to the list of all possible values of the delays of influences of the goals in the hierarchy. This progress is organized simultaneously with the process of determining the achievement degree of the main hierarchy goal and if so, there are feedbacks in the hierarchy that continues until the condition (3) is met. In fact, the formation of the list of goal influence delays is performed together with the calculation of the above-mentioned recommended planning interval. Its duration corresponds to the maximum value among the calculated impact delays in the list.

3.7. Resource allocation

At the final stage, the technology of building strategic plans is important to determine a list of activities (projects) with their financial support, which will make it possible to achieve the strategic goal to the maximum extent within a given time interval under known funding limitations. As we have shown,

MGDEA makes it possible to calculate the main (strategic) goal achievement degree at a certain point in time based on the model of the subject domain and project implementation degrees. So, the statement of the funding allocation problem looks as follows:

What is given:

1) A set of projects $P = \{P_i\}, i = (\overline{1, n})$.
2) For each project P_i, the dependence function $S_i = f(R_i)$ of the degree of its implementation S_i on the amount of funding R_i is set (the function is shown in Figure 7.1).
3) Algorithm for calculating the main goal's achievement degree based on the vector of project implementation degrees $\overline{S}: E(\overline{S})$.

We should find:

vector $\overline{R_x}$, in which $E(\overline{S_x}) \rightarrow max$, under constraint $\sum_{i=1}^{n} R_i \leq R_T$, where R_T is the total program funding volume.

Problems of optimal resource allocation are usually solved using various optimization methods, such as mathematical programming, but this problem has features:

- we are dealing with a model of a weakly structured system where the goal function cannot be represented analytically but only its algorithmic representation (for example, in the form of an algorithm for calculating the main goal achievement degree);
- since the input data for building the model are subjective, expert estimates, which are not strict and accurate enough requirements for the accuracy of resource allocation determination, are also not very high. In other words, it is enough to have a not (necessarily) optimal but good enough – rational version of the solution.

From the standpoint of a practical problem solution, it is advisable to move from the search for a solution on a continuous scale to the search in a discrete area. For this purpose, it is proposed to specify the accuracy of resource allocation as part of the input data. This value represents some unit of financial resource discretization. In connection with the above-mentioned features, the application of evolutionary methods, which essentially represent variants of targeted random search, is suitable for solving this problem.

Among the evolutionary methods, it is proposed to use a modification of the genetic algorithm (GA) first proposed by Holland (1992). GA is an algorithm that allows you to find a satisfactory solution to analytically intractable or complex problems by sequentially selecting and combining the desired parameters using mechanisms similar to biological evolution.

GAs operate with a set of individuals (population), which are strings. Each of them encodes one of the problem's solutions. In this way, GA differs from most other optimization algorithms, which at a certain point in time operate with only one solution variant, improving it. With the help of the fitness function, among all individuals of the population, the following ones are distinguished:

- the most adapted (good solutions – with the maximum values of the fitness function), which get the opportunity to cross-breed and produce offspring (descendants);
- the worst (bad solutions) that are removed from the population and do not produce offspring.

Thus, the adaptability of the new generation is, on average, higher than the previous one. The universality of GA is that only such parameters as the fitness function and coding of solutions depend on a specific problem. Other steps for all tasks are performed in the same way. Therefore, let's focus on these parameters of the resource allocation problem.

As a fitness function, we consider the function of the main goal achievement degree under given levels of project implementation. This function has already been implemented and is used in many functional modes of the Solon3 DSS. So, currently, it does not require re-implementation and can be used as a fitness function of GA.

Let's address such an aspect as coding solutions to the problem in greater detail. In the beginning, the, i.e. a resource intended for further allocation between projects, is subject to discretization, that is, division into elementary (indivisible) parts. The value of the resource discretization unit is set by the user. This procedure is not only permissible but also expedient. In practice, the result of the allocation of resources with some precision is required. If the selected precision is excessively high, the results must be rounded to the required limits. The solution variant in this formulation of the problem is a vector, where each element is the number of elementary resource units allocated to a project.

In order to calculate the fitness of individuals – to find the value of the function of the main goal achievement degree - it is necessary to preliminarily calculate the degree of implementation of each project under a specified

funding volume. That is, for the project corresponding to the element of the decision vector, according to the modeling function (the appearance of which is shown in Figure 7.1), it is necessary to find the degree of its implementation. Parameters of the function of dependence of project implementation on funding for each project are pre-entered when building the domain model. It is assumed that these data (namely: the number of resources necessary for the full implementation of the project, the minimum reasonable number of resources for the project, and the expected percentage of the project completion under minimum funding) are obtained from the developers of the business plans of the projects.

The choice of GA operators and parameters represents some complexity when implementing and using the selected method. The following GA operators were used for this realization: tournament selection from two individuals, one-point crossover, mutation, and elitism.

