Florin Lungu
- Coordinator -

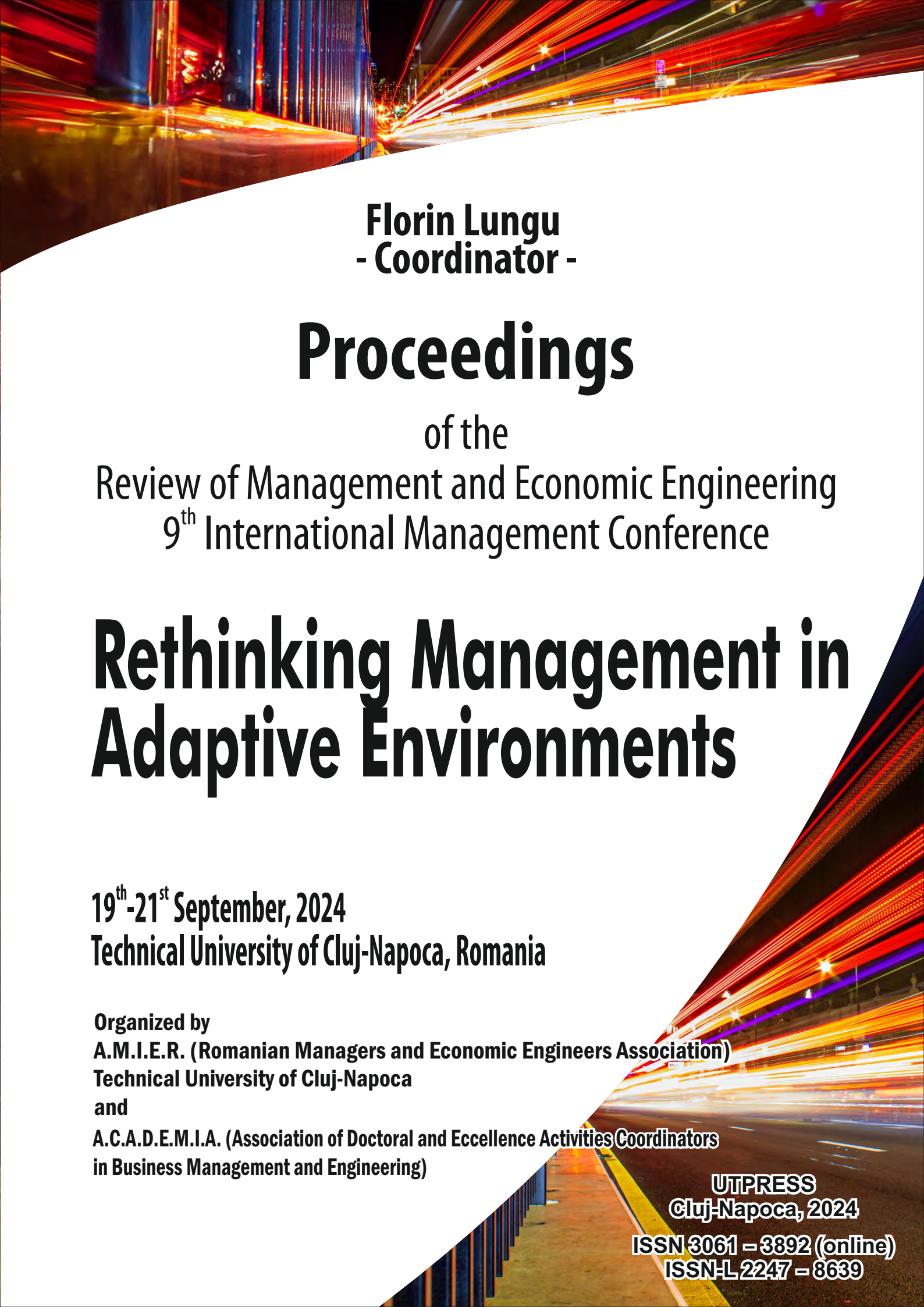
Proceedings

of the
Review of Management and Economic Engineering
9th International Management Conference

Rethinking Management in Adaptive Environments

19th-21st September, 2024
Technical University of Cluj-Napoca, Romania

Organized by
A.M.I.E.R. (Romanian Managers and Economic Engineers Association)
Technical University of Cluj-Napoca
and
A.C.A.D.E.M.I.A. (Association of Doctoral and Eccellence Activities Coordinators in Business Management and Engineering)



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FLIPPED CLASSROOM AND CERTIFICATE COURSES FOR STUDENT EDUCATION IN INDUSTRIAL ENGINEERING

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Abstract

Purpose *– Flipped classroom is an instructional approach that reverses the traditional order of teaching and learning, by delivering the content online before the class and engaging the students in active learning during the class*

Methodology/approach *- This paper reviews the literature on the use of flipped classroom concepts and certificate courses in student education and reports from practical implementation in study programmes of industrial engineering.*

Findings *– The paper identifies the benefits, challenges, and best practices from literature and practical implementation.*

Research limitations/implications *– Flipped classroom is an instructional approach that reverses the traditional order of teaching and learning, by delivering the content online before the class and engaging the students in active learning during the class. Certificate courses are short-term, focused, and flexible learning opportunities that can enhance the students' skills and competencies in specific domains.*

Practical implications *– Flipped classroom concepts and certificate courses are short-term, focused, and flexible learning opportunities that can enhance the students' skills and competencies in specific domains.*

Originality/value *– The paper provides examples of the successful implementation of several courses in the study programme of industrial engineering on both, bachelor and master levels.*

Key words: *flipped classroom, certificate course, student education*

Introduction

The rapid development of information and communication technologies (ICT) has transformed the landscape of education, creating new opportunities and challenges for both teachers and learners. One of the emerging trends in education is the use of flipped classroom concepts, which aim to enhance the quality and effectiveness of teaching and learning by shifting the focus from passive to active learning. Another trend is the use of certificate courses, which offer flexible and personalized learning pathways for students who want to acquire or update their skills and competencies in specific areas. Both flipped classroom concepts and certificate courses have the potential to improve the student outcomes and satisfaction, as well as to meet the changing needs and expectations of the labor market and society.

However, the implementation of flipped classroom concepts and certificate courses is not without challenges, such as the need for adequate preparation, support, and evaluation, the possible resistance from some teachers and students, and the issues of quality assurance and

recognition. The paper will review the existing literature and evidence on the use of flipped classroom concepts and certificate courses in student education, and to identify the best practices and recommendations for their successful integration.

Flipped Classroom Concepts and Certificate Courses: An Overview

Flipped classroom is an instructional approach that reverses the traditional order of teaching and learning, by delivering the content online before the class and engaging the students in active learning during the class (Bergmann & Sams, 2012), (Abeysekera & Dawson, 2015), (Lage, Platt, and Treglia 2000).

The flipped classroom concept is based on the premise that students can learn the content at their own pace and place, and use the class time for more interactive and collaborative activities, such as discussions, problem-solving, case studies, and projects, that require higher-order thinking skills and teacher guidance (Bishop & Verleger, 2013). The flipped classroom concept also aligns with the constructivist and social learning theories, which emphasize the active and social construction of knowledge by the learners, rather than the passive and individual transmission of knowledge by the teachers (Kim, Kim, Khera, & Getman, 2014). Moreover, the flipped classroom concept supports the principles of universal design for learning (UDL), which aim to provide multiple means of representation, engagement, and expression for diverse learners, and to reduce the barriers and increase the opportunities for learning (Meyer, Rose, & Gordon, 2014). However, the flipped classroom concept is not a one-size-fits-all approach, and there are different ways to implement it, depending on the goals, context, and resources of the teachers and learners. For example, some flipped classroom models may use a hybrid or blended format, where some of the content is delivered online or face-to-face. (O'Flaherty & Phillips, 2015). Some flipped classroom models may use a synchronous or asynchronous mode (Chen, Wang, Kinshuk, & Chen, 2014) where activities might be customized and tailored to the individual needs and preferences of the students (Zainuddin & Halili, 2018).

Certificate courses are short-term, focused, and flexible learning opportunities that can enhance the students' skills and competencies in specific domains. Certificate courses are usually offered by educational institutions, professional associations, or online platforms, and they can be accredited or non-accredited, depending on the quality standards and recognition criteria of the providers and the stakeholders (Buckley, 2018). Certificate courses can be classified into two main types: credit-bearing and non-credit-bearing. Credit-bearing certificate courses are part of the formal education system, and they can be integrated into the degree programs or taken as standalone courses, depending on the admission and graduation requirements of the institutions. Non-credit-bearing certificate courses are part of the informal or non-formal education system, and they can be taken for personal or professional development, without any prerequisites or credentials (Chen, 2016). Certificate courses can be delivered in various formats and modes, such as face-to-face, online, or blended, and synchronous, asynchronous, or mixed. (Oliver, 2019).

Comparison and Complementarity of Flipped Classroom Concepts and Certificate Courses

Flipped classroom concepts and certificate courses are both innovative and flexible approaches to education, that can offer multiple benefits for the students, such as increased motivation, autonomy, and achievement, as well as enhanced skills and competencies in specific domains. However, they also have some differences and limitations, that need to be considered and addressed, such as the need for adequate preparation, support, and

evaluation, the possible resistance from some teachers and students, and the issues of quality assurance and recognition.

The use of certificate courses in student education is an innovative form of learning that is geared towards the needs and interests of learners. Certificate courses are short, thematically focused courses that can be offered online or face-to-face. They aim to provide learners with specific competences or qualifications that they need or want to enhance for their professional or academic career. Certificate courses can be taken as part of a regular degree program or as additional continuing education.

The following SWOT analysis identifies the main similarities and differences between flipped classroom concepts and certificate courses. A detailed overview of the results can be found in figure 1 and 2 at the end of this paper. The analyses are based on the following authors: Bishop and Verleger (2013), Lo & Hew (2017, O'Flaherty & Phillips (2015), Baturay et al. (2019), Chen et al., (2013, 2014), De Coi et al. (2007),), Govaerts et al. (2012), Zainuddin & Halili (2016), Fussenecker et al. (2023) and Niemann et al. (2009, 2022, 2023, 2024), Littlejohn et al. (2016), Milligan et al. (2017), Nawrot & Doucet (2014).

As the figures 1 and 2 show, flipped classroom concepts and certificate courses have some common strengths, weaknesses, opportunities, and threats, as well as some unique ones. Therefore, it is possible to combine and integrate the two approaches, in order to maximize their advantages and minimize their disadvantages, and to create more effective and efficient learning experiences for the students. For example, flipped classroom concepts can be used to deliver the content of certificate courses online, before the class or the assessment, and to engage the students in active learning during the class or the assessment. Certificate courses can be used to provide flipped classroom concepts with more focused and flexible learning opportunities, that can enhance the students' skills and competencies in specific domains.

Development of course modules and training programs

Several flipped classroom courses have now been developed at Flix at Duesseldorf University of Applied Sciences in the field of industrial engineering education, which are used as course and teaching formats for the training of students in the area of elective subjects, but also in compulsory subjects.

Service Engineering course module:

The challenges outlined above place enormous demands on the developers of services in the future. Therefore, the goal was to develop a consistent methodology for the development of services, which takes up and implements these requirements. In this context, a training course was developed at the Flix Research Centre for Life Cycle Excellence at the University of Applied Sciences Duesseldorf. The target group of the course are engineering students and professionals (see Figure 3). The course teaches the basics of designing and developing modern services using "hands-on" training modules. Figure 4 shows a rough overview of the topics, methods and practical parts of the course contents. The course participants develop and design a service step by step using methods and tools that are learned and tested within the course. In this way, the course participants simultaneously learn the methodological tools in a creative course atmosphere. The course lasts approximately five days and can be extended or shortened on a modular basis depending on the group of participants and the objectives. At the end of the course, in addition to the presentations of the developed services, there is also an examination of the theoretical basics (online examination). The course is also suitable for delivery in an online format. However, experience has shown that a face-to-face format is advantageous due to the numerous group work and practical interactions. The course language and the teaching materials are in English.

Business models and entrepreneurship course module:

In this course, students are introduced to the development of business models and business plans in group work. The courses consist of brainstorming workshops in the initial phase of the course and are then continued in small groups of 4-5 students each for detailed elaboration. While the initial phase (brainstorming) is still moderated centrally by the lecturer for all course participants, the further detailed development takes place in small groups with weekly meetings in which the lecturer takes on the role of a coach. At the meetings, the students present their work progress to the lecturer, who supports the group with suggestions, critical questions and advice. The students take the active part in the discussions, the lecturer only takes on the role of a coach. The group members also plan the next work steps independently and thus also determine the pace of work in the group. Documents on the sub-topics to be worked on as well as deadlines and submissions are available centrally (in TEAMS) for all course participants. The path to the goal as well as the distribution of tasks and deliverables are determined individually within the group by the group members. The central instructions also contain information on the examination papers to be submitted, but the content and type of presentation is also determined by the group members. The assignments are designed as semester tasks. The module handbooks for the courses have been adapted accordingly. For formal reasons, however, the examination performances must be organised in such a way that it is possible to assign the performances to the individual group members at a later date.

Course module Methods of Production Optimization:

This course module is used in the Master International Industrial Engineering program. The aim is to enable students not only to master lean management methods in theory, but also to master some methods "hands-on" and to be able to apply them using practical examples. To this end, the course participants are also divided into small groups with the task of developing a training program for a methodology for the other course members. In particular, the training program should focus on the practical mastery and practice of a method. The methodology is then carried out in a final examination under the direction of the students as a training team with the other course participants on the basis of a self-designed practical exercise. After completing the course, students also receive a certificate from the FLiX-Institute confirming that they have completed the training. This certificate can then be attached to subsequent job applications.

For this course, there is also the option of taking an examination for the "Six Sigma Yellow Belt" with an external examination provider (for a fee) after completing the course.

Summary and Oulook

The paper describes the demand and necessity for a transformation in teaching modes towards flipped classroom formats and/or certification course modules To master the steps a literature review has been performed to identify strengths, weaknesses, opportunities and threats arising from this methodical shift. Ideas and toolboxes can be found in the literature and can be used as a blueprint for the education and training of future industrial engineers. According to the findings FLiX research centre has developed a set of training courses and implemented them into their educational programs for both, students and business professionals on bachelor and master level.

Keeping the current industrial, social and ecological changes in mind the content development is rather dynamic. Besides looking for a suitable funding possibility, recommendations for further adjustments are welcome. A proposal is to set up a new online and onsite class to train the future European service engineers within a network of interested universities.

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Figures

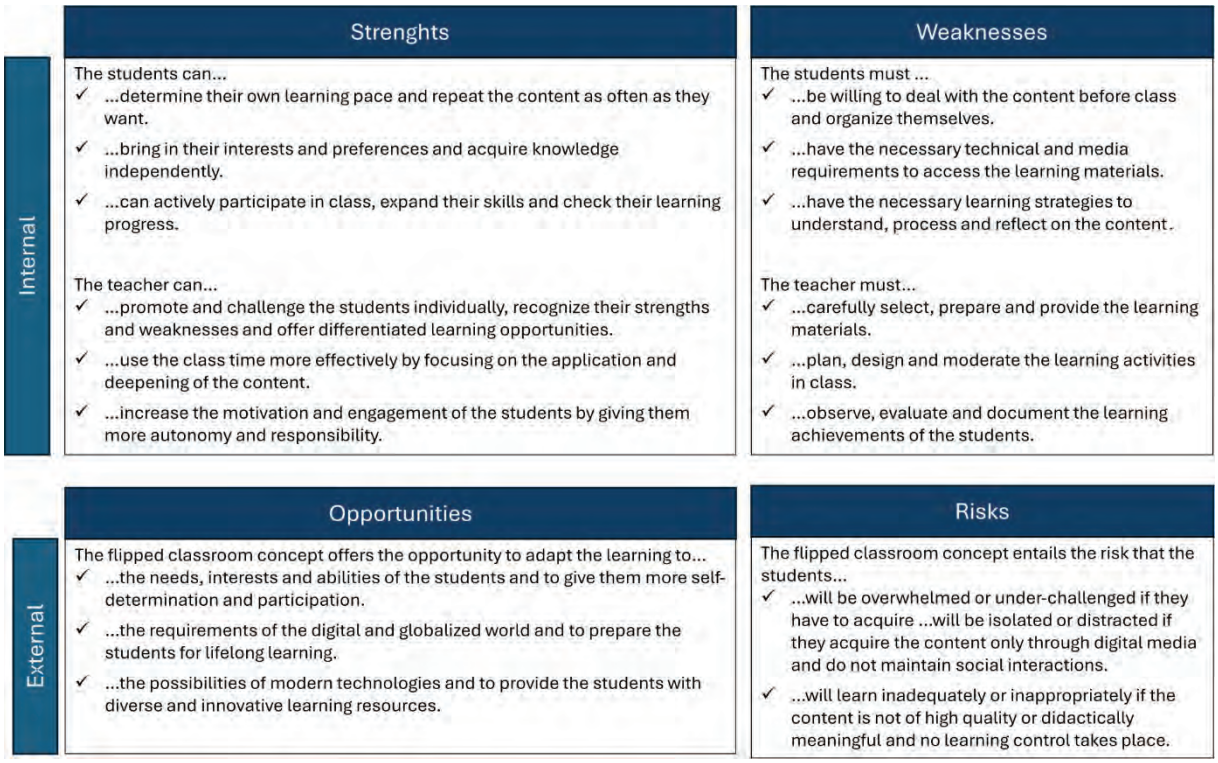

Figure 1: SWOT Analysis of Flipped Classroom Concepts

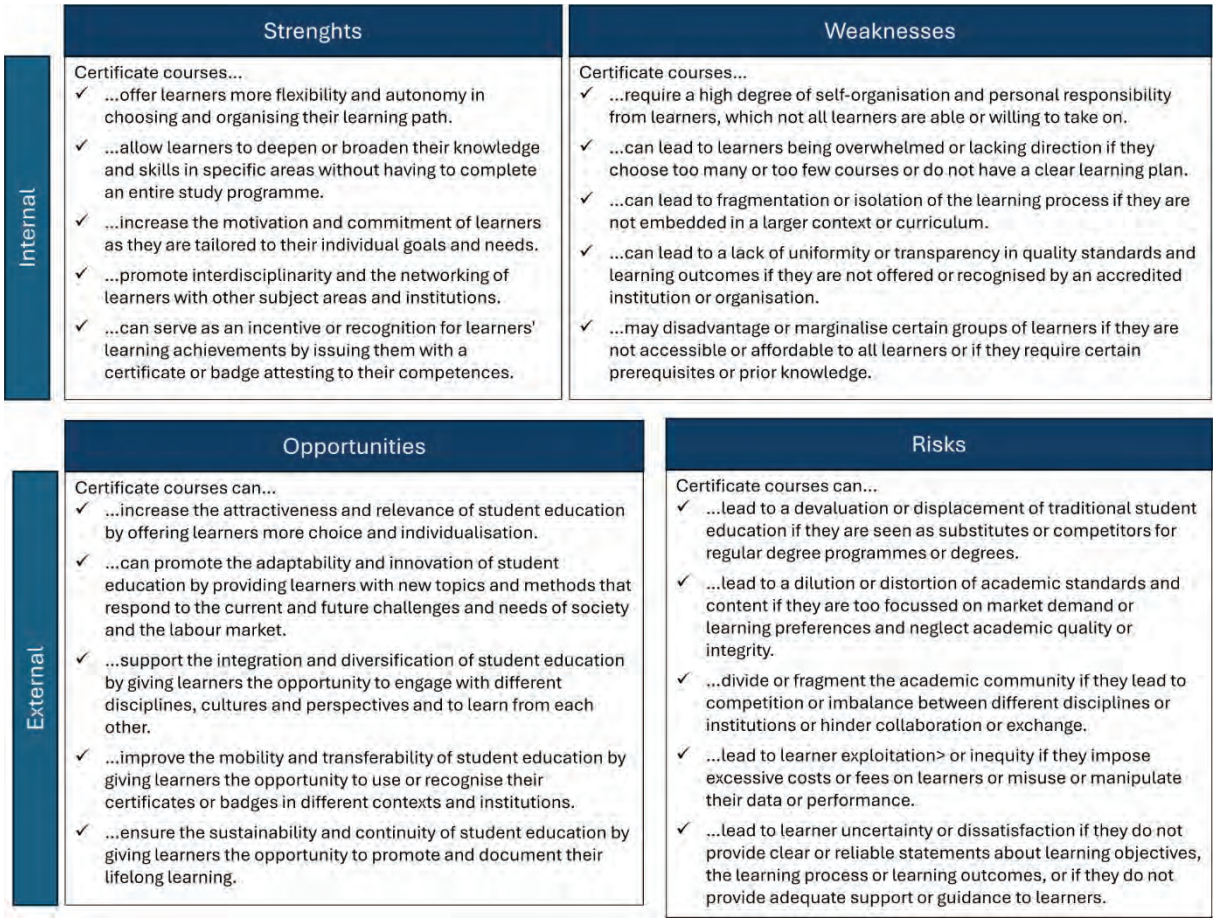

Figure 2: SWOT Analysis of Certificate Course Modules

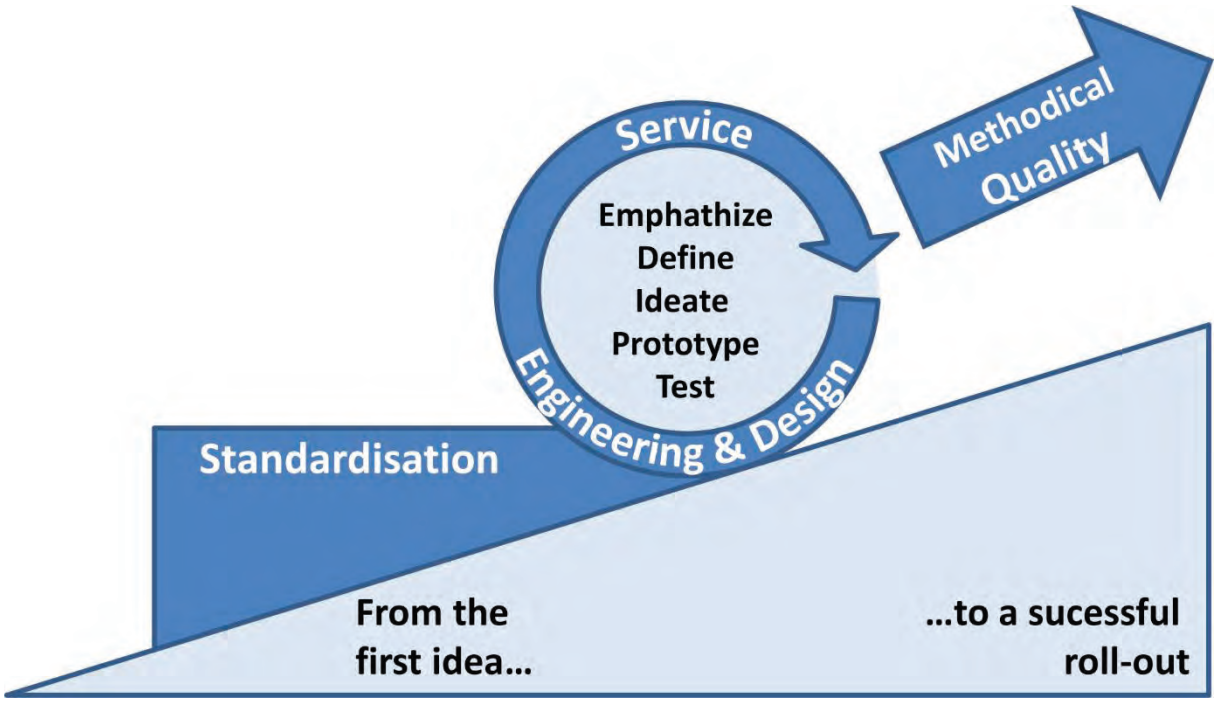

Figure 3. Service Engineering training course [source: own graph]

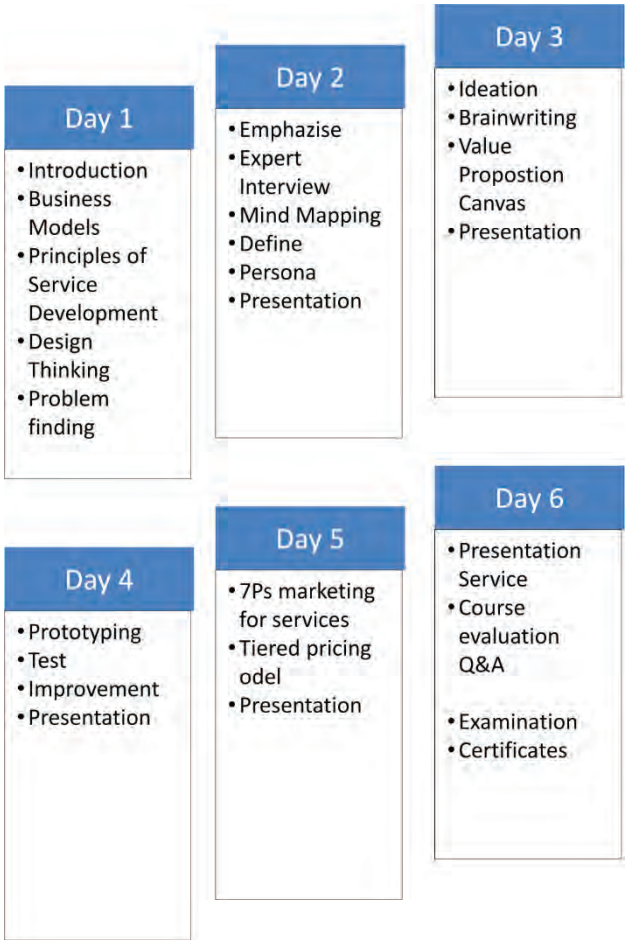

Figure 4. Course content [source: own graph]

COMPANY'S ACQUISITION AND ITS EMPLOYEES' SATISFACTION

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Abstract

Purpose *– The measure of the success or failure of mergers or acquisitions comes from numerical, economic, and commercial data. We want to figure out the impact of acquisitions on employees' satisfaction. We distinguish between senior-ranked and junior-ranked employees to give stakeholders better chances for success.*

Methodology/approach *- The main mechanism is a questionnaire. It was validated before being distributed among potential respondents. Using factor analysis, we determined three factors that express employees' satisfaction.*

Findings *– We found that generally, the three factors, namely Transparency and Communication, Involvement and Belonging, and Trust and Stability, cover several aspects of employees' feelings toward acquisitions or mergers. However, senior employees are significantly more satisfied than junior employees.*

Research limitations/implications *– The research emphasizes the need for junior employees' cooperation and involvement. It seems that senior employees were exposed to more details related to the acquisition.*

Practical implications *– The findings will help stakeholders pay more attention to junior-ranked employees and achieve better success while acquiring companies.*

Originality/value *– This is a phase in long-run research. Its value lies in quantitative measures of employees' attitudes and involvement in their organization's life.*

Key words: *acquisition, senior ranked employees, satisfaction.*

Introduction

Purchasing companies is a common and well-known process in various industries. Huge companies have acquired many companies worldwide. The measure of the success or failure of the purchase comes from numerical, economic, and commercial data. Its profitability and capacity for growth measure a company. The data can be impressive and promising but do not always indicate what is happening in society from a personal point of view.

The employees, the engine for the company's success or failure, are the human capital, and the degree of success depends on them. The employees who make up the company belong to all ranks, from the student-hourly worker to the senior manager. Everyone is responsible in one way or another for the company's success. Therefore, space must be made for every employee and harnessed for the company's success. Now, with the company's purchase, the company is going through upheavals both in terms of organizational culture and the lack of acknowledgments and transparency shown to the employees.

When you enter this process, you build an orderly plan regarding finances, profits, knowledge, information, markets, customers, etc., but no company builds a transition and "soft landing" plan for employees. This arose from the need to check the satisfaction of employees in companies that had undergone acquisition.

The research question is to what extent, if any, there is a difference between senior-ranked employees and junior-ranked employees regarding the company's purchase.

Literature Review

The literature survey is comprehensive and in-depth and includes many topics that create an overall picture. First shown the need and reasons for purchases and how the purchase is affected by the process of crossing the innovation threshold through purchases (Cefis and Marsili, 2015)

Today, companies acquire new companies to merge and bridge the gap between their current position and their future performance in terms of innovation and performance (Nathan, 2014).

All of these are examined using models for the impact of purchases on procurement, which we will expand on in the literature survey.

The main topic presented in the literature survey is the management of human resources as a necessary factor for the success of the purchase. When considering the success of a purchase, one of the influencing factors is human capital (Sinkovics et al. 2011). The studies show that the thorough management of human resources and their integration are necessary for the success of the process. Part of the sharing is reflected in the personal communication in the organization.

It is known that the purchase process is challenging, and sometimes, secrecy must first be maintained in order to avoid harming the negotiations. However, the issue of confidentiality is also an obstacle and a problem of lack of transparency with the employees. Hence, even in the stages of preparing the plan for the purchase, emphasis must be placed on communication and determining what information will be passed on to the employees and how It will be possible to reflect the process to them. This is one of the main characteristics of proper leadership among the organization and the management.

Later on, the issue of the effect on employment and workers' wages is also reflected. Studies show that there is a negative effect on the scope of the employed—a trend of constant decline—but at the same time a positive effect on wages. All studies show that there was an increase in workers' wages. In addition, it seems that purchases are a lever for occupational efficiency among the employees(Schuler, and Jackson,. (2017).

The subject of the new organizational culture is also essential and central. The theoretical and research literature discusses the role of organizational culture in mergers and acquisitions and indicates that cultural differences can create major obstacles to achieving integration benefits. It is assumed that cross-border acquisitions perform better in the long term if the buyer and the target come from countries that are not culturally distinct.

The issue of cultural differences is especially reflected in global acquisition processes, in which the purchasing company and the acquired company come from different countries with great geographical distances.

The influence of the human aspect on the results of purchases. The research shows that complete transparency and frequent and enthusiastic communication about the change may reduce the employee's uncertainty during the change. The survey is comprehensive and

touches on several points, the main subject of which is the employees (Katsuyuki and Takuji, 2012).

Emotions play a significant role in the success of the purchase; these emotions affect the outcome variables. The initial assumptions of management are a significant factor in the merger process;. Stimulation and push from management can affect the individual. Also, communication, the conduct of the managers, and the transparency and reliability of the information passed on to the employee will affect his feelings and, hence, his attitude and behaviour in the merger process (Philip and Finbar, 2002).

Methodology

The study population consists of students, production workers, office workers, managers, and senior managers who work in Israeli companies that have been acquired in recent years.

The research is quantitative, and questionnaires were used. The questionnaire was drafted after conducting the literature survey to be sufficient and cover all the topics and points with satisfaction that we must conclude. The purpose of examining the questionnaire is to check the relevance of the questions included in the questionnaire (validity) and the degree of clarity of the questions (reliability).

Both tests were done by judges using methods of apparent validity and inter-judge reliability. In addition, this examination helped us ensure that the questionnaire included all aspects relevant to the research topic. About 194 employees filled out the questionnaire that was distributed to the companies. The questionnaire was distributed in a computerized form to the employees' email and was also given manually to employees whose work does not require a personal computer.

The sampling methods used are non-probability sampling methods: manual delivery to selected employees among the production workers and workers and students. These employees volunteered to fill out the questionnaire. In addition, a convenience sample was used: sending the questionnaire by email to office workers and management personnel.

The questionnaire results were analysed in two parts: the first part is descriptive statistics, which describes the participants filling out the questionnaires in the various demographic segments using averages, standard deviations, minimum and maximum values, and more. The second part is inferential statistics, which describes the testing of research hypotheses using correlation and regression tests.

Employee satisfaction consists of several parameters, including transparency, communication, involvement, belonging, trust, and stability.

We defined three factors regarding employee satisfaction. 1) Transparency and Communication, 2) Involvement and belonging, and 3) Trust and Stability.

Findings

First, we presented the findings for the junior level about the three categories that make up the satisfaction.

First Category - transparency and communication

The average level of satisfaction regarding transparency and communication is 2.9; the employees feel that the company has a moderate degree of openness and communication.

Second Category - involvement and belonging

The satisfaction average regarding involvement and belonging stands at 3.1; that is, the employees feel that there is a moderate degree of involvement and belonging in the company.

Third Category - trust and stability

The satisfaction average regarding trust and stability is 2.97; the employees feel that trust and stability exist in the company to a moderate degree.

Second, we presented the findings for the senior level about the three categories that make up the satisfaction.

First Category - transparency and communication

The average level of satisfaction regarding transparency and communication is 3.6; the senior ranked employees feel that the company has a moderate degree of openness and communication.

Second Category - involvement and belonging

The satisfaction average regarding involvement and belonging stands at 3.5; that is, the senior employees feel that there is a moderate degree of involvement and belonging in the company.

Third Category - trust and stability

The satisfaction average regarding trust and stability is 3.3; the employees feel that trust and stability exist in the company to a moderate degree.

When all the junior-level results are collected, the findings for the junior level can be presented. With reference to the research hypotheses, one can see substantiation in the above findings—there is a gap in the participation of the employees and in treating them as human capital. Management and human resources do not emphasize the employee as a person.

According to the research findings, weighing all the results and the average of the three research categories discussing transparency, communication, involvement, belonging, trust, and a sense of stability, we concluded that people at the junior level feel only moderately satisfied with the organization. This indicates a lack of communication and transparency in the organization; the respondents do not feel safe enough, which can harm their loyalty in the workplace and create a lack of motivation that can directly harm their productivity and leakage of knowledge and workforce from the organization to the outside.

Discussion and conclusions

Comprehensive analysis of junior and senior level

In the study we surveyed a population of 194 respondents.

35% of the senior level respondents and about 65% of the junior level respondents.

First category - transparency and communication

For the junior level, the average satisfaction is 2.91, while the average satisfaction in the senior level is 3.58

The junior level employees feel transparency and communication to a moderate degree only compared to the senior level who feel transparency and communication to a great extent.

It can be understood that there is a difference in the sense of transparency and communication between the different levels, the senior level feels a different sense of security than the junior level.

Second category - involvement and belonging

For the junior level, the average satisfaction is 3.1, while the average satisfaction in the senior level is 3.54

The junior level employees feel involvement and belonging to only a moderate degree compared to the senior level who felt involvement and belonging in the organization to a large extent.

It can be understood that there is a difference in the feeling of involvement and belonging between the different levels, the senior level feels a different sense of security than the junior level.

Third category - trust and stability

For the junior level, the average satisfaction is 2.9, while the average satisfaction in the senior level is 3.32

Both ranks trust the company and feel only moderately stable.

In order to reduce the gaps between the ranks and harness all the company's employees to the company's success and progress, the employees must be strengthened and empowered, consolidated, explained and shared in the entire purchasing process. To impart a sense of security and stability in ways of complete transparency, providing information and general involvement. It must be remembered and internalized that employees who are satisfied with their workplace bring the company to many economic and business achievements and successes. Employees should be seen as human capital.

We recommend creating meetings in which management allows the employees to express their feelings and explain their positions while answering the employees' points to create trust, openness, and a feeling that there is someone to turn to and that there will be an appropriate response.

When employees feel a sense of security and stability in the workplace, their performance will improve accordingly.

Later, the research results for the senior level were presented about the three families that make up the satisfaction.

First Category - transparency and communication

The satisfaction average regarding transparency and communication is 3.58; that is, the employees feel that there is a great deal of transparency and communication in the company.

It was found that the average results for the background variables—gender, marital status, and age—were the same.

In addition, it was found that the background variables of seniority and education differ in examining the issue of transparency and communication.

The difference is reflected between employees with up to two years' seniority in the workplace and the rest of the employees. Those with low seniority feel that there is only a small amount of transparency and communication, with an average satisfaction of 2.2, while the rest of the employees feel that there is transparency and communication in the organization to a large extent.

It is possible that the difference in satisfaction stems from the gap in years of seniority at the workplace. In addition, the employees started their work in the existing situation after the purchase without knowing and feeling the changes that occurred before and after the purchase.

Also, there is another difference between those with a bachelor's degree and the rest with an average satisfaction of 3.04. Those with a bachelor's degree feel moderate transparency and communication in the company. In contrast, the rest of the research population thinks that there is a sense of openness and communication in the organization to a large extent.

Second Category - involvement and belonging

The satisfaction average regarding involvement and belonging stands at 3.54; the employees feel that there is a moderate degree of involvement and belonging in the company.

It was found that the average results for the background variables—sex, seniority, marital status, and age—were the same.

In addition, it was found that there is a difference in examining the issue of trust and stability in the background variable - education.

The significant difference is reflected between those with a bachelor's degree in average satisfaction of 2.8 and the rest of the sample population. According to the findings, those with a bachelor's degree feel that there is a moderate degree of trust and stability in the company, while the rest of the population feels that there is a large degree of trust and stability in the organization.

In order to reduce the gaps between the ranks and harness all the company's employees to the company's success and progress, the employees must be strengthened and empowered, consolidated, explained and shared in the entire purchasing process. To impart a sense of security and stability in ways of complete transparency, providing information and general involvement. It must be remembered and internalized that employees who are satisfied with their workplace bring the company to many economic and business achievements and successes. Employees should be seen as human capital.

Referring to the research questions and hypotheses, it was found that there is a gap between the ranks in the degree of satisfaction of the employees, and there is also a general feeling of a lack of transparency and communication when it comes to the issue of purchasing. It seems that there is no emphasis on human capital and the research confirmed and validated the issue.

Following the study, several points and ideas for further research emerged such as: there is a lack of management tools and a management tool adapted to the human resources in the organization must be built.

The recommendations for further research are based on the research we carried out, and are adapted to students specializing in the field of human resources. The tool will be able to be used by many companies and will be a complementary study to the gap and deficiencies identified in our studies.

Another recommendation is to divide the research population into engineers, marketing people, human resources people, R&D workers and check the degree of employee satisfaction according to the nature of their work.

Notes

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TRAINING TEACHERS OF PRE-UNIVERSITY LEVEL IN ABSTRACTION AS SKILL OF COMPUTATIONAL THINKING

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Abstract

Purpose *– Several studies carried out in recent years confirm the importance of introducing Computational Thinking and Programming as cross-curricular competences, not only in university studies but, above all, among Secondary School students.*

Methodology/approach *- We have developed a project for Primary and Secondary Education teachers in different areas in the Basque Country to promote the acquisition of Abstraction.*

Findings *– This article presents the results of the work carried out in the 2018-2019, 2019-2020 and 2020-2021 academic years, where computational thinking, and abstraction particularly, can be a cross-curricular competence for any filed: engineering, management, economics, etc.*

Research limitations/implications *– We have developed a project for Primary and Secondary Education teachers in different areas in the Basque Country to promote the acquisition of Abstraction.*

Practical implications *– Incorporating computational thinking into the educational curriculum can benefit students, in any field and at any age.*

Key words: *abstraction, computational thinking, cross-curricular competence.*

Introduction

To be successful in the changing world we live in, one needs to be adaptable, responsive to change, able to solve problems and develop software and hardware, or even use and generate technology. According to Sá and Serpa (2018) and considering the current reconfiguration of Higher Education in Europe, its vision and mission and its constant search to provide its students with the knowledge and competences that will enable them to succeed in their future professional life, Higher Education institutions are obliged to provide their students with a strong technical and scientific background.

Contrary to popular belief, CT is not only applicable in the field of computer science or robotics. Learning to think computationally, starting with learning to use abstraction as a basic tool for reasoning, brings with it a number of educational benefits that strengthen intellectual skills and enhance learning in any subject.

Jeanette Wing (2006) was who gave the definition of CT that is considered most popular: “Computational Thinking is the thought processes involved in formulating problems and their

solutions so that the solutions are represented in a form that can be effectively carried out by an information-processing agent".