By default, it is proposed to use the following experimentally selected input parameters: the number of individuals in the population is 50, the probability of mutation is 0.05, and the GA completion parameter is the number of generations with the same result - 50. It is possible to change these parameters by selecting more suitable ones in order to effectively obtain a result for a given model.

So, within the study, the problem of rational allocation of limited resources between projects was solved. The results of this work were checked with the correct finetuning of the parameters and coincided with the results of the proof by exhaustion (brute force, complete enumeration) method. Verification was carried out on examples with a limited number of projects and a small number of given elementary units in the total number of resources.

4. Results: An example of a practical application of the technology

For example, let's take a strategic goal for a small business entrepreneur "Conquer the car service market segment." It is easy to make sure that this goal is a qualitative, linear type.

Decomposition of the main goal is carried out using the Consensus-2 system, and as a result, we get sub-goals of the main goal:

1) Open an office.
2) Improve the level of service.
3) Increase the volume of service.
4) Hire qualified personnel.
5) Other factors.

The result of the decomposition of the main goal – a graph of the goal hierarchy is shown in Figure 7.2. Further decomposition of sub-goals relationships between goals forms the model structure, shown in Figure 7.3, where the screenshot of the DSS is presented with the display of the subject domain model of the goal-oriented type. In this form, the model of the subject domain is represented in the Solon-3 DSS.
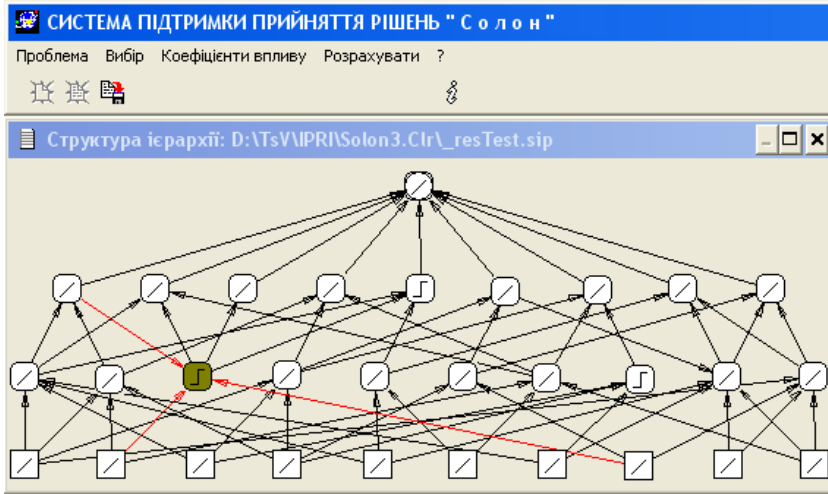

Figure 7.3. Screenshot of Solon-3 DSS: a window with graphic view of a goal hierarchy structure with feedback arcs and threshold goals

On the graphic representation of the model structure, you can see the presence of feedback links (that is, arcs going from higher levels of the hierarchical structure to lower levels), as well as threshold goals (corresponding vertices are marked with a characteristic sign). Such a model can be built individually (by one knowledge engineer) using the Solon3 software development tool or downloaded from the web server built collectively in the Consensus2 system.

The DSS has a number of calculation tools necessary for forecasting and decision-making support. The result of calculations used to build a strategic plan, is a list of measures with funding allocated for them for a certain period.

Figure 7.4 shows the resource allocation calculation dialog box, where the total number and accuracy of resource allocation are entered. Besides that, the minimum and maximum required amounts of resources and percentages of project completion in each situation are entered for each of the projects. The input of the accuracy value is programmatically controlled, and the value

is limited from below depending on the entered total number of resources in order to prevent situations of excessive growth of problem dimensionality. The "Change algorithm parameters" button displays the dialog for adjusting the GA input parameters. The right column of the table after the calculations shows the recommended amount of resources to be allocated to each project.
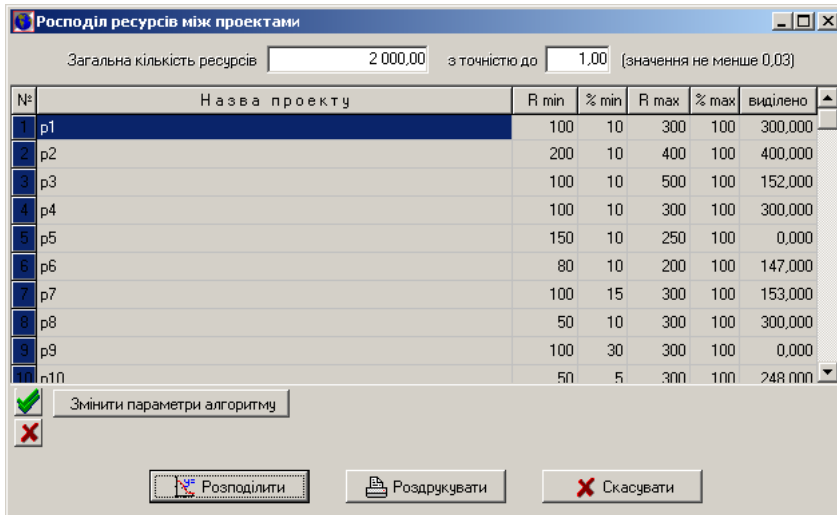