We are not only talking about big problems solved by researchers, innovation or technology development, we are also talking about thinking in such a way that, when we solve problems, we can rely, if we need or want to, on technology, on digital tools. Let us think, for example, of the kitchen robot, which can help us to improve the quality of life or, in general, all those devices that help us to be more efficient in the work we do. Let us think about the future work that we will develop taking into account the technological advances that are available to us at that time (Geppert et al., 2017).

In the Autonomous Community of the Basque Country, the Basque Government's Department of Education, in the HEZIBERRI 2020 plan (Basque Government, 2014), which is a plan for future education, includes digital competence among the basic cross-curricular or generic competences. Likewise, in order to train non-university teachers in CT, with the aim of enabling them to implement it in their classrooms, it promotes training courses within the called PrestGara programme (Basque Government, 2019).

This article analyses an experience carried out in the courses given in the period 2018-2021 within the PrestGara programme, with the participation of Primary, Secondary and High School teachers.

Abstraction and Computer Science

Computational Thinking (CT), as a cross-curricular competence, has several concepts in common with some innovative methodologies, such as PBL (Problem Based Learning), and is closely related to some fields, such as STEM. Concepts such as "knowledge construction" are included in the DNA of CT, but it does not imply that it is a property of CT. We mean that there are some relationships between Computational Thinking and some innovative methodologies. According to Jonasen and Gram-Hansen (2019), CT and PBL search and increase processes as problem-solving, problem understanding and critical thinking. In the same way, Chen (2017) focused on the advantages of these methodologies for the programming language teaching. The connection between CT and PBL is also cited by Gao et al. (2019), relating the problem-solving process when it is divided into several steps to analyze problems and establishing logic thinking.

According to the Computer Science Teachers Association (CSTA) and the International Society for Technology in Education (ISTE) (2011), the main characteristics of CT include:

- Logically analysing and organising data.

- Data modelling, data abstractions and simulations.

- Formulating problems in such a way that computers can help.

- Identifying, testing and implementing possible solutions.

- Automating solutions through algorithmic thinking.

- Generalising and applying this process to other problems.

Thus, according to Liu and Wang (2010), Computational Thinking is a hybrid of other modes of thinking, such as abstract thinking, logical thinking, modelling thinking and constructive thinking.

We believe that these concepts and skills are part of Computational Thinking, but it will be better defined, and therefore easier, more accurate and appropriate to assess, if we use the right sequence of skills.

Therefore, we can define Computational Thinking as a type of analytical thinking that employs mathematical and engineering thinking to understand and solve complex problems within the constraints of the real world through an appropriate use of its skills. (Bilbao, Bravo, García, Varela, & Rebollar, 2017). The skills that we consider to be part of CT are the following: abstraction; modelling; decomposition; algorithmic thinking and automation; data collection, analysis and representation; generalisation; evaluation and adjustment.

In addition, the most important and highest level thinking process in Computational Thinking is that of abstraction (Wing, 2011).

Since abstraction is considered a key CT skill, some authors think that the introduction of this cross-curricular competence and programming in primary education requires empirical research at the earliest age at which students can handle abstraction (Armoni & Gal-Ezer, 2014).

The different ways of seeing abstraction are closely related to the field of Computer Science and can be very useful when we want to apply abstraction in exercises or programmes in this field. Nevertheless, they are not two different forms of abstraction, but different ways of understanding or applying abstraction, and there are other ways of seeing it for other fields such as Art, Medicine, etc.

How to train in abstraction

A training experience carried out in the period 2018-2021 is presented. During this period, training courses were given to Primary, Secondary and High School teachers in the Basque Country as part of the “PrestGara” programme. These training courses aim to show teachers the different CT skills, so that they can subsequently put these concepts into practice in their subjects. The ultimate goal of the entire process is for students from primary to secondary school to become familiar with skills such as abstraction through various activities. In this way, by the end of their school studies, and before entering university, they will have acquired the CT competence that is so important for tackling the problems they will face both in their university degrees and in their subsequent professional development.

3.1. Structure of the course

The course had an initial session in which the theoretical contents to be addressed, the study materials to be used and the development of the tasks to be carried out during the weeks of the course have been explained. The work that must be handed in periodically is tutored and it receives the corresponding feedback from the teaching staff. In these assignments, course attendees prepare exercises for their students in primary and secondary classes to practice and reinforce their skills, particularly abstraction. These tasks, developed and presented by course attendees, are evaluated by the course teaching team and represent the grade that these participants obtain as a result of their progress in the course.

Both at the beginning and at the end of the course, participants have to answer two surveys. The first one measures the degree of prior knowledge they have about CT, and the second one measures the degree of satisfaction with which they finish the course.

3.2. Description

The courses have been approached from a practical point of view, but providing the participants with the essential theoretical notions. Thus, the first session begins with the introduction of the basic fundamentals of Computational Thinking, defined as the set of thinking processes involved in the formulation of problems and representation of their solutions, so that these

solutions can be executed by an information processing agent (human, computers or combinations of both). CT is a cognitive competence that includes the mental tools needed to solve complex problems, and it includes the process skill that allows to have the problem perfectly focused and understood, as well as the possible ways of solving it in order to subsequently use the digital tools. It is explained that all this is possible based on the skills that make up and characterise this competence: abstraction; modelling; decomposition; algorithmic thinking and automation; data collection, analysis and representation; generalisation; evaluation and adjustment. Its direct relationship with STEAM is also established. Subsequently, emphasis is placed on the need to create activities that can be used in the classroom to effectively develop this competence.

In addition to introducing the theoretical idea of CT competence, we can distinguish several other objectives in the taught courses. A first objective is to explain by means of examples each of the skills of this competence, with special emphasis on Abstraction, which is the essence of CT. This part includes the design of the assessment rubric for these skills, as will be seen later.

A second objective has been to explain how to design activities aimed at developing the CT competence, which can be used in the subjects taught by each teacher. The aim of these activities is for students to acquire CT skills, so that the level of acquisition of this competence can be assessed at the same time as the knowledge of the subject itself.

It has been detected that it is important to be clear about the ultimate goal of the activity. We must not lose sight of the fact that the final aim is for teachers to integrate this problem-solving competence into their classes. On the one hand, these activities should serve as support for the learning of the different subjects and, on the other, for the student to acquire CT skills.

3.3. Development of the training

The courses were divided into three parts. The first part dealt with the basic concepts of CT, developing two types of examples. On the one hand, those that served to illustrate a specific CT skill and, on the other hand, examples of activities that, suitably structured, served to show the use of CT through the set of skills that make it up. This part also included the design of the evaluation rubric. In the second part, students carried out their own examples and activities as practice in applying the concepts explained. This part was tutored, and consisted of the production and delivery of several documents, which finally made up the activity that each course participant had to prepare to put into practice with their students. The third part was a final session in which the participants presented their work.

Once the concept of abstraction has been explained, a tool has been provided to participants in order to evaluate the level of acquisition of this skill by their students through the tasks proposed to them. For this purpose, the rubric shown in Table 1 has been proposed in the course. It is a simple and quick method for assessment, and at the same time, it can be applied in various fields, without being anchored to the specifics of the subject or problem.

Table 1. Abstraction assessment rubric

Poor (0)	Student does not identify any of the main objectives or ideas of the problem to be solved. Student does not eliminate any of the unnecessary details of the problem to be solved.
Not-enough (1)	Student does not identify any of the main objectives or ideas of the problem to be solved. Student eliminates some of the unnecessary details of the problem to be solved.
Fair (2)	Student identifies some of the main objectives or ideas of the problem to be solved. Student eliminates some of the unnecessary details of the problem to be solved.
Advanced (3)	Student identifies the main objectives or ideas of the problem to be solved. Student eliminates all the unnecessary details of the problem to be solved.
Excellent (4)	Student identifies the main objectives or ideas of the problem, and expresses them correctly. Student eliminates all the unnecessary details of the problem to be solved.

The levels of acquisition of abstraction will be determined by the percentage of objectives and main ideas of the problem that are identified, as well as the percentage of unnecessary details that are removed. Remember, as McGregor (2006) says, that abstraction removes details from a view of the system but not from the system. This implies that details are virtually eliminated to get to that main idea, but then they have to be worked with to solve the problem.

Assessment and discussion

Information was collected from the participants (pre-university teachers) at the beginning of the course through a survey divided into three sections: information about the participant, whether they had knowledge of CT prior to the course, and the motivation for participating in the course.

With regard to the most descriptive part, 64.5% of the teaching staff who took part in the courses were women, and the majority of them taught mainly in Secondary Education and High School (95%), while the rest taught or had taught in Vocational Training or Primary Education.

With regard to the subjects taught by the participants in their centres, practically all subjects taught in Secondary and High School are covered, as can be seen in Table 2.

Table 2: Subjects taught by participants

Mathematics	Biology	Spanish language	Basque language
Physics /Chemistry	Applied Anatomy	Entrepreneurship	English language
Informatics	Earth Sciences	Economics	ICT
Technology	Contemporary World Sciences	Scientific Culture	Social Sciences
Plastic	Geology	Ethics	

As it can be seen, there are subjects corresponding to all fields of education, from the most technological to those corresponding to the Humanities. This is important, as Computational Thinking, and particularly abstraction skill, can be a cross-curricular for any area, although it obviously has a greater direct application in STEM fields.

At the beginning of the course, all teachers expressed their lack of knowledge about CT. Most of the participants asked before the course what Computational Thinking was. A question that was also common before the start of the course was whether CT was exclusively aimed at programming topics.

As for the main reasons for attending the course, they were as follows:

- Use of new ways of teaching in order to attract students' attention.

- The need for teachers and their teaching methods to adapt to the near future.

- Providing students with cross-curricular competences, which are of interest for both their personal and professional life.

- Encourage students to understand computer programmes, for example, Scratch.

At the end of the courses, participants have to fill in a final evaluation survey with a 5-point Likert scale, where the scores are “1 = Strongly disagree” and “5 = Strongly agree”.

Table 3 shows the questions as well as the descriptive statistics: mean, standard deviation, skewness coefficient and kurtosis.

It can be seen that all the questions are rated above 3 (in fact, almost all above 4), and that they are asymmetrical distributions with the left tail of the distribution longer than the right as all the asymmetry coefficients are negative. Statistics indicate a good assessment by the participants, who, it should be remembered, had started with a null or almost null level of CT.

Positive kurtosis coefficients indicate that the corresponding distributions have higher skewness than the Normal distribution; conversely, negative skewness coefficients indicate that the corresponding distributions are flatter than the Normal distribution. A distribution with a positive kurtosis value indicates that the distribution has heavier tails than the normal distribution, and in the case of the question “The given material has helped me to develop the course”, the kurtosis value is higher than 3.5. This item also has the highest mean. This leads us to think that the examples given during the course, in addition to the rest of the material, are successful in introducing CT to teachers who did not know what it was and in any field of education.

Table 3: Descriptive statistics for the final assessment questions

	Mean	Std. Dev.	Skew.	Kurt.
The face-to-face classes have been necessary to understand CT.	4,26	,999	-1,634	2,854
The activities presented in the classes have been adequate for the purpose of the course.	4,00	1,095	-,976	,408
The activities explained have had the appropriate level.	4,10	1,106	-1,150	,696
The given material has helped me to develop the course.	4,29	,938	-1,673	3,645
Planning online activities has helped me understand CT.	4,16	,934	-,865	-,138
The estimated time to make the deliveries has been adequate.	4,10	1,044	-1,331	1,595
The feedback received has been helpful in solving the doubts.	3,87	1,258	-1,030	,016
The course has met my expectations.	3,84	1,214	-,627	-,740

Finally, the assignments submitted by the course participants were also evaluated. These assignments, designed and developed by the course participants themselves, presented activities to be carried out in their primary and secondary classes to strengthen the concepts and skills related to Computational Thinking. The objective is, on the one hand, to practice and carry out the inclusion of CT in their classrooms, and on the other hand, to measure the understanding and progress of the participants.

The evaluation was carried out by means of two grades:

- Participation grade.

- Progress grade.

The participation grade indicates in some way the participant's interest in learning the concepts presented throughout the course, valuing the questions and answers in discussion forums, the response to small follow-up tests, and the “participation” itself with the delivery of the work requested throughout the course.

The progress grade values the quality of the assignments that they, the participants, present as activities of the course and the final work that they present, in which they put into practice all the knowledge acquired throughout the course, designing exercises or tasks to be implemented in their classrooms in order to apply concepts like Abstraction. The correction of these works made by the participants themselves based on the feedback provided by the course teachers is also taken into account.

If we compare the grades obtained by the participants by intervals (Fig. 1), we see this difference between the participation grade and the progress grade. The implementation of concepts such as abstraction in the tasks of the subjects, in the day-to-day life of the schools, is a complicated aspect that is helped by the feedback provided during the course.

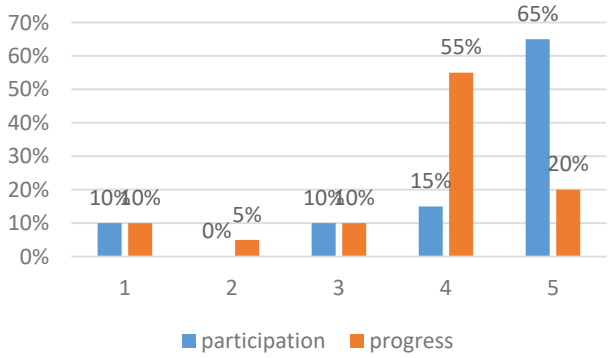

Fig. 1. Comparison of participation and progress grades by intervals.

Conclusion

Training in Computational Thinking, in general, and in the concept of Abstraction, in particular, is a current challenge in the educational systems of many countries. This training at the student level must begin in pre-university education, and to this end, Primary and Secondary school teachers must be trained to be able to apply and implement these concepts in their classes.

According to the teachers participating in the course, which has been running for three years, Abstraction is one of the most difficult Computational Thinking skills to understand without training support. However, after the training, it is possible to transfer it to pre-university classes. Moreover, this translation can be carried out in any field of Education.

It is important to highlight the heterogeneity of the teachers who want to train in Computational Thinking, coming from subjects as disparate in the education system as Computer Science and Art. In our opinion, this shows, on the one hand, the cross-cutting component of CT and its validity, and on the other, its interest for pre-university teachers. Thus, CT should be a cross-curricular competence throughout the whole education system.

Finally, we cannot forget the evaluative part, without which any educational process would not be complete. A rubric has been proposed to measure abstraction in the exercises that a teacher has to assess. This rubric is general, as it is the concept of Abstraction, and can be applied to any type of exercise. But like Abstraction itself, which has different nuances depending on where it is applied, the rubric needs to be “adapted”, as shown in the previous sections, to the exercises to be assessed.

Acknowledgement

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META-ANALYSIS OF SUSTAINABILITY MANAGEMENT IN COMPLEX DEVELOPMENT ENVIRONMENTS: BY INTEGRATING SUSTAINABILITY REQUIREMENTS INTO SYSTEMS ENGINEERING APPROACHES

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Abstract

Purpose – The complexity of developing product service systems continues to increase. At the same time, development cycles are becoming ever shorter and the requirements for safety, conformity and sustainability ever higher. In this article, a meta-analysis is carried out on the possibility of integrating sustainability aspects as requirements in a systems engineering approach and the differences are discussed.

Methodology/approach *- A systematic literature search of articles in* ScienceDirect *between 2016 and 2023 is carried out. The keywords are sustainability and system engineering incl. synonyms. In a further step, the papers are screened for their relevance to* product service systems and the relevance for the purpose*.*

Findings – To address sustainability in complex technical systems, a holistic, model-based approach is required to ensure that sustainability aspects are considered. By using frameworks and methods such as macPro² and SysLM, requirements and indicators for sustainability can be integrated into the development phase, whereas currently only the environmental dimension is usually considered via resource and energy indicators.

Research limitations/implications *– In order to achieve a complete picture, additional databases must be considered and research results from ongoing projects must be awaited.*

Key words: *sustainability**,** Systems engineering*

Introduction

Digitization, sustainability, and customization have already transformed every aspect of product and service development, leading to increasingly complex product service systems (PSS) and significant implications throughout their entire life cycle. Development cycles are getting shorter, and the requirements for safety and regulations are increasing. The product development process is becoming more complex, making a holistic approach and new control methods essential.

Sustainability (Hauff, 2014) and PSS (Kern et al., 2009) should be considered as a system. This leads to the assumption that a system theory-based approach is an appropriate solution for dealing with complexity (Schlüter, 2023).

This leads to the research question for this paper, if sustainability aspects can be integrated as a requirement in a systems engineering approach.

When considering the management of complexities and relationships in economic systems, the "Tableau Economique" is primarily regarded the enabler for input-output analysis (Söllner, 2021: 53). However, a scientific definition of "system" and "engineered systems" can often be

traced back to the concepts of (Bertalanffy and Sutherland, 1974; Bertalanffy, 1950: 23–29) and is ultimately defined by INCOSE (2019) and ISO/IEC/IEEE 15288 (2023): "A system is an arrangement of parts or elements that together exhibit behavior or meaning that the individual constituents do not." A system can be viewed both as a product and in terms of the services it provides. Furthermore, "System of Systems" (SoS), as defined by INCOSE (International Council on Systems Engineering), refers to a complex series of systems that are interconnected and interdependent, each of which can operate independently but work together to achieve a higher purpose.

Sustainability is based on the concept of three pillars: ecology, economy and social (Hauff, 2014) or people, planet and profit (Sanders and Wood, 2020). Many definitions are derived from this. For example, Landrum and Edwards (2009) says that in the business environment, all current and future stakeholders act in a way that ensures the long-term existence of the company and the social, economic and ecological systems associated with it. Brandstotter et al. (2003) even includes the sustainability in his definition of PSS, with the addition of "PSS ties to reach the goals of a sustainable development, which means improved economic, environmental and social aspects”. Thus, PSS can serve as an approach to decouple value creation from increased resource consumption (Vezzoli et al., 2014; Kjaer et al., 2019), to combining economic growth and sustainability (Reim, Parida, and Örtqvist, 2015; Tukker, 2004). Goedkoop et al. (1999) have already defined PSS as an aggregation of products and services to deliver value propositions to customers. Used synonyms are "product service bundle", "hybrid service bundle" as well as “hybrid value creation" (Meier, H., Uhlmann, E., Kortmann, D). Meier et al. (2011) even includes PSS in the industrial area as a package of product and service components to provide a solution-oriented and value-added approach across the lifecycle.

The INCOSE Systems Engineering Handbook offers a comprehensive insight into the methodology as well as the available standards and guidelines (Walden, 2023:). However, the aspect of sustainability is only marginally considered. Sustainability engineering is defined in 3.1.10. as an approach that supports the circular economy over its entire life cycle by using the concept of design for sustainability, with environmental and social aspects as key elements: The consideration is not continuous, but rather is highlighted selectively, e.g. only for the application area of "power and energy systems". With regard to the creation of requirements, the manual refers to the technical processes according to ISO/IEC/IEEE 15288:2023: This specifies at 6.4.2.1: "The purpose of the stakeholder needs and requirements definition process is to define the stakeholder needs and requirements for a system that can provide the capabilities needed by users and other stakeholders in a defined environment".

Systemic literature research

A systemic literature research is considered a suitable method for answering the research question, which according to Zawacki-Richter et al. (2020) and Nordhausenet al. (2020), consists of the following steps: ´development of the research question´, ´ design conceptual framework ´, ´ in- and exclusion criteria´, ´define databases´, ´identification of search terms and synonymous´, ´identification of key words´, ´development and verification of search strings´ and ´conduct research´.

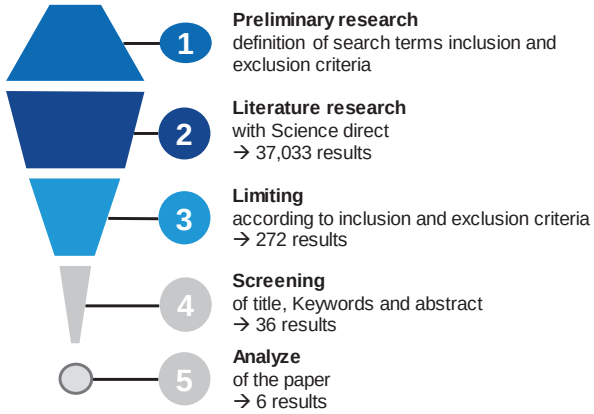

Figure 1: Process of the systematic literature review with results per stage

A preliminary database-unspecific research, showed initiatives such as a special issue “Systems Engineering for Sustainable Development Goals“ of the journal “Sustainability” or the research project “SLE - Sustainable Lifecycle Engineering” started in the end of 2023 to include the dimension of sustainability in MBSE methods (no publications yet), or the publication by Schneider et al. (2023).

To refer to the most recent findings, only publications after the year 2016 are considered, as the "Systems Engineering Handbook V4.0" was published in 2015, and the latest version was released in 2023, along with the most recent version of the "Guide to the Systems Engineering Body of Knowledge" (SEBoK Editorial Board, 2023).

Initial criteria:

- time: 2016 onwards
- language: English
- search string: (sustainable OR impact OR sustainability) AND ("systems engineering" OR "MBSE" OR "model-based systems engineering" OR "advanced systems engineering" OR “requirement engineering”

Limiting criteria:

- peer reviewed and accessible
- subject areas: engineering & environmental science
- Keywords in title: sustainable, impact, sustainability

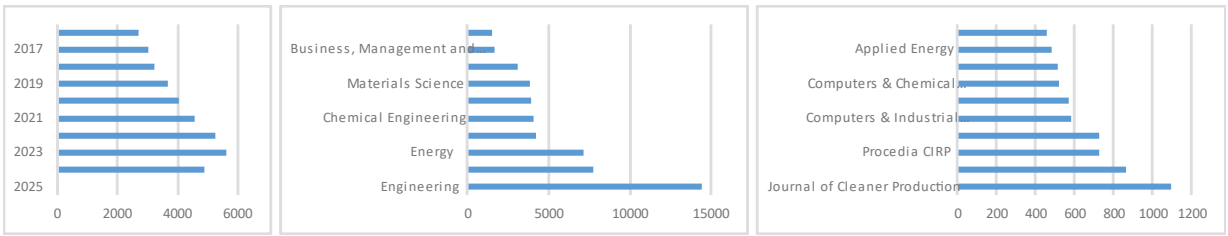

Figure 2: Results of the first literature research (y-axis) by year on the left, by subject area in the middle and by journal on the right (x-axis)

Due to the focus on peer reviewed journal publications ScienceDirect by Elsevier as databases is used. The focus is on journal publications to ensure the quality, but without taking the journal ranking in account. As seen in Figure 2, the initial search produced 37,033 results, which could be limited to 272 by taking the limiting criteria in account. By screening the titles, abstracts and keywords, if the content fits to the problem, they could be limited to 36.

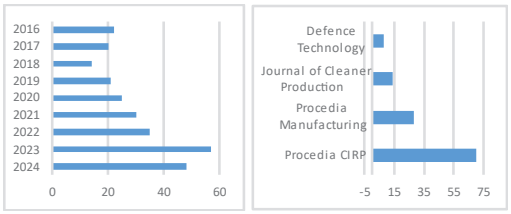

Figure 3: Results of the literature research by *applying limiting criteria* (y-axis) by year on the left and by journal on the right (x-axis)

By reading the papers they could be reduced to 25, which addressed at least two of the following topics and synonyms: systems engineering, sustainable indicators and PSS.
Only six addressed all three topics:

- Bougain and Gerhard (2017)
- Eigner et al. (2017)
- Forte et al. (2022)
- Jaghbeer et al. (2017)
- Mamrot et al. (2016)
- Stürmlinger et al. (2020)

Comparison of the selected papers

The comparison of the papers does not cover fundamental topics such as the Internet of Things and digital twin, but instead focuses on the applied methods. An explanation of the methods cannot be provided here, and reference must be made to the respective publications. However, it can already be deduced from the titles that the lifecycle approach plays a central role and will be compared first before going on to discuss the other methods.

Forte et al. (2022) even writes that the complexity cannot be managed in the in development phase, but that ways must be found to make this possible over the life cycle. Bougain and Gerhard (2017) state that sustainability aspects are not part of MBSE and integrate indicators into four life cycle phases to facilitate eco-design methods. Forte et al. (2022) uses the System of System Lifecycle Concept (Forte, Göbel, and Dickopf, 2021) to enable traceability beyond the actual system boundaries. Eigner et al. (2017) and Mamrot et al. (2016) also rely on data from downstream lifecycle phases to influence product development.

The differences can be found in the applied methodology. macPro² (Eigner, Koch, and Muggeo, 2017), a model based design approach for developing cybertronic systems is mentioned by *Eigner et al. (2017), Stürmlinger et al. (2020) and Bougain and Gerhard (2017)*. *Eigner et al. (2017)* uses SysLM as a basis to support eco-design methods in order to provide data from the subsequent life cycle phases for product development (Eigner, Hauff, and Schäfer, 2011; Eigner, Schäfer, and Apostolov, 2013). *Bougain and Gerhard (2017)* refer to an earlier phase of the lifecycle and develop an abstracted requirements diagram for MBSE to integrate indicators for energy consumption. *Forte et al. (2022)* uses specific SoS KPI management with sustainable requirements for energy and resources to enable reconfiguration. *Mamrot et al. (2016)* employ the "Demand Compliant Design" (Schlund and Winzer, 2009) for the representation of complex socio-technical systems. This approach integrates systems engineering with sensor data and service reports from the usage phase, facilitating the development of these systems.

Stürmlinger et al. (2020) highlights the impact of product changes on the production phase, introducing a new perspective. The underlying methods are MacPro² and Consensus. Despite the focus on simulation-based modelling, the elaboration by *Jaghbeer et al. (2017)* presents valuable approaches for system modelling.

Discussion

The differences in approaches can be attributed to the varying application cases and the associated subjects of investigation. Eigner et al. (2017) use an autonomous excavator as a case study to demonstrate the integration of sustainability aspects, while Forte et al. (2022) examine a scenario of an autonomous construction site to showcase the application of IoT-based reconfiguration approaches. Bougain and Gerhard (2017) use a 3D printer, Stürmlinger et al. (2020) a valve, and Mamrot et al. (2016) a hydraulic pump.

Additionally, the mentioned technological approaches, such as the use of IoT, digital twins, or model-based systems as the basis for implementing the method, influence the results. For example, Forte et al. (2022) IoT-based approach enables real-time monitoring and adjustment of systems, leading to different outcomes than Bougain and Gerhard's (2017) model-based approach, which focuses on the modeling of environmental aspects.

There is a paradox between the focus on the use phase and the associated reactive product changes and the increasing costs of change over the course of the life cycle. This may be due to the fact that the approaches presented are designed bottom-up and take the product or production as a basis to derive sustainability indicators, especially in the energy and resource sector, while there are isolated approaches such as *Jaghbeer et al. (2017),* which pursue a top-down approach, as in (Zhao et al., 2015) und (Lee, Kang, and Noh, 2014), which use higher-level frameworks (e.g. GRI) to derive sustainability indicators. The focus is usually on the environment, sometimes also on the economy, but only rarely on social issues *(Jaghbeer et al., 2017).*

The temporal distribution of the papers is worth mentioning; one is from 2016, three from 2017, two from 2020 and one from 2022. This contradicts the distribution of all papers.

Conclusion and outlook

Sustainability has so far only been dealt with marginally in systems engineering. All authors emphasize the need for holistic, model-based approaches to incorporate sustainability into complex technical systems to ensure that environmental aspects are considered throughout a product's life cycle. By using frameworks and methods such as Macpro² or SysLM, sustainability requirements and indicators can be integrated into the development phase, whereby currently only the environmental dimension is usually considered via resources and energy indicators over the use phase to facilitating the development. In this context, it must be determined whether integration is feasible at an early stage and which indicators can be used in this context. Further research is needed to investigate the extent to which indicators are sector and case dependent and how higher-level indicators can be captured by existing sustainability indicator frameworks and translated into requirements diagrams for MBSE.

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ASSESSMENT OF THE IMPROVEMENT OF THE MANAGEMENT OF THE PENITENTIARY SYSTEM IN ROMANIA AS A RESULT OF THE COVID-19 PANDEMIC

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Abstract

Purpose *– The main objective of this paper is to assess the progress made within a state institution in the field of national defence and security in Romania in a crisis situation, such as the COVID-19 pandemic.*

Methodology/approach *- We have used a secondary analysis as the main research method to obtain the essential information about the impact of the COVID-19 pandemic on the institution, collecting both quantitative and qualitative data. Additionally, participatory observation helped us extract the most relevant elements from the pandemic period, based on which we have conducted a series of analyses.*

Findings *– The results obtained highlight the causal relationship between the efficiency of the managerial system of the prison system in Romania and the digitization of the institution, as a response to the crisis situation generated by the COVID-19 pandemic.*

Research limitations/implications *– The main limitations are related to the method of data collection, the information obtained from document analysis, most of which are public documents, which may be scarce or may be presented in a favourable light for the institution.*

Originality/value - *The originality of the work is outlined in researching the managerial mechanisms applied in Romanian prisons during the pandemic period and how these have been sustained over time.*

Practical implications *– The implications consist in conducting a comparative analysis of managerial practices, before and after the COVID-19 pandemic.*

Key words: *management, penitentiary system, pandemic*

Introduction

This paper explores the impact of the COVID-19 pandemic on the evolution of the prison system in Romania. To obtain conclusive results, the study considered the period from 2019 to 2023, mainly analysing the annual reports of the National Administration of Penitentiaries. The COVID-19 pandemic period brought a series of challenges for organizations globally. Thus, organizations everywhere have had to rethink their management strategies and adapt to the crisis situation that had emerged (Marcelo F. Aebi and Mélanie M. Tiago, 2020).

If we talk about management practiced in public institutions in Romania, we can also discuss its rigidity, generated by the applicable legislative norms, especially since the institution in

question manages a sensitive segment of the population (Alina-Elena Ionașcu (Huluba), 2021). As a result, the pandemic period was difficult to control in the prison administration system, a closed, overcrowded system where social distancing can rarely be maintained, with an increased risk of airborne transmission of the virus. Consequently, legislative interventions were needed to facilitate the implementation of prevention and control measures against SARS-CoV-2 infection, adapted to the specific nature of the prison system in Romania and the existing situations in detention facilities (Ștefan and Grecu, 2020).

The pandemic has highlighted the existing weaknesses in the Romanian prison system and emphasised the need for reforms to improve conditions in prisons, access to medical care, and reintegration programs, by developing a prison system that ensures respect for the fundamental rights of incarcerated individuals and facilitates their reintegration into society after release. Among the vulnerabilities that have emerged during the reference period, the most important ones have been related to overcrowding in detention facilities (Ștefan and Grecu, 2020) and the poor digitization of procedures, which are further addressed.

Prison overcrowding

Prison overcrowding played a crucial role in the rapid spread of the SARS-CoV-2 virus, laying the groundwork for an environment conducive to the amplification of infectious diseases. Being a relatively closed-circuit structure, the COVID-19 pandemic was treated as a major challenge by the managerial system from the onset of the first cases in Europe, when only a few prison administrations were not affected by COVID-19 infections: 15 institutions reported infections among both staff and inmates, while 14 reported infections only among staff (Marcelo F. Aebi and Mélanie M. Tiago, 2020). Thus, the existing risk factors that can amplify and spread infectious diseases in the carceral environment are outlined, such as: penitentiary mobility, pre-existing conditions among incarcerated individuals, and complex security procedures.

Figure 1 presents the evolution of prison population in Romania within the interval 20219-2023 (pre Covid-19 and post-Covid 19), which shows a gradual increase from 20 578 to 23 360 persons, recording a total increase of 13.5%.

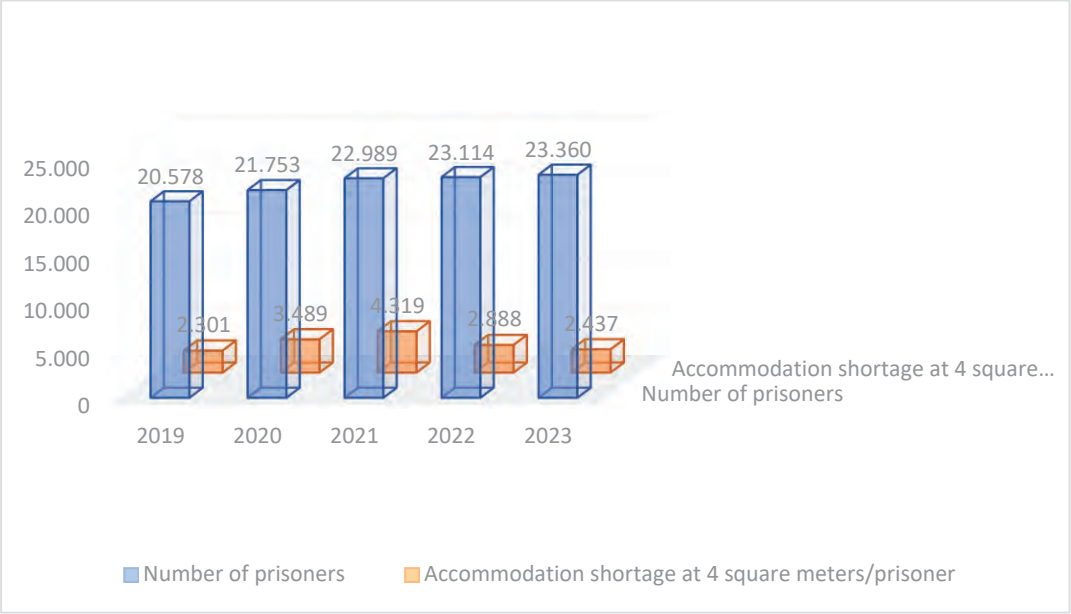

Fig.1 The evolution of the prison population in Romania
Source: (ANP, 2020), (ANP, 2021), (ANP, 2022).

To prevent detention spaces from becoming infection hotspots, a series of prevention and emergency intervention measures were taken to delay the entry of the coronavirus into the carceral environment as much as possible. Thus, the first confirmed case of coronavirus among incarcerated individuals appeared on September 24, 2020, approximately 7 months after the confirmation of the first case in Romania, on February 26, 2020, and approximately 5 months after the first cases appeared among employees (Adrian Streinu-Cercel et al, 2020).

Taking into account that investments in infrastructure are costly and long-term, it was necessary to identify quick solutions. The health security measures aimed to:

- establishing quarantine sections in the six healthcare units of the penitentiary administration;
- efficiently managing the held spaces to control inmates with a high degree of vulnerability;
- conducting epidemiological screening;
- establishing a technical-medical support group to monitor the implementation of the action plan;
- increasing the budget for the purchase of necessary equipment for prevention and infection control;
- legislative adaptation regarding the increase in staff (without competition, for a specified period) in crisis situations;
- digitization of procedures (Ștefan and Grecu, 2020).

From our point of view, the most sensitive areas, in terms of the necessity of interpersonal relationships, affected by the COVID-19 pandemic, were represented by the Social Reintegration Department and the Human Resources Management Department, both having a major impact on the optimal conduct of activities.

The existing epidemiological context at the international level posed a particular challenge in terms of the need to implement alternative communication methods both within the system, referring here to communication between units and communication with the management team at the central headquarters, and between incarcerated individuals and their families. The solution identified to reduce the risks caused by social interactions comes from the digital sphere and is represented by moving physical interactions into the digital sphere through specialized applications such as Zoom, Microsoft Teams, Cisco Webex Meetings, Skype. (ANP, 2020).

On the human resources management front, to supplement staff for efficient crisis management, a total of 115 positions were filled without competition for a duration of six months in key sectors: medical and operational, across 33 units. The process resulted in the filling of 67 positions out of a total of 976 candidates, including 48 in the medical sector and 19 in the operational sector. Also, aiming to intensify efforts to ensure the necessary personnel, at the end of 2020, 1413 vacant positions were opened for competition from external sources, along with 185 from internal sources. This culminated in 1925 recruitments in 2021 (considering the positions opened for competition in 2021). Among all these newly recruited prison officers from external sources, numerous were rookies, and in 2022, for the first time, initiation courses or training courses were organized for 1086 prison officers, online or in a hybrid system (ANP, 2020), (ANP, 2021), (ANP, 2022).

It is important to mention that the trends have persisted, and although the number of annual recruitments is decreasing, courses have continued in an online/hybrid format, given their effectiveness. Practice has shown that conducting initiation courses online/hybrid facilitates the integration of prison officers into their work and team, creates an emergency lever for interventions in case of force majeure, and even though courses are no longer held in person, much more emphasis is placed on the practical aspects of the activities.

From the perspective of the social reintegration sector, technology comes precisely to support the main goal of the National Administration of Penitentiaries, which is to involve incarcerated individuals in activities in the field of psychosocial assistance, education, training, and employment to spend as little time as possible in detention rooms, given European recommendations, which foresee a number of 8 hours per day for reintegration activities (ANP, 2021). Ultimately, the aim is to reduce the rate of recidivism.

According to Article 41 of the Penal Code, there is recidivism when, after the finality of a conviction decision to a prison sentence exceeding one year or life imprisonment until rehabilitation or the expiration of the rehabilitation term, the convicted person commits another intentional or exceeded intention offense, for which the law provides a prison sentence of one year or more or life imprisonment (Ministry of Justice apud Penal Code, 2023).

Although integrating technology into social reintegration activities has been quite challenging, we can observe a downward trend in the recidivism rate in recent years, from t0 (the pandemic year, 2020) to the present (see figure 2). This indicates how, out of the necessity to adapt to crisis situations, the management system has contributed to reducing the recidivism rate through the digitization of this atypical environment.

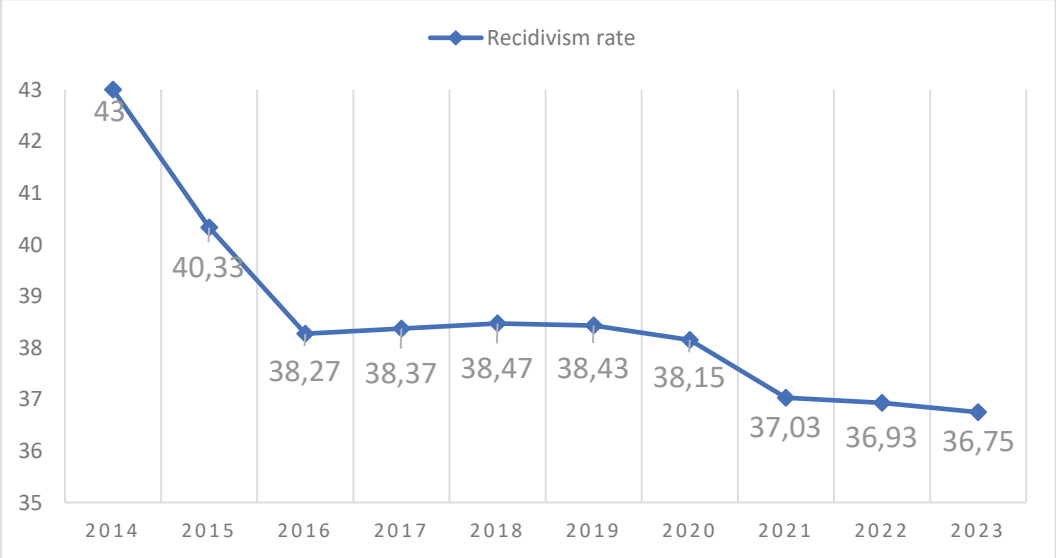

Fig.2 Recidivism rate in Romania
Source: (ANP, 2020), (ANP, 2021), (ANP, 2022).