Figure 7.4. Screenshot of Solon-3 DSS dialog box for entering input data and displaying the results of resource allocation calculations

The table displayed on the screen in Figure 7.4, the resource amount allocated to the project, ranges from R_{min} to R_{max}. In addition, the values proposed for the allocation of resources are multiples of the entered accuracy (resource discretization unit).

The mode of calculating the distribution of resources is initiated through the corresponding window, in which the parameters for calculations are entered, namely: the accuracy of the calculation of the goals achievement degrees, the planning period, the number of days (24 hours) during which the strategic goal must be achieved, and the calculations for each day of the planning period or for characteristic reference points on the time axis (see Figure 7.5).
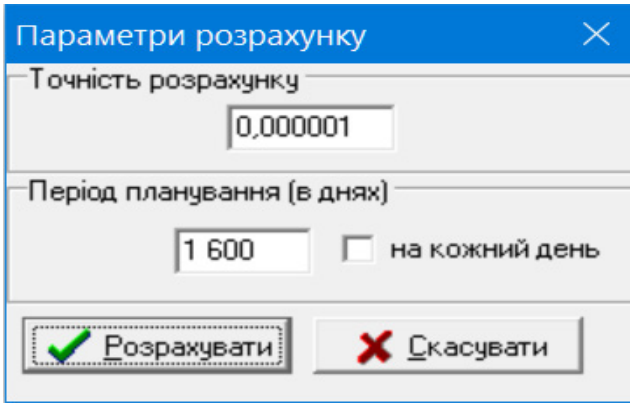
Figure 7.5. Screenshot of the Solon-3 DSS with a window for entering calculation parameters

Projects for financial resources have been allocated (as a result of rational distribution calculation), and they will be included in the list of measures that are implemented for the most effective achievement of the strategic goal during the given period of time, under a fixed amount of funds reserved for this period. The same projects that did not receive funding as a result of the calculation (0.000 in the last column of the table with the "allocated" caption) will be excluded from consideration at this stage.

It is possible to perform a series of resource allocation calculations for different values of available resources and on different planning intervals, thereby determining the financial needs for the achievement of a strategic goal in the medium and long-term prospect.

5. Conclusion

The chapter proposes an original way of automating the process of group construction of weakly structured subject domain models based on the application of existing and newly developed knowledge-oriented methods for building strategies.

The main point of the chapter is two-fold:

1) It presents an original technology, allowing DMs from various weakly-structured domains to formalize and structure the decision-making and strategic planning processes, turning it into a more or less rigorous step-by-step procedure.

2) It illustrates the implementation of the technology using the respective original software tools.

Theoretical foundations and methods for the reliable acquisition and application of collective knowledge in various fields have been developed. The availability of this theoretical basis has allowed us to come to a practical application of the newly-developed toolkit for strategic business planning in various areas. Although this chapter is largely focused on the theory and methodology of the strategic planning process, the technology has found multiple managerial applications in such spheres as:

- personnel evaluation;
- higher educational establishment evaluation;
- space industry efficiency evaluation;
- sustainable urban planning and environmental protection;
- information operations prevention;
- scenario analysis.

The key limitation of the approach is the involvement of human factors. Experts are human beings who make mistakes during goal decomposition and evaluation. Moreover, the number of objects an average expert is able to analyze at the same time does not exceed 7 ± 2. Finally, the robustness of the approach can be verified mostly through modeling and simulations of the expert estimation process (although some experiments and studies by the author and his colleagues used empirical data obtained through expert sessions). Further research will be aimed at ensuring the credibility of the suggested approach, its experimental studies, and its applications to new subject domains.

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Biographical note

Vitaliy Tsyganok obtained his Ph.D. degree in Computer Science and later the scientific degree of Doctor of Engineering in System Analysis and Decision Making at the Institute for Information Recording of the National Academy of Sciences of Ukraine, Kyiv, Ukraine. He is presently the head of the Department for Intelligent Technologies of Decision-Making Support at this institute. He is a professor at the Faculty of Information Technology of the Taras Shevchenko National University of Kyiv and the Institute of Special Communication and Information Protection of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute." His research interests include expert assessment methods, decision-making support, operations research, systems analysis, and mathematical modelling of complex weakly structured systems.

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