To compensate for the limitation of activities of the Social Reintegration Directorate during the state of emergency, socio-educational activities for incarcerated individuals involved the creation and broadcast, using the radio-TV studios within the penitentiary units, of their own programs. These programs served an educational, informative, and moral-religious role, replacing the classic occupations from which the inmates were deprived. They contributed to maintaining the reintegration programs for the prison population in Romania and implementing the strategic objectives outlined in the National Strategy for the Social Reintegration of Persons Deprived of Liberty, approved by Government Decision no. 430/2020 (ANP, 2020).

The technologization of interactions within prisons

During the state of emergency, due to the suspension of visitations, maintaining the connection of inmates with family members, relatives, or other persons was ensured through phone calls and online communications. In this regard, the duration and number of phone calls were increased, and the number of online communications allowed for inmates was supplemented, regardless of disciplinary status and frequency of family contact, corresponding to the number of visits they were entitled to, depending on the execution regime or category they belonged to. Through appropriate institutional measures, a reduction in the rates for phone calls made by inmates was achieved, but only during the state of emergency (ANP reports, 2020).

Video conferences for inmates have become an important means of communication during the pandemic, when personal visits were restricted or suspended in many prisons around the world. In Romania, as well as in other countries, these video conferences were used to allow inmates to maintain contact with their families and to communicate with lawyers or other relevant individuals (Marcelo F. Aebi and Mélanie M. Tiago, 2020). They have become a valuable resource in prisons to facilitate communication and access to essential services during the pandemic. However, it is important to find a balance between the use of technology and ensuring a humane and fair approach to the treatment of inmates.

Given the increase in the number of hearings via video conference due to requests from the courts, the 47 terminals dedicated to video conferencing for the hearing of inmates became insufficient. As a solution, an additional 86 access accounts for the video conferencing system belonging to the Special Telecommunications Service were provided, using the "Polycom RealPresence Desktop" application, which allows the enrollment of computers as video conferencing terminals for inmate hearings. Figure 3 shows a significant increase in 2020 compared to 2019, when only 1,484 hearings were conducted via video conference with the courts (ANP reports, 2020).

The causal relationship between the changes made during the pandemic period and the reduction in the recidivism rate is direct, from our point of view, and highlights the increased efficiency of penitentiary system procedures.

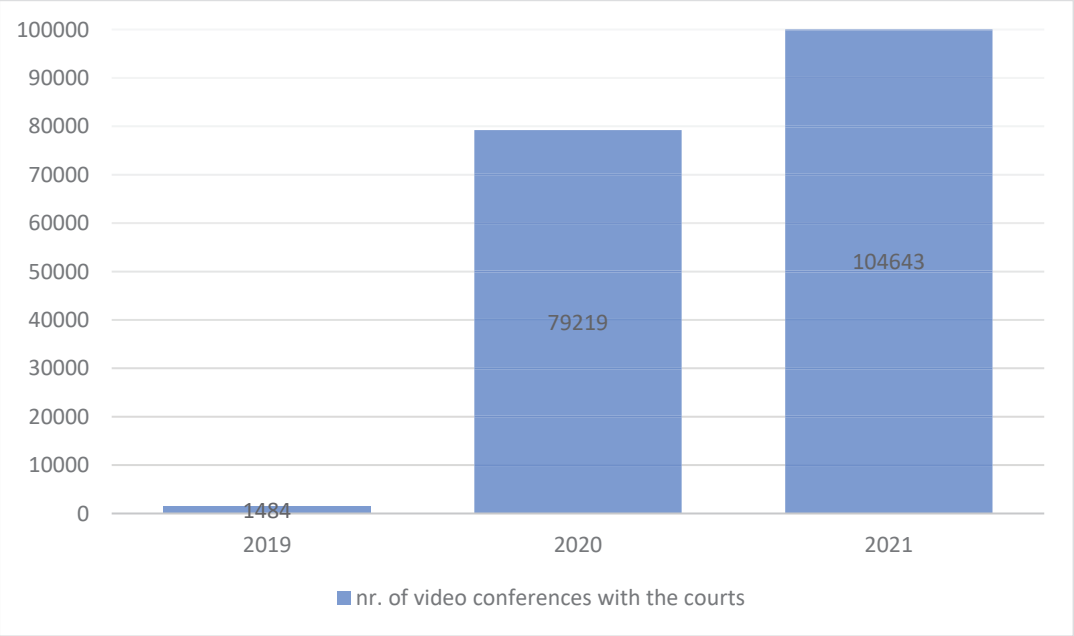

Fig.3 The evolution of the video conferences in Romania
Source: (ANP, 2020), (ANP, 2021), (ANP, 2022).

Conclusions

The paper aimed to highlight the progress made within the penitentiary system, driven by the pandemic situation. Thus, the paper contributes to identifying the approaches and management methods that can ensure institutional evolution at the level of the National Administration of Penitentiaries. Additionally, the study can facilitate the improvement of the legislative system in Romania.

By engaging in this endeavour, we have observed the leap made by the penitentiary system in a short period of time from a conservative management style to an innovative type of management, given the measures taken and especially the technologization of procedures.

The limitations considered at the beginning of the research did not represent an impediment, given that the data taken from the activity reports were only statistical data. The analysis was conducted objectively and impartially, following the steps of a scientific research.

A new direction that can be explored in detail, building on this research, is the realization of a study at the European level, focusing on the comparative analysis of the practices of European Union member states and Romania, with the aim of identifying best practices that can be adopted within the Romanian penitentiary system.

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CHANGING ORGANIZATIONAL CULTURE IN SCHOOLS

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Abstract

Purpose *- Organizational culture is based on beliefs, values and behaviors considered appropriate by its members. This can cause employees to leave the organization or stimulate them to behave in a certain way. This paper aimes to analyze if and how the organizational culture in pre-university education institutions could be changed.*

Methodology/approach *- For comprehensive understanding of this concept, a literature review will be conducted based on various studies, books and specialist articles.*

Findings *- The study will focus on identifying factors influencing school organizational culture and presenting a model for change.*

Research limitations/implications *– The limitation of the present research derives from the complexity of the addressed topic. The present paper provides an overview of literature review, however an interesting future research direction could be the analysis of school organizational cultures by school level. It would be equally useful to analyze and compare the organizational cultures in the rural environment with those in the urban environment.*

Practical implications *– This paper presents the factors that influence the culture of a pre-university educational institution and identifies a model of culture change in schools.*

Originality/value *– The originality of this work consists in following the process of changing the school organizational culture from the influencing factors to a concrete model of change.*

Key words: *organizational culture, pre-university educational institutions.*

Introduction

Whether we like it or not, we are all born into a certain culture, we develop and place ourselves in a certain cultural horizon, and we are all both creators and receivers of culture at the same time. Culture mirrors things and represents, at the same time, a frame through which the world is viewed. In depth, it reproduces the reality of those in social organizations, providing support, identity and creating a framework conducive to occupational learning. Each pre-university educational institution (school) presents a different reality or even a different mentality of school life, which is most often expressed as "the way we do things around here" [Deal and Peterson, 2016].

In specialized literature, there is no consensus regarding the definition of organizational culture. However, it emerges that the organizational culture represents an important subsystem of the institution and is a factor that dictates the organizational effectiveness and the level of

quality of the professional life of its members. Several approaches have led to correct but different definitions depending on the perspective.
Organizational culture is found in all organizations, without exception, regardless of their type. In schools, the concept of organizational culture is also very important.

A rather neglected concept has been that of improving organizational culture, Schein (1999) considered that the essence of organizational culture is "the deeper level of basic assumptions and beliefs that are shared by members of an organization, that operate unconsciously and that define the organization in a basic way “for granted"".

Influencing factors of organizational culture in schools

A school's culture is honed, over time, by history, context and people. The influencing factors in this sense are represented by:

1. History (school age) can influence cultural changes. Schein (1990) identified three important periods in the development of a business organization that can be transposed in schools. Thus, in the early years, the dominant values are those transmitted from the founders of the institution, the school explaining its culture, clarifying its values and building - and a unique identity that it proves among the newcomers: teachers, students, parents. Organizational culture is the connecting network on which development is supported. Around the middle of its age, the institution is fairly well integrated, but the process of growth and renewal is not completed . It is possible that, in external and internal contexts, there have been changes that have altered strengths and weaknesses. The defining aspects of culture are now integrated and taken for granted, making organizational culture increasingly implicit. Subcultures have also emerged that slow down the process of cultural awareness, so that change becomes more and more difficult. Stagnation/stability or decline are real challenges to the change process. This level is reached when the school no longer provides feedback to its environment. Dysfunctional elements emerge, but the school faces challenges launched by old assumptions. [Fink, 1999].

2. The external environment of the school organization also shapes its organizational culture. Each community formed by students, their parents present their own ideas about how a real school should be, ideas born from their own experience as students. This fact is very clear from the phrase " a real school is what I went to when I was a child " [Metz, 1991]. Different factors such as political, economic or legislative ones can also influence the organizational culture of a school. For example, education unions, as part of the institution's external environment, can influence a school's culture and/or influence the institution's focus on improvement.

3. Primary and secondary school cultures are different [Cooper, 1988]. In primary institutions the culture is influenced by care and control, hence the feeling of leaving the family when students leave primary school. The culture in the secondary school is characterized both by the size and structure of the departments, and by the academic orientation of the teachers - the difference between a science teacher and an art teacher, as well as the experience of students moving from one teacher to another and from one discipline to another.

4. The students of the institution and their social environment also influence the school culture. Thrupp believes that the social mix of the school is a determining factor in the way the institution functions, starting from the influence exerted by the interactions between the students. In principle, the students of the institution give it a special note, through the student culture. This aspect acquires an additional connotation when they reach the age of adolescence, when values and identities undergo changes. [Thrupp, 1997].

5. School culture is also provoked by social changes regardless of whether they are connected to learning, school population, management, technology or the repositioning of women in society [Dalin & Rolff, 1993]. The school must react quickly to these changes. Although culture can change as a result of changes in participants, it can also play a stabilizing role, especially for the long-lived parts of the culture. For this reason school organizational culture can seem immobile to those who follow rapid changes. Although it has both characteristics - dynamic and static - culture constantly evolves and reconstructs itself [Hopkins, Ainscow and West, 1994].

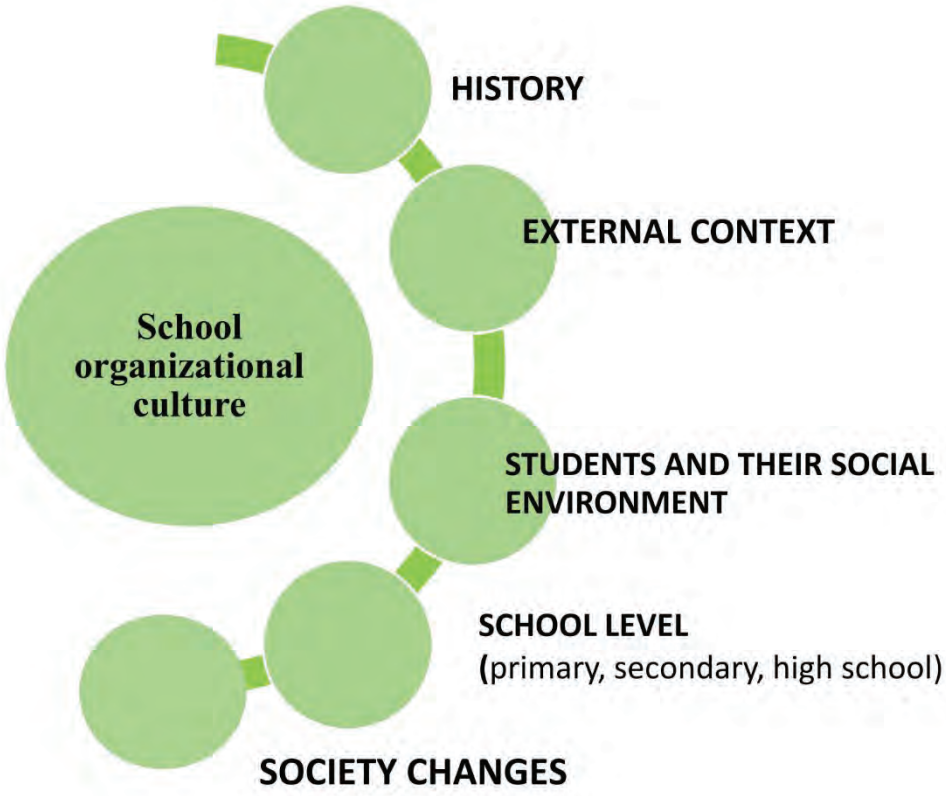

Figure 1. Influencing factors of school organizational culture, adaptation after (Hopkins, Ainscow, & West, 1994)

Changing an organizational culture generally means limited change or fundamental change. The specialist literature mentions three typologies of efforts for cultural change: revolutionary efforts aimed at deeply modifying the organizational culture; phased efforts that, through their entirety, desire a substantial reshaping of the culture; limited efforts aim changes at the level of subcultures or some components of the organizational culture.

Effective organizational culture change involves the following strategies: unfreezing the old culture and developing motivation for change; fruition of favorable moments-opportunities, changed situations or past deficiencies; establishing the clear objective of the change; maintaining continuity with the past; creating a safe psychological environment, formal and informal training of relevant teams, identifying and presenting positive role models, hiring staff, having support groups for overcoming losses or fears; creating behaviours, cultural forms, artefacts and establishing appropriate socialization tactics; promoting charismatic leaders; making a solid transition plan; the integration of the understanding and avoidance of risks and benefits in risk management, as well as the inequitable allocation of risks and/or benefits [Schein, 1999].

Structure and culture are interrelated concepts. Most efforts to improve the school are directed towards structural changes: time - for example dividing the school year into four-five periods delimited by short breaks; space- moving related departments such as science and mathematics to the same floor to encourage cooperation; roles and responsibilities - creating a change/school improvement manager position [Bush, T.G, 2014].

This aspect derives from the ease of manipulation of the structures. In order for them to make changes, more attention must be paid to the adjacent subculture. And culture can be influenced by structures. For example, if you want to increase the degree of collegiality between teachers, but the program does not allow them to meet during the day, there will be a barrier. Andy Hargreaves notes that teaching is expected to be an isolated act because "Structures of teacher isolation have their roots in schools that have been organized as egg crates since the mid-nineteenth century" [Hargreaves et al., 1996].

School improvement initiatives introduced by national decision-makers place great importance on so-called rational-empirical change strategies. These are based on the idea that schools are rational places and the people inside them adopt the proposed changes if they are shown to benefit them. From Clark and Guba's linear analysis a model of educational change emerges - "research, development and dissemination" (R, D+D) [Clark & Guba, 1965].

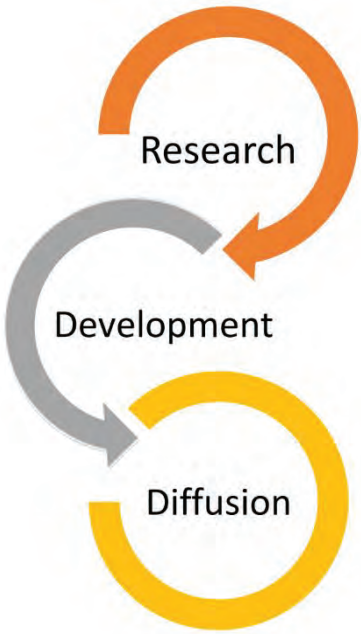

Figure 2. The model of the stages of educational change, adaptation after [Clark & Guba, 1965]

Schools strive to create positive culture and climate by training all members. The development of school culture is based on a set of beliefs, values and norms that are generally accepted and consciously implemented as a natural behavior that creates a bridge between school elements and stakeholders. Useful steps that the school can take to achieve a favorable culture - include the formulation of strategies, the analysis of the internal and external environment, the implementation of established strategies and monitoring or carrying out an evaluation.

In order to get a picture of the culture and climate existing in the school, the internal and external environments are analyzed. At the same time, the possibility of developing the necessary information technology is of increased relevance. SWOT analysis can be used in this

case. The vision, mission and objectives of the institution must incorporate the strategies and be understood by all stakeholders. Different behavioral habits generally derive from differences in understanding of the vision, mission or objectives. Their uniform understanding directs collective behavior toward the school's vision, mission, and goals [Cavanagh, R. F., & Dellar, G.B., 1998].

Implementation of the strategy is an activity that must be carried out by schools, related to the habit of achieving, communicating, interacting, and providing a healthy and pleasant school environment. Ensuring the school environment is linked to meeting school standards, as stipulated in the National Education Law. The buildings meet the health requirements, are properly ventilated and lit, are connected to water and sewage, have a rainwater distribution system and waste collection systems [Lubis, F. R., & Hanum, F. 2019].

Monitoring and evaluating activities can be done to determine the development of the existing system and the performance of each implementer to create an enabling school. Monitoring can be done throughout the year, while evaluations can be done monthly, semestrial, and yearly, at the end [Bower, R. J., & Scheerens, J. 1994].

Considering the previous explanation, it can be said that the learning outcomes of the students and the quality of the school depends on the organizational culture and the school climate. The latter can benefit the principals, teachers, administrative staff and students. The principal can easily manage the school, teachers easily do their work, students feel valued, safe, and parents feel accepted and involved in school activities. These are major benefits that support school success [Gruenert & Whitaker, 2015].

Discussion and conclusions

Educational institutions and different categories of organizations must focus on building and sustaining organizational cultures.

School improvement initiatives introduced by national decision-makers and beyond place great importance on so-called rational-empirical change strategies. These are based on the idea that schools are rational places and the people inside them adopt the proposed changes if they are shown to to benefit them.

Just as no one person is identical to another, the organizational culture in one institution cannot be the same as another.

The public sector has mainly practiced a hierarchical culture based on rules, procedures, and stability over time, but to increase efficiency it should borrow more from the entrepreneurial organizational culture.

Limitations and future research directions

Pre-university education institutions differ from each other from several perspectives. In addition to the children's level (age) (preschool, primary, secondary, high school, professional), differences can be mentioned even between institutions at the same level. For example, a rural school is very different from an urban school. Likewise, a theoretical high school differs fundamentally from a technological one.

Beyond these aspects related to students, human resources play an essential role in creating or changing the organizational culture in schools. However, each person is unique, and hence the uniqueness of each collective in schools.

This paper provides an overview but is not specific in any way. An interesting future research direction could be the analysis of school organizational cultures by school level. It would be equally useful to analyze and compare the organizational cultures in the rural environment with those in the urban environment.

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STRATEGIZING OPEN INNOVATION: KEY APPROACHES FOR MODERN ENTERPRISES

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Abstract

Purpose – This paper investigates and evaluates various open innovation strategies that contemporary businesses can use to strengthen their competitive position. It examines key approaches such as co-creation, crowdsourcing, intellectual property sharing, hackathons, and open-source development.

Methodology/approach – The methodology combines a comprehensive literature review with case studies of leading companies that have successfully implemented these strategies. This approach provides insights into the practical application and benefits of open innovation strategies.

Findings – The findings reveal that open innovation enables firms to leverage external ideas and technologies, resulting in accelerated innovation, reduced costs, and increased adaptability in dynamic markets. The research highlights the importance of integrating these strategies to build a robust innovation ecosystem.

Research limitations/implications – The study is limited by its reliance on secondary data and case studies, which may not capture the full spectrum of open innovation practices across different industries. Future research should involve empirical studies to validate these findings and explore the challenges enterprises face in implementing open innovation.

Practical implications – Businesses should adopt a strategic approach to open innovation, fostering collaboration both within and outside the organization to drive continuous improvement and growth.

Originality/value – This paper demonstrates that open innovation strategies are interconnected and can create a synergetic effect that amplifies their individual benefits.

Key words: *open innovation, co-creation, crowdsourcing.*

Introduction

In recent years, open innovation has gained increasing popularity as enterprises seek to gain a competitive edge, constantly revolutionizing the way companies approach research and development. Unlike closed innovation, which relies solely on internal resources and ideas, open innovation embraces external contributions, facilitating a more dynamic and diverse approach to problem-solving.

Open innovation is variously described as a process, as a set of relationships between companies or as a cognitive paradigm. This paradigm gained popularity with the release of Henry Chesbrough's book "Open Innovation: The New Imperative" in 2003, where Chesbrough stated that companies "can and should use both internal and external ideas, and paths to market, as they look to advance their technology" (Chesbrough, 2003). Therefore, open innovation involves organizations working together and collaborating, sharing ideas, experiences, and technologies to generate value that could not be achieved if the work would be conducted in isolation.

An important aspect is that strategies such as crowdsourcing, hackathons, and co-creation are at the forefront of this paradigm shift, enabling companies to accelerate innovation, reduce costs, and enhance their adaptability in rapidly changing markets. Thus, the research conducted based on extensive literature review, aims to define practical implications of the open innovation strategies adopted in time. The main objective is to present the existing open innovation strategies and to highlight how those strategies are implemented within organizational setting.

Open innovation strategies

Co-creation

Open innovation emphasizes active collaboration between various organizations and the sharing of intellectual property, while co-creation specifically focuses on the relationship between an organization and a defined group of stakeholders, most commonly customers. One of the most well-known definitions of this concept describes co-creation as "an active, creative, and social process based on collaboration between producers and users, initiated by the firm to generate value for customers" (Prahalad and Ramaswamy, 2000). This definition highlights the fact that co-creation involves more than just collaboration with end-users, requiring an exchange of knowledge and resources to deliver personalized experiences.

Co-creation is included in the open innovation strategies as it involves consumers directly in organizational processes, therefore generating value. Prahalad and Ramaswamy (2000) point out that co-creation is used to define a new category of consumers, the "active" consumers, who are directly involved in the processes of the organization. This involvement transforms the traditional passive consumer role into an active one, where customers participate in the process of value creation.

Based on this foundation, Gronroos (2012) makes a step further and defines co-creation as "a collaborative activity involving all parties in direct interactions, aiming to contribute to the value generated for one or both parties." This perspective underscores the mutual benefits derived from co-creation, where both the organization and the customers gain value through direct interaction and collaboration. In practice, co-creation can take various forms, including customer feedback sessions, co-design workshops, and online platforms where customers can contribute with different ideas and innovations. By involving customers in the innovation process, firms can leverage the collective intelligence and creativity of their user base, leading to more innovative and personalized products and services. This active participation fosters a deeper connection with customers, enhances customer satisfaction, and ultimately drives business success. Thus, we can say that co-creation, as an integral part of open innovation, represents a powerful strategy for companies aiming to stay competitive in today's rapidly evolving market landscape.

Crowdsourcing

Crowdsourcing harnesses the collective intelligence of a large group of people, typically through online platforms, to generate innovative ideas and solutions. Jeff Howe coined the term in 2006, describing it as a method where organizations use the internet to outsource tasks traditionally performed by employees, to a large, undefined group of people via open calls (Howe, 2006).

In the same manner, Prpic (2015) asserts that crowdsourcing can be viewed as the utilization of the IT industry to outsource business responsibilities, leveraging the collective power of a crowd to achieve previously unattainable goals and gain an advantage. The focus of crowdsourcing is on these groups of people, known as crowds, which consist of individuals from various locations around the world, most commonly connected through online platforms. The tasks addressed to the crowd, can vary in complexity, and the crowd is expected to contribute through "work, funding, knowledge, or experiences" ensuring mutual benefits: the users gain "economic, social, or individual skill development satisfaction", while organizations leverage these contributions to gain competitive advantages (Arolas and Guevara, 2012).

According to Brabham (2013), the control of the process of creating goods and ideas in crowdsourcing should be positioned to maximize "the benefits of a traditional top-down approach with those of an open and creative bottom-up approach". When this activity is too strictly controlled by the organization, such as in a simple preference contest, the crowd becomes merely a pawn in the organization's broader objectives, with the benefits oriented more towards the organization for publicity reasons. On the other hand, when control is more community-driven, as seen within platforms like Wikipedia or other open-source projects, the crowd self-governs and sets its own strategic goals, with the organization playing a less significant role, generally serving as a hosting platform.

LEGO Ideas is a prime example of crowdsourcing, where the company leverages the creativity and innovation of its fan community to generate new product ideas. Through the LEGO Ideas platform, fans can submit their own designs for new LEGO sets. These submissions are then open to votes from other community members. If a design receives enough support, typically 10,000 votes, it is reviewed by a group of LEGO employees for potential production as an official LEGO set. This approach allows LEGO to tap into a diverse pool of talent and creativity, benefiting from the collective intelligence of their community. The crowd benefits by seeing their designs potentially turned into real products, often with public recognition and monetary rewards, while LEGO gains fresh, market-validated product ideas that help them in maintaining and growing their product line. This model is just one of the many more, exemplifying how crowdsourcing can create a symbiotic relationship between a company and its customers, leading to innovative and popular products.

Intellectual Property Sharing and Licensing

Given that innovation is increasingly driven by user contributions and collective effort, we can argue that companies must recalibrate their intellectual property rights management strategies to successfully adapt to this shift. It is essential for them to develop methodologies that strike a delicate balance between traditional and isolated approaches necessary for the legal acquisition of intellectual property rights and the integration of transparency to transition towards an open innovation process (Lee et al., 2010).

Chesbrough (2003) suggests that in the age of open innovation, companies should encourage and facilitate a diverse approach to intellectual property, allowing ideas and technologies to flow more freely between different organizations and sectors. Unlike closed innovation, which promotes strict control and exclusivity over internally developed intellectual property,

Chesbrough (2003) views intellectual property as an asset that can be licensed or shared to accelerate innovation and achieve mutually beneficial advantages.

Bogers, Bekkers, and Granstrand (2012) argue that protecting the intellectual property and controlling the use of inventions are key aspects of many firms' strategies, but in order to succeed in open innovation, firms must share knowledge with others. Licensing can take various forms, including exclusive licensing, grant-back licensing, which allows the licensor to use the improvements made by the licensee to the licensed technology, or patent pools, where multiple patent holders license their technologies to each other to facilitate the development of new products (Bogers, Bekkers, and Granstrand, 2012). These licensing strategies must align with the strategic objectives of open innovation and contribute to the creation of new business models and collaborative approaches within innovation ecosystems.

Hackathons

Hackathons are intensive collaboration and programming events, regardeded as a tool or strategy of open innovation, bringing together participants from diverse fields to develop innovative and sustainable solutions to complex social and industrial challenges within a short timeframe. These events are designed to foster creativity, rapid prototyping, and collaborative problem-solving. The term "hackathon" combines "marathon" and "hacking," originating in the 1960s when students would gather for intense programming sessions resembling a marathon, often lasting 24 hours.

Mehta and Shah (2022) describe hackathons as an open innovation strategy that reveals competencies and skills in a manner that encourages collaborative innovation and the emergence of creative solutions. In the same spirit, Franco, Presenza and Petruzzelli (2022) categorize hackathons as strategies that generate innovative ideas, emphasizing their ability to bring together diverse actors and generate value through intensive collaboration and focused brainstorming.

A thorough definition of the hackathon is offered by Halvari et al. (2020), who characterize it as "one type of organized, goal-driven innovation contest, a short timebounded event with a challenge to be solved creatively in coopetition and collocation of teams, whose results are presented and recognized in a ceremony at the end of the event". This definition highlights the essential characteristics of hackathons, such as their competitive nature, the intensity of team collaboration, and the objective of generating innovative solutions within a concentrated timeframe. Halvari et al. (2020) suggest that a hackathon, as a concept, encompasses nine necessary and sufficient attributes that define it: organization, limited duration, collocation, challenge, ceremonial process, team, objective, collaboration, and creation process.

Originating from the software development industry, where they were established as competitive events for creative problem-solving and new prototype development, hackathons have expanded into broader domains, including social project initiation and ideation for addressing social issues. Hackathons can also be conceptualized as friendly activities or competitions used by software programmers and other domain experts to develop solutions for a specific challenge over a short and predetermined period (Mehta and Shah, 2022).

Corporate Venture Capital

Corporate Venture Capital (CVC) involves direct investments in innovative startups by corporations seeking to access emerging technologies and new business models. Pinkow and Iversen (2020) argue that corporate venture capital represents a crucial strategy in the realm of open innovation, providing organizations with a structured method to access external

innovations and respond to the rapidly evolving dynamics of markets and technologies. An important aspect mentioned by Kortum and Lerner (2002) states that CVC cannot be separated from the traditional concept of venture capital, as both forms of financing are interdependent. The authors define the three essential characteristics of CVC as providing investment capital to young and rapidly growing companies, offering management support, and maintaining a long-term perspective.

Building on this foundation, Pinkow and Iversen (2020) categorize the strategic objectives of CVC into three main areas: strengthening the core business, leveraging the ecosystem, and exploring new markets and technologies. Strengthening the core business through CVC involves investing in startups or entrepreneurial ventures that can enhance the corporation's current position and core competencies. This approach allows corporations to improve internal research and development efficiency and protect their existing business by identifying disruptive technologies that could pose potential threats. Leveraging the ecosystem focuses on creating and enhancing a robust ecosystem around the core business by investing in companies operating in complementary markets. The goal is to stimulate demand for the corporation's existing products and technologies and facilitate the transfer of knowledge and skills, thereby contributing to sustainable innovation and creating new growth opportunities. Exploring new markets and technologies through a CVC strategy aims at identifying and adopting emerging innovations that lie outside the corporation's primary field of activity. This approach provides the opportunity to access new technical and market knowledge, supporting technological diversification and expanding the corporation's portfolio in new and innovative directions.

Open Source

Open source refers to the practice of making software source code freely available for anyone to use, modify, and distribute. This strategy encourages collaborative development and knowledge sharing, leading to faster innovation and broader adoption of technologies. Open-source development is fundamental to creating shared technological resources, facilitating an environment of collective progress and innovation.

Among other criteria, a fundamental requirement for open-source projects is the availability of the source code, as its absence would make the development or evolution of the software extremely difficult, if not impossible (Gacek and Arief, 2004).

West and Gallagher (2005) state that viewing open source as an open innovation strategy encompasses two key elements: shared rights to use the technology and the collaborative development of that technology. However, they note that unlike individual participants, firms must also consider capturing economic returns to justify their investment. West and Gallagher (2005) identified four approaches to open innovation in the context of open-source software.

- *Pooled R&D* represent a model that involves firms collaborating to contribute to shared research and development efforts. A well-known example is the support for the Linux operating system through the Open Source Development Lab.
- *Spinouts* are an approach that involve transforming internal development projects into externally visible open-source projects.
- *Selling complements* is a method focused on selling goods and services that complement a core innovation.
- *Donation of complements*, a scenario in which firms generate revenue from the core innovation but seek to donate certain complements. An example is the mods for computer games, where game publishers release editing tools to encourage users to create customized versions of the games, therefore extending the product's lifecycle and maintaining the consumer interest.

Synergies among Open Innovation Strategies

It is important to note that these open innovation strategies, co-creation, crowdsourcing, intellectual property and licensing, hackathons, and open source do not operate in isolation but often overlap and interconnect. For instance, crowdsourcing can significantly enrich the co-creation process by bringing in diverse perspectives and ideas from a wide pool of participants. A prime example is the LEGO Ideas platform, where fans submit their own designs, which are then reviewed and potentially produced by LEGO, merging crowdsourcing with co-creation.

Similarly, sharing intellectual property can lead to new collaborations within co-creation initiatives, fostering a more dynamic and innovative environment. For example, pharmaceutical companies often license their technologies to universities and research institutions, which then collaborate to develop new drugs, combining the strengths of both parties.

Hackathons often incorporate elements of co-creation and crowdsourcing, creating intense, collaborative efforts that drive rapid innovation. Events like the NASA Space Apps Challenge bring together coders, scientists, designers and space enthusiasts to solve complex problems using open data provided by NASA, blending hackathons with crowdsourcing and co-creation.

Additionally, open-source projects grow on the principles of co-creation and crowdsourcing, enabling continuous development and improvement through shared knowledge and resources. The Linux operating system is an emblematic example, where developers from around the world contribute to the codebase, enhancing and expanding its capabilities through a collaborative, open-source model.

This integrated approach enhances the effectiveness of each strategy, leading to more impactful and sustainable innovation outcomes, summarized in Table 1. By utilizing these interconnected strategies, organizations can build a robust innovation ecosystem that taps into the collective intelligence and creativity of a diverse range of contributors.

Table 1. Open Innovation Strategies in relation to the co-creation process

Open Innovation Strategies	***Co-Creation process***
Crowdsourcing	• Enrich the process by adding new perspectives and ideas • Developed platforms
Intellectual property	• Enhance new collaboration • Fostering dynamic and innovative environment
Hackathons	• Generates rapid innovation • Use crowdsourcing as collaborative effort
Open source	• Unrestricted way of co-creation • Enables continuous development and improvement • Allows knowledge and resources sharing

Conclusion

Open innovation strategies, encompassing co-creation, crowdsourcing, intellectual property sharing, hackathons, and open-source development, are vital for modern enterprises seeking a competitive edge. These strategies facilitate the integration of external ideas and technologies, promoting a dynamic and adaptive innovation process.

This study demonstrates that these strategies are not isolated but interlinked, creating a synergetic effect that amplifies their individual benefits. While the reliance on secondary data and case studies provides valuable insights, further empirical research is needed to explore the practical challenges and broader applicability across different industries. Adopting a holistic approach to open innovation, enterprises can then build an innovative ecosystem, positioning themselves for sustainable growth and success in a rapidly changing market environment.

In conclusion, the successful implementation of open innovation strategies requires a strategic and well-coordinated effort across the organization. Firms must foster an environment that values collaboration, transparency, and knowledge sharing. By doing so, they can harness the full potential of open innovation, leading to sustained competitive advantage and long-term success. Future research should focus on developing frameworks and tools to support the practical application of these strategies, ensuring that businesses can effectively navigate the complexities of open innovation and fully realize its benefits.

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REVISITING SERVICE DOMINANT LOGIC: A CONTEMPORARY PERSPECTIVE ON VALUE CO-CREATION

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Abstract

Purpose – To investigate the concept of Service-Dominant Logic within a value co-creation framework. From this point of view, a representation on how S-D Logic redefines the co-creation process will be provided, along with the roles of actors engaged into the process of value co-creation.

Methodology/approach - This paper aims to explore and highlight the relevant definitions, existing frameworks, theories and models by using qualitative research methodology. From this point of view, a systematic literature review regarding existing papers on Service-Dominant Logic and value co-creation processes has been performed.

Findings – Through this literature review, in this paper we identify key themes and patterns which emphasize the use of Service-Dominant Logic principles and its relevance for the current research stream.

Research limitations/implications – The main limitation of this research is related to the fact that in order to understand Service-Dominant Logic, the methodological approach was based only on secondary data from the existing literature. While the qualitative approach provides a comprehensive understanding of the analyzed concepts, it also requires the need of filling the gap in terms of quantitative validation by using primary data.

Practical implications – From the practical point of view, implementation of the Service-Dominant logic within various industries has been highlighted. Customers engagement, enhancing innovation activities or processes and service delivery represent few of the most important practical implications strengthened by S-D Logic implementation. From this perspective, practical and existing examples have been provided, such as innovative marketing strategies, user involvement into content generation within music industry platforms, healthcare collaborative patterns.

Originality/value – This article contributes to the existing body of knowledge by providing systematic literature review in order to highlight practical applications of the S-D Logic and to emphasize its relevance for the value co-creation field of research.

Key words: *service, co-creation, value, service-dominant logic.*

Introduction

The landscape of marketing faced significant transformation over the past few decades and one of the main reasons for this is marked by the rapid evolution of customer needs and technological advancements. For a long time, marketing focused on the exchange of goods with businesses trying all kinds of modalities to sell their products to customers, but this product-centric view has been gradually replaced by a distinctive approach that focuses on delivering solutions to consumer problems. Moreover, it must be highlighted that in this evolving paradigm, the concept of co-creation has become more and more popular.

Co-creation is a process that involves a collaborative partnership between businesses and consumers in the process of value creation. The key aspect within this process is related to the creation of collaborative interactions among both parties. According to De Koning et al those type of collaborative linkages are no longer related only to the created transactions, they are rather concentrated on the experience generation (De Koning et al., 2016). More precisely, as Prahalad and Ramaswamy (2004) mention, co-creation is used in the context of defining a new category of "*informed, connected, empowered, and active*" consumers. Therefore, apart from generating new innovations, this co-creative process ensures that the solutions provided are better aligned with the real needs of the users.

Parallel to the rise of co-creation is the growing recognition that the customers at the core of this type of process are seeking to gain potential solutions, rather than just stand-alone products. With this type of transition becoming more and more popular, it eventually led to the emergence of what we know today as the Service-Dominant Logic.

Service-Dominant Logic, a paradigm that was originally presented by Vargo and Lusch, offers a different research paradigm on the concept of value and value generation (Vargo and Lusch, 2004). The authors 'approach is bringing forward the importance of established interactions among different actors (Vargo and Lusch, 2004; Prahalad and Ramaswamy, 2004).

From this point of view, the main objective of the present research is to explore the S-D Logic landscape in order to highlight the meaning of created value, the most relevant patterns and frameworks of analysis.

The Shift from Goods to Service

In order to understand the value creation, process it is relevant to highlight the transition from the logic dominated by goods manufacturing to the approach where services are dominant within economical exchanges (Vargo et al., 2020). In G-D Logic, the focus is concentrated on tangible goods and the value embedded in these goods by producers. In contrast, S-D Logic considers that the offered services are the ones relevant as the basis for economic exchange. This approach brings forward the development and use of generated knowledge, skills and competences beneficial for various actors, aspects that Vargo and Lusch (2004) use in redefining service as "*the application of specialized competences (knowledge and skills) through deeds, processes, and performances for the benefit of another entity or the entity itself*".

This shift requires recognizing that goods are merely vehicles for service delivery and that value is co-created in fact through interactions between providers and beneficiaries, highlighting the intangible, dynamic nature of value creation, where the focus shifts from static products to continuous and collaborative processes (Vargo and Lusch 2004; 2006).

Operant and Operand Resources: Understanding their roles in S-D Logic

Resources are the essence of any service-oriented organization, supporting all aspects of their operations and initiatives and therefore it is absolutely imperative that they are managed and used properly, encouraging innovation and sustaining competitive advantage in a dynamic environment.

In the same context of highlighting the importance of resources, Storbacka et al. (2012) argue that they are crucial components of design because they build the foundation for co-creation. One relevant remark would be that resources can be seen as enablers and barriers simultaneously, as their presence can motivate other actors to engage in co-creation activites, while their absence can even make co-creation impossible (Storbacka et al., 2012).

Vargo and Lusch (2004) distinguish between two types of resources: operand and operant. “Operand resources” (Vargo and Lusch, 2004, pp 2) are typically tangible and static, such as raw materials and physical goods (Arnould et al., 2006; Vargo and Lusch, 2004). These resources are those that consumers have the ability to allocate for achieving specific operations, including social and life projects and it is important to mention that these consumers possess a collection of material objects that vary in quantity and quality, some of which are acquired through exchanges with merchants, while others include gifts, inherited items, found objects, or self-created items (Arnould et al., 2006).

In contrast, operant resources are intangible and dynamic, encompassing skills, knowledge, and competences that act upon operand resources in value creation process. This type of resources is considered as the most important of value creation and achieving the competitive advantage (Vargo and Lusch, 2004). Moreover, the operant resources are perceived through the lens of companies’ intangible capabilities, skills and knowledge which are required and enabled in order to respond to the customers’ needs and contexts (Vargo and Lusch, 2004). Vargo and Lusch (2004; 2008) also emphasized that these resources are dynamic and in continuous development.

Vargo and Lusch (2004, 2006, 2008) view operant resources as essential in the service-centered logic. They highlight that abundant natural resources are leveraged through innovation and knowledge, providing the example of the microprocessor (primarily composed of silicon, which is just a common resource, but which requires additional leverage in order to be valuable). Therefore, resources are not just raw materials and they become valuable tools when enhanced with human intelligence: "*resources are not, they become*." (Vargo and Lusch, 2004).

Arnould et al. (2006) state that the relationship between firms and customers can be understood through the lens of operant resources, emphasizing the active role both parties play in the value creation process. From the firms' perspective, customers are seen as operant resources - active participants who add value through how they use and integrate products and services into their lives, while in a similar manner, from the customers' viewpoint, firms become essential operant resources, providing the tools necessary to achieve personal goals and improve quality of life (Arnould et al., 2006).

Core principles and fundamental laws of S-D Logic

The principles underlying Service-Dominant Logic were originally formulated into fundamental premises. Vargo and Lusch originally presented the eight relevant principles of S-D logic in their 2004 article but since then, these principles have gone through several transformations, with additional premises being added as S-D logic has been expanded and elaborated (Vargo and Lusch, 2006, 2008, 2016). Currently, S-D logic consists of eleven foundational premises with five of these identified as the fundamental laws of S-D logic (Vargo and Lusch, 2016). This

approach can be seen as a relevant keystone for other principles generation. In this research paper, our focus was on highlighting and summarizing these fundamental laws of Service-Dominant Logic as it is presented in Table 1.

Table 1: Service – Dominant Logic Fundamental Laws (Vargo and Lusch, 2016)

No.	***Fundamental Laws***	***Description***
FL1	*Service is the core resource for exchange*	• Defined through created competences • Service is the core of existing exchanges among actors • Products are serving as a resource for service
FL2	*Value is co-created by multiple actors*	• Value co-creation is main process • Co-creation means interactions and relations among different actors • Interactions materialized through resources allocation and exchange • Customer plays a central role in value creation
FL3	*Actors within an ecosystem act as resource integrators*	• Multiple sources for necessary resources • Use complex networks of potential actors' engagement • Co-creation through complex interactions • Service ecosystem at the core
FL4	*Value is always defined by the users*	• Creating value based on the context • Relies on customers experience and the manner of usage • How and when the customer is engaging into co-creative process
FL5	*Value co-creation is coordinated through actor-generated institutions and institutional arrangements*:	• There should exist an orchestrator • Coordination can be realized by using specially designed rules and norms • Collaborative interactions depend on the environment they are evolving

The meaning of "value" in S-D Logic

Vargo et al. (2020) highlighted that collaborative exchange of value represents the core of the entire logic. The authors explored the idea that in value co-creation the provided services can be seen as delivery channels (Vargo, et. Al, 2020). However, in this case, intangible resources are highly valued, such as competences, skills and knowledge (Vargo, et. Al, 2020) and relations and interactions are viewed rather as dynamic and mutually beneficial exchange. This type of approach eventually led to different meanings of value.

In the Goods-Dominant (G-D) logic, the concept of "value in exchange" is preferred as it suggests the meaning of created and embedded value by and within the existing products or goods by the manufacturer itself (Grönroos, 2008). Alternatively, Grönroos (2008) suggests that value is actually generated and created by the beneficiary only when it is consumed, naming it "value in use".

Based on previous research, Grönroos explores the concept of value and its creation within the Service-Dominant Logic (Grönroos, 2008, 2011), concentrating his research on the exploration of distinguishing value in use and value in exchange, to highlight the role of value generators (clients) and value creators (manufacturers) and of the process itself (Grönroos, 2008).

According to Grönroos (2008), value in exchange is traditionally associated with the moment of exchange or transaction, where value is embedded in the product and realized through the exchange of goods and services for a specific price. This represents the classic view of economics and marketing which relies on transactional value. However, Grönroos (2008) emphasizes the second type of value, value in use, which refers to the value created and perceived by the customer in the context of the actual use or consumption of a product or service. Value in use highlights the importance of the customer experience and the personal processes by which the customer integrates the firm's resources into their daily activities, creating individual value. Consequently, the shift in value meaning can be traced, as it is represented in Figure 1.

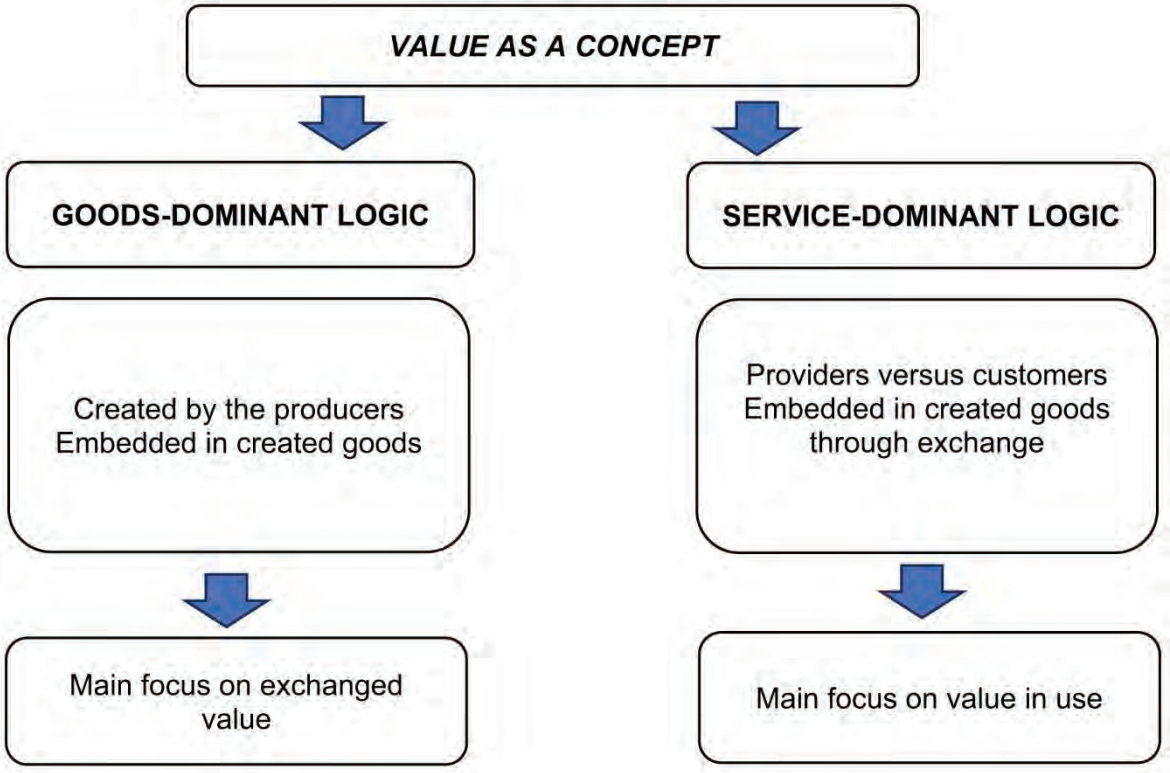

Figure 1. The transition of the value concept from Goods-Dominant to Service-Dominant logic (Vargo and Lusch, 2004; Grönroos, 2008, 2011).

Therefore, Grönroos (2008, 2011, 2013) argues that firms do not directly "create" value and that instead, they facilitate value creation, with real value being generated by customers at the moment and in the context of use. Grönroos (2013) encourages firms to focus on understanding and enhancing value in use through customer interaction and by facilitating their value creation processes. This approach promotes a more customer-oriented perspective, contrasting with traditional product or transaction-oriented models.

Conclusion

Service-Dominant Logic represents a paradigm shift in understanding economic exchanges and value creation. Value co-creation, presented through the lens of dynamic resource allocation and exchange and by taking into account various actors and the relations established among them, can be seen as a complex framework to foster and promote innovation and service as a valuable resource. Based on this assumption, it can be noticed that the Service-Dominant Logic approach is rather focused on multiple actors' involvement, where resources are mainly intangible and an active engagement into the process is preferred.

As businesses and industries continue to evolve or even transform, the principles of this logic will become more and more relevant. By adopting a service-dominant perspective, organizations can better navigate the complexities of modern markets and enhance their competitive advantage, creating more sustainable and meaningful value for all of the stakeholders.

Service-Dominant Logic, while influential, cannot avoid criticism and faces challenges in its application and theoretical development. Campbell et al. (2013) argue that the S-D logic provides a narrow perspective on the economy and society by excessively focusing on operant resources (human capabilities) while neglecting the importance of operand resources (physical assets), underlining the fact that this logic underestimates the complexity of resources.

In conclusion, while Service-Dominant Logic has significantly shaped contemporary understanding of value creation and customer relationships, its future research should address its critics' concerns and evolve towards a more balanced perspective, aiming to refine S-D Logic by incorporating a more comprehensive view of resources and their interactions, ensuring its relevance and applicability across various economic and social contexts.

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THE IMPORTANCE OF THE EVALUATION PROCESS TO INCREASE THE PERFORMANCE OF HUMAN RESOURCES: AN OVERVIEW

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Abstract

Purpose *- aims to provide an overview of the importance of the evaluation process for increasing the performance of human resources, detailing the benefits it brings to individuals and organizations alike.*

Methodology/approach *– a qualitative research approach will be conducted focusing on the review of the existing literature on performance evaluation process, human resources management, and organizational performance.*

Findings *– would emphasize the multifaceted benefits of the evaluation process, illustrating how it not only enhances individual performance but also contributes to broader organizational success and a positive workplace culture.*

Research limitations/implications *– can derive from the subjectivity of the evaluation as performance evaluations can be influenced by the biases of the evaluators (internal factors). On the other hand, uncontrolled external factors, such as economic conditions or organization changes, can influence employee performance independently of the evaluation process.*

Practical implications *– would focus on actionable steps that organizations and HR professionals can take based on the findings.*

Originality/value *– lie in the potential to offer insights and practical contributions to the field of human resource management*

Key words: *evaluation performance process, human resources performance, organizational performance.*

Introduction

In any organization the main resource is represented by people, and a good manager must know the people he or she works with, must know not only WHAT can be relied on, but especially WHO. A really delicate problem in the management of an organization is represented by the evaluation of the professional performance of the human resource. Evaluation is part of the managerial function of control and provides a picture of the reality of the organization (Dragomyretska, 2014).

The evaluation of human resources' performance is a crucial part of organizational performance management. In recent years, as organizations constantly seek change and competitive advantage, the key to success lies in performance evaluation (Armstrong, and Baron, 1998). Thus, integrated performance management systems have been developed, most of which are based on competencies.

Organizations, particularly those with private funding, have realized the need to implement a system for evaluating employee performance in order to achieve economic success and a competitive edge. Concurrently, many public institutions have also recognized this need. An important aspect to consider during the evaluation/assessment process is both quantitative (the number of objectives achieved) and qualitative factors (how tasks were carried out, challenges encountered, and how any problems were resolved). Therefore, this paper aims to emphasize the significance of the evaluation process in enhancing employee performance, whether in the public or private sector.

Principles for improving the performance evaluation process

The activity of evaluating human resource performance in organizations is a controversial activity, which gives rise to different opinions and arouses contradictory reactions regarding it. However, it was concluded that the main objectives of the evaluation systems, generally accepted, are: increasing the organization’s productivity; establishing the basis for administrative decisions such as promotions, job changes, resignations, and additional training; identifying the objectives and responsibilities of the work place; employee performance evaluation based on these objectives; identifying, for each employee, aspects and improvement areas to increase performance (Emilian et. al, 2003).

Milan Kubr suggests that organizational performance evaluations often focus on numerous criteria and overlook essential aspects (Kubr, 2002). However, this viewpoint is not justified. Evaluations, especially qualitative ones, take into account various factors, including results, traits, and behaviors, thereby offering a comprehensive understanding of employees' work attitude and behavior. Effectively managing this information can help organizations improve their personnel management systems.

Edwards Deming claims that managers focus on creating performance measurement systems that are far too complex and sophisticated to be understood by employees (Manolescu, 2001). Deming, like Kubr, believes that performance evaluation through a performing system should contain representative criteria and be as easy and simple to understand as possible. The two specialists wanted to emphasize that "a complex evaluation system is not necessarily efficient" (Manolescu, 2001). A different vision from that of Deming and Kubr is that of Gerald Cole, who considers evaluation essential, a component of particular importance for ensuring the well-being of an organization. Cole emphasizes the definition of the evaluation as the bilateral discussion between the subordinate and the hierarchical superior to identify the aspects that need to be improved, as well as the elaboration of an action plan (Mathias, Nica, and Rusu, 1997).

Consequently, the performance evaluation must be conducted with utmost attention, as effective management of it can lead to significant benefits for the organization. In this context, certain principles have been outlined to help organizations improve how they carry out the entire performance evaluation process:

- *The first principle* requires that performance evaluation should consider both the individual performance of the employee in their current role and how well they contribute to the organization's goals. Performance and objectives are distinct concepts but should be closely linked throughout the evaluation process.

- *The second principle* focuses on evaluating how well the employee performs the tasks of the job rather than relying on subjective impressions of the evaluator about the employee's work style. The aim is to make the performance analysis objective rather than being based on subjective evaluations of the employee's work style.
- *The third principle* states that the evaluation must be mutually acceptable to both the evaluator and the subject. Both parties must agree that it benefits both the organization and the employee.
- The fourth principle refers to performance evaluation as a means of improving employees' productivity within the organization by better preparing them to produce (Certo, 2002).

The stages of the human resource performance evaluation process

There are several reasons for the development of performance appraisal systems, with their main functions being administrative and employee development. From an administrative standpoint, evaluations provide organizations with valuable information for decision-making processes involving bonuses, salary increases, promotions, and other forms of recognizing and fairly compensating good work (Huțu, and Avasilcăi, 2011). They also enable managers and employees to identify areas with performance deficits, allowing them to develop plans to address the identified issues, as shown in figure 1, which presents the stages of the human resource performance evaluation process.

Creating a solid plan for employee evaluation is a crucial and intricate step in the evaluation process. Managers need to set clear evaluation objectives, establish evaluation criteria and standards, and communicate these to the employees from the beginning. Often, employers make the mistake of assuming that employees understand expectations without clearly communicating and explaining what is required of them. This can lead to misunderstandings and results that fall short of expectations. Additionally, employers need to determine the frequency of evaluations, which are commonly conducted annually in most organizations, and decide who will conduct the evaluations and the methods to be used (Blaga, 2011).

Another crucial step is the evaluation, which involves gathering the initially established data using the predetermined methods. If the initial steps are executed correctly, the data collection process becomes relatively easy (Murphy, 2019).

After collecting the data, the next step involves analyzing the results. The measured results are analyzed and then communicated to the employees. Following this, the necessary measures are taken based on the evaluation. Discussing with employees the areas that need improvement provides an opportunity to guide them toward enhancing individual and organizational performance (Akinbowal, Lourens, and Jinabhai, 2014). Decisions regarding promotions, compensation, additional training, or dismissal are all reliant on performance evaluations. An effective performance appraisal system is essential for meeting legal requirements related to promotions, compensation, and dismissal policies (Katic, and Bevanda, 2019).

The evaluation of the human resource in a Romanian organization

In Romania, there are a multitude of systems and ways to evaluate the human resource in an organization, but practice is faced with evaluation forms imposed by law, standardized with predetermined performance criteria. Romanian legislation, through the Labor Code, grants organizations the right to establish their own individual performance objectives, as well as the evaluation criteria for their achievement. In Law 53 - Labor Code of January 24, 2003, republished and updated, it is stipulated that upon employment the employee must be informed about the criteria for evaluating the employee's professional activity applied at the employer level.

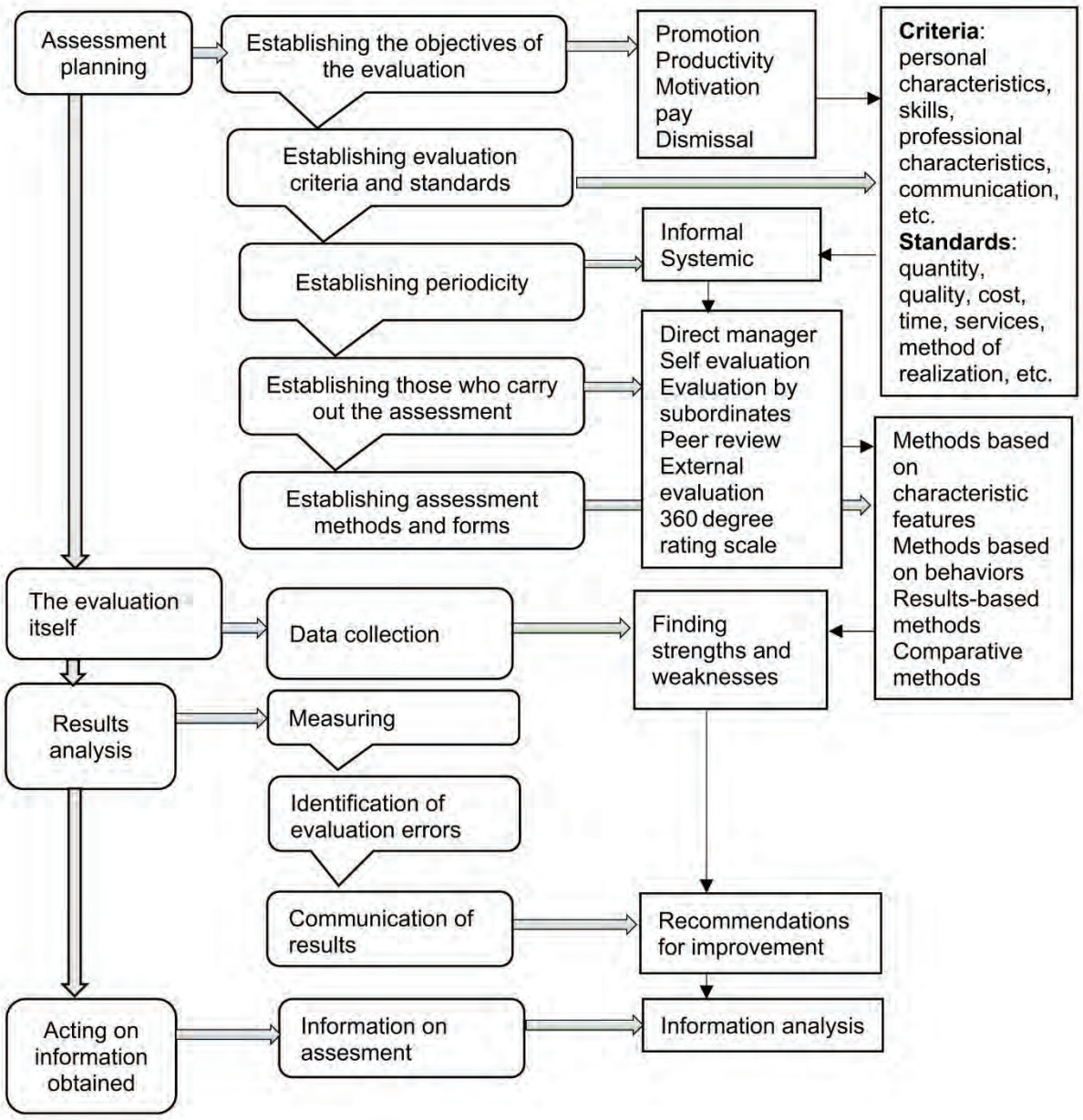

Figure 1. Stages of the human resource performance evaluation process/ system, adaptation after (Mathias, Nica, & Rusu, 1997)

All these must be expressly stipulated in the individual employment contract, but must be distinct from the general evaluation criteria applied at the level of the organization. Thus, the employee's performance objectives are individualized, distinctly designed, personalized for each employee, but the employer is not obliged to include them in the individual employment contract, only those specific at the organization level are included in the individual employment contract, and in the case which is also the case in the collective case, but also in the internal order regulation. The individual employment contract is the result of a negotiation between the two parties, the employee by signing it expresses his agreement regarding the general criteria for evaluating the professional activity.

If, in terms of the legal character that refers to the legal performance of organizations, the Labor Code does not establish clear limits, leaving them to the choice of the employer, in terms of individual performance criteria, the imperative, but also the dispositive character of the

articles clearly emerges, these being essential especially in the case of collective redundancies, where they are the main tie-breaking criterion and only then are the other criteria established by the collective labor agreement or other laws taken into account.

In public organizations in Romania, the appreciation coefficients are established randomly, and the establishment of the general qualification is not given objectively, objectivity being another big problem when it comes to evaluation. Appraisers are sometimes unaware of the organization's performance standards and make a superficial assessment.

Discussion and conclusions

Different countries and cultures have different interpretations of performance evaluation. Human resource management specialists have found that methods of assessing performance that work well in one country and are appreciated by employees may not work in other countries and may be rejected by those employees. This is due to cultural differences and varying value systems. For an evaluation method to be effective, the evaluators must consider the cultural characteristics of the country where the organization is based (Emilian et al., 2003).

Performance evaluation is a fundamental aspect of human resource management. It assesses to what extent employees have fulfilled their tasks and responsibilities within the organization. Without this process, the organization lacks essential data to base its decisions regarding overall performance and the performance of individual components.

Consequently, it is important for a performance evaluation approach to align with the organization's strategic goals, focus on organizational results, and provide constructive feedback for improvement. During periodic reviews, an employee's work performance is assessed to identify strengths, weaknesses, and areas for improvement. Different organizations utilize performance evaluation results in varying ways, with some using the information for rewarding purposes while others do not fully leverage it. Therefore, performance evaluations are crucial for organizational development.

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DETERMINATION OF ORDER EXECUTION PRIORITY USING A FUZZY DECISION SYSTEM. THE CASE OF PRODUCTS OBTAINED BY INJECTION MOLDING OF PLASTIC

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Abstract

Purpose *– This paper aims to present the development and implementation of a fuzzy logic system used for production scheduling, designed to improve the decision-making processes and manage uncertainties.*

Methodology/approach *– The research adopts a methodological framework that combines principles of fuzzy logic with production scheduling theories. A system was developed and tested using real data from production. The approach involved creating a set of rules, tailored to meet specific needs in the production environment.*

Findings *– The system improves the efficiency of production scheduling through dynamic adjustment of priorities based on input variables. This helps to adhere to deadlines and improves resource management.*

Research limitations/implications *– The study is limited because it approaches specific production scenarios and requires adjustment for use in other industrial contexts. Future research could improve the model by introducing other variables to make it more versatile.*

Practical implications *– The system can improve production efficiency and assure adherence to deadlines, providing a useful tool for production managers.*

Originality/value *– The study highlights the advantages fuzzy logic offer when it comes to managing the uncertainties in production processes and it provides a framework that can be adapted and extended for broader use in production operations.*

Key words: *fuzzy logic, production scheduling, decisional system.*

Introduction

Production scheduling represents a fundamental pillar of operational management, having a direct impact on a company's efficiency and competitiveness. In a more and more dynamic industrial environment, the ability to optimally organize and plan production activities becomes essential on the long term. This complex process involves not only efficient resource management and production schedules, but also a very tight bond between the various departments of a company. The main objective of production scheduling is to assure a continuous and optimized flow of operations, while minimizing costs and avoid wasting resources. In the ever-evolving landscape of manufacturing and production, the necessity for precision and adaptability in scheduling processes becomes crucial. Traditional scheduling techniques, although efficient in certain scenarios, often meet difficulties trying to face the

uncertainty and complexity of the modern industry. As the companies struggle to obtain increased efficiency, reduced costs and a better resource usage, emergent technologies are researched to revolutionize the existing production scheduling methodologies. One of these technologies that gained popularity in recent years is fuzzy logic. Introducing a certain degree of flexibility and adaptability in programming algorithms, fuzzy logic systems have the potential to overcome the dynamic nature of manufacturing environment.

For example, Tedford and Lowe (2003) highlight the importance of fuzzy logic when it comes to considering multiple criteria and making fast decisions during production, showing how fast it can adapt to changes in the dynamic field of production. Moreover, Klir and Yuan (1995) provide a comprehensive theoretical foundation for fuzzy logic, emphasizing its application in systems where uncertainty and vagueness are prevalent. Their work underscores the importance of fuzzy sets in modelling complex production processes.

In his paper, Benhamian (2016) presents a series of scheduling procedures based on fuzzy sets for different types of production: single machine, parallel machines, flow shop, job shop and open shop.

This paper explores the application of fuzzy logic in production scheduling, bringing into light the principles and advantages of its implementation in the industrial setting.

The development of a production scheduling system based on fuzzy sets

Production scheduling is an essential process when it comes to managing the required operations, which involves the organization and planning of the manufacturing activities so that the efficiency is maximized, costs are minimized and unpleasant situations such as missing a deadline are avoided. Production planning involves making decisions based on the analysis of a complex set of data, such as demand estimation, production capacity evaluation, required resources allocation, operation programming, production monitoring, stock management, etc. Based on the complexity of the data, making a decision can sometimes be very difficult. Therefore, managers rely on well-established rules and standards and, with the advancement of technology, on certain specialized software. However, Jain and Meeran (1999) review deterministic job-shop scheduling, highlighting the limitations of traditional methods and proposing innovative solutions to overcome these challenges. Their work demonstrates that fuzzy logic can effectively adapt to real-time changes in production conditions, improving overall scheduling efficiency and responsiveness. The integration of fuzzy logic helps in navigating the vast solution space, ensuring optimal scheduling outcomes even in complex and dynamic environments. Moreover, Negnevitsky (2005) research mentions the versatility of fuzzy logic systems in different industrial applications, including production and quality management. Even so, if the resources are limited, certain problems can appear when it comes to production management.

One such problem could arise when, for example, multiple orders require the use of the same machine (equipment). Resolving such a problem is the subject of this paper, which aims to develop a decisional system based on fuzzy sets, to help establish the priority of each of the orders. The system was developed using the fuzzy toolbox in Matlab. The priority will be determined based on three criteria: production time (PT), due date (DD) by which the products must be delivered, and the existing safety stock (SS). The block diagram of the decisional system is provided in figure 1. Therefore, these three criteria will represent the three input variables and the output variable will be the priority (P), together constituting the linguistic variables of the system.

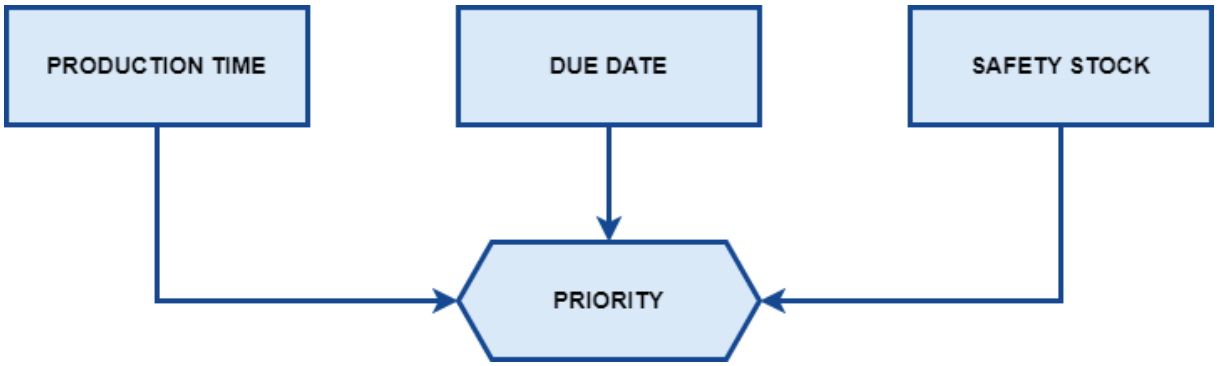

Figure 1. The block diagram of the decisional system

The influence the input variables have on the priority is as it follows:

- Production time (PT) is defined by the number of hours required to finish manufacturing of an order. It is directly proportional to the priority, meaning that orders with longer production times will take precedence over smaller batches.
- Due date (DD) is defined as the time when the product must be delivered. It is inversely proportional to the priority, therefore orders with a closer deadline will be prioritized.
- Safety stock (SS) is defined as the number of units of the product to be manufactured, that are currently in stock. The safety stock is inversely proportional to the priority, therefore precedence will be given to the products with lower safety stock.

Going forward, the range of values for the input and output variables will be determined. These are as follows:

The domain of values for the production time PT is presented in formula (1).

$$PT: D_{PT} = [0, 120] \text{ [hours]} \quad (1)$$

The domain of values for the due date (DD) is presented in formula (2).

$$DD: D_{DD} = [0, 12] \text{ [days]} \quad (2)$$

The domain of values for the safety stock SS is presented in formula (3).

$$SS: D_{SS} = [0, 200] \text{ [\%]} \quad (3)$$

The domain of values for the priority P is presented in formula (4).

$$P: D_{P} = [0, 10] \quad (4)$$

After that, the linguistic terms associated with each variable and the corresponding membership function for each linguistic term will be determined.

The linguistic degrees associated with PT are established in formula (5).

$$PT: LT_{PT} = \{VS, S, M, L, VL\} \quad (5)$$

Where: VS – very short, S – short, M – medium, L – large, VL – very large.

The linguistic degrees associated DD are established in formula (6).

$$DD: LT_{DD} = \{VC, C, M, F, VF\} \quad (6)$$

Where: VC – very close, C – close, M – medium, F – far, VF – very far.

The linguistic degrees associated with SS are established in formula (7).

$$SS: LT_{SS} = \{VS, S, M, B, VB\} \quad (7)$$

Where: VS – very small, S – small, M – medium, B – big, VB – very big.

The linguistic degrees associated with P are established in formula (8).

$$P: LT_{P} = \{NP, LP, MP, HP, VHP\} \quad (8)$$

Where: NP – non-priority, LP – low priority, MP – Medium Priority, HP – high priority, VHP – very high priority.

The membership functions of the input variables are presented in figure 2 and for the output variable, the priority, the functions are illustrated in figure 3.

The next step involves establishing the decisional inferences and the rule base. The rule base is a set of instructions that establish the influence the input variables have upon the output variable. Because there are five input variables, each of them having five membership functions, the total number of rules will be 125. Below there are some examples of rules:

1. If (PT is VS) and (DD is VC) and (SS is VS) then (P is HP)
2. If (PT is VS) and (DD is VC) and (SS is S) then (P is MP)
3. If (PT is VS) and (DD is VC) and (SS is M) then (P is MP)
4. If (PT is VS) and (DD is VC) and (SS is B) then (P is MP)
5. If (PT is VS) and (DD is VC) and (SS is VB) then (P is LP)
6. If (PT is VS) and (DD is C) and (SS is VS) then (P is MP)
7. If (PT is VS) and (DD is C) and (SS is S) then (P is MP)

……

53. If (PT is M) and (DD is VC) and (SS is M) then (P is HP)
54. If (PT is M) and (DD is VC) and (SS is B) then (P is MP)
55. If (PT is M) and (DD is VC) and (SS is VB) then (P is MP)
56. If (PT is M) and (DD is C) and (SS is VS) then (P is HP)
57. If (PT is M) and (DD is C) and (SS is S) then (P is HP)
58. If (PT is M) and (DD is C) and (SS is M) then (P is MP)
59. If (PT is M) and (DD is C) and (SS is B) then (P is MP)
60. If (PT is M) and (DD is C) and (SS is VB) then (P is MP)
61. If (PT is M) and (DD is M) and (SS is VS) then (P is HP)

……

119. If (PT is VL) and (DD is F) and (SS is B) then (P is MP)
120. If (PT is VL) and (DD is F) and (SS is VB) then (P is MP)
121. If (PT is VL) and (DD is VF) and (SS is VS) then (P is HP)
122. If (PT is VL) and (DD is VF) and (SS is S) then (P is MP)
123. If (PT is VL) and (DD is VF) and (SS is M) then (P is MP)
124. If (PT is VL) and (DD is VF) and (SS is B) then (P is MP)
125. If (PT is VL) and (DD is VF) and (SS is VB) then (P is LP)

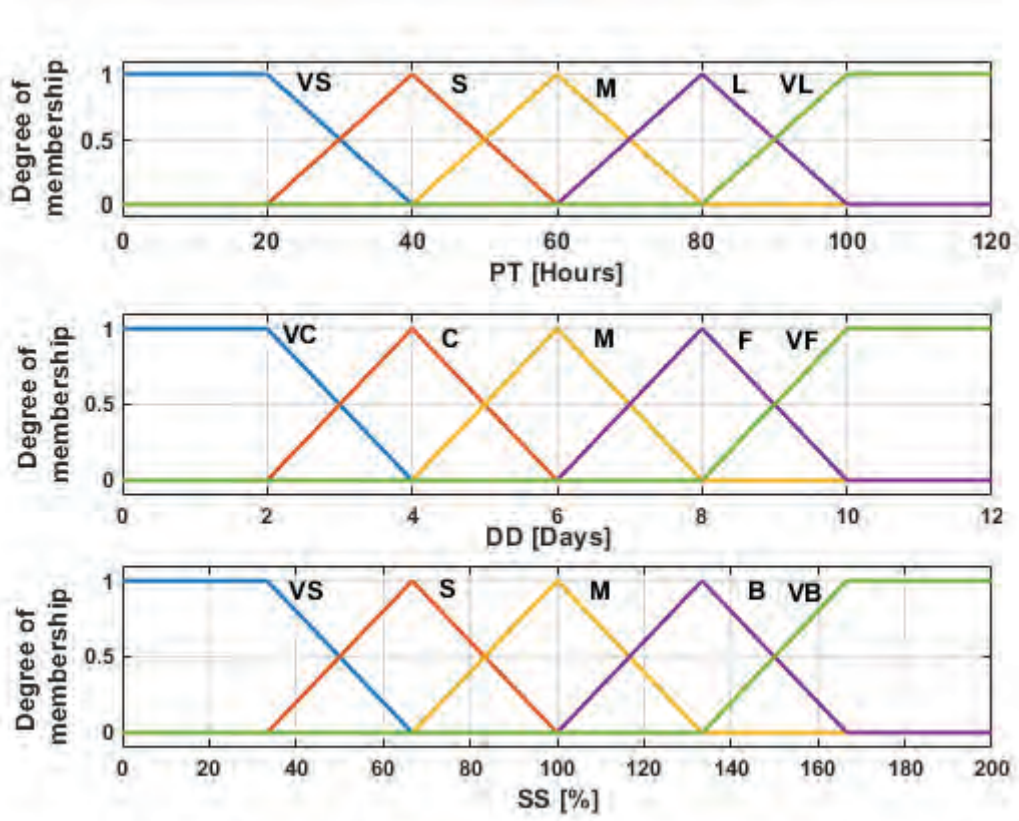

Figure 2. Membership functions associated to the input variables

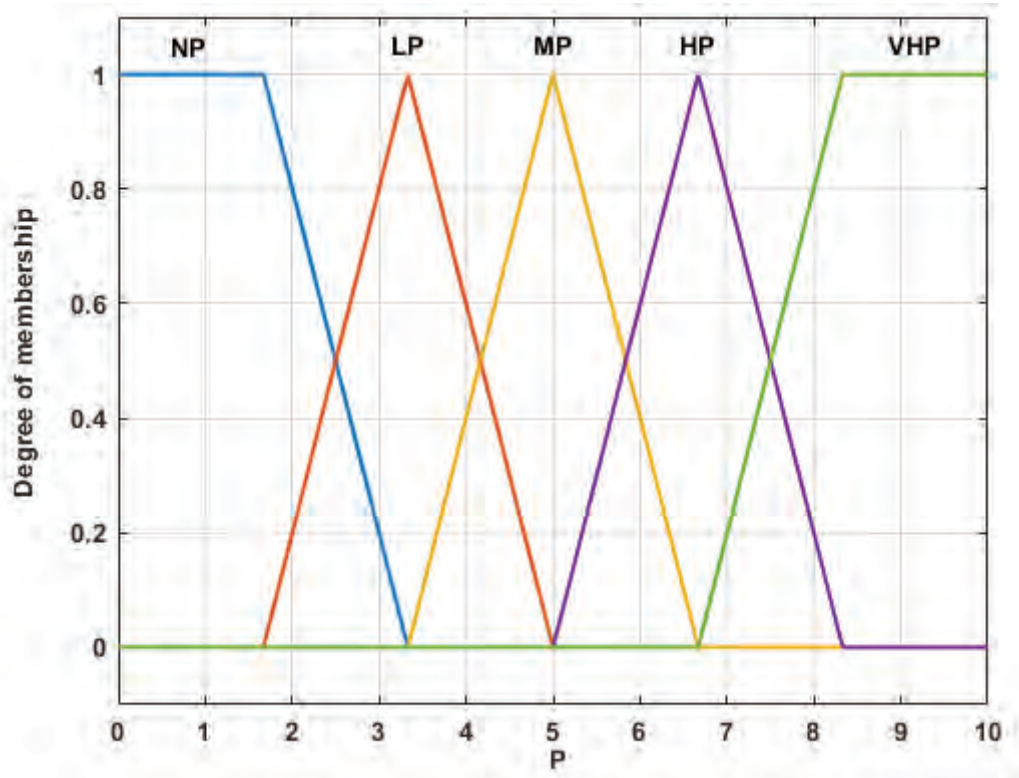

Figure 3. Membership function corresponding to the output variable

The final step is the data deffuzification, which means transforming the output variable from fuzzy values into concrete values that can be used and applied in production activities. Essentially, the fuzzy results are converted into real decisions or actions. The method used for deffuzification will be the centre of gravity method, as it is one of the most commonly used methods in practice. The decisional system that was developed is illustrated in figure 4.

Figure 5 presents the variation surface of the output variable (P) in relation to the input variables DD and PT.

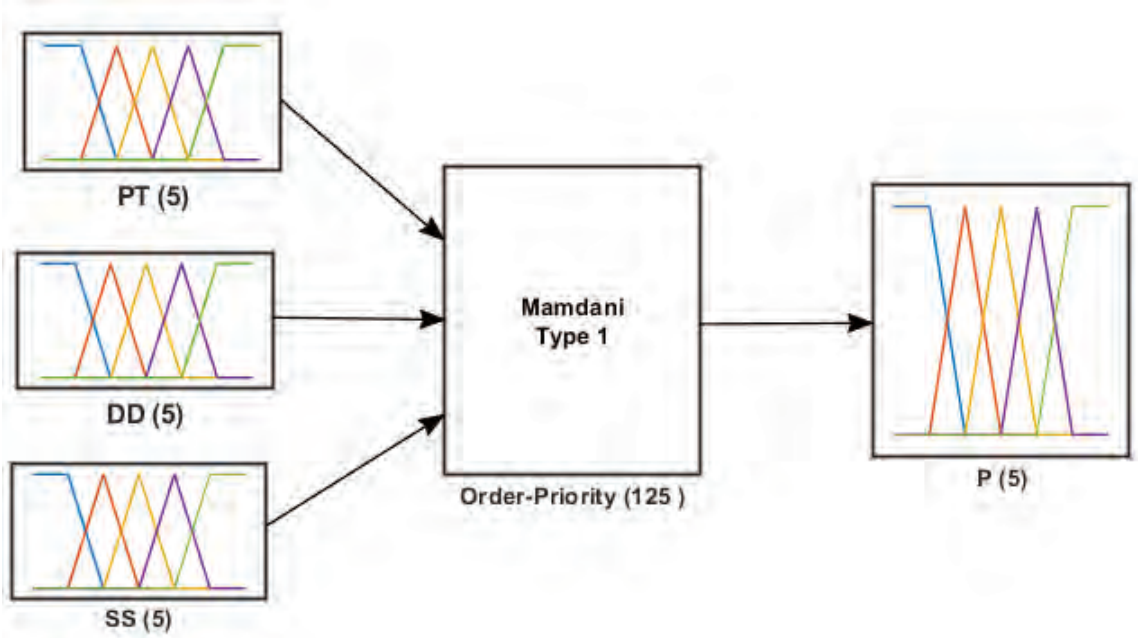

Figure 4. The decisional system developed in the fuzzy logic toolbox in Matlab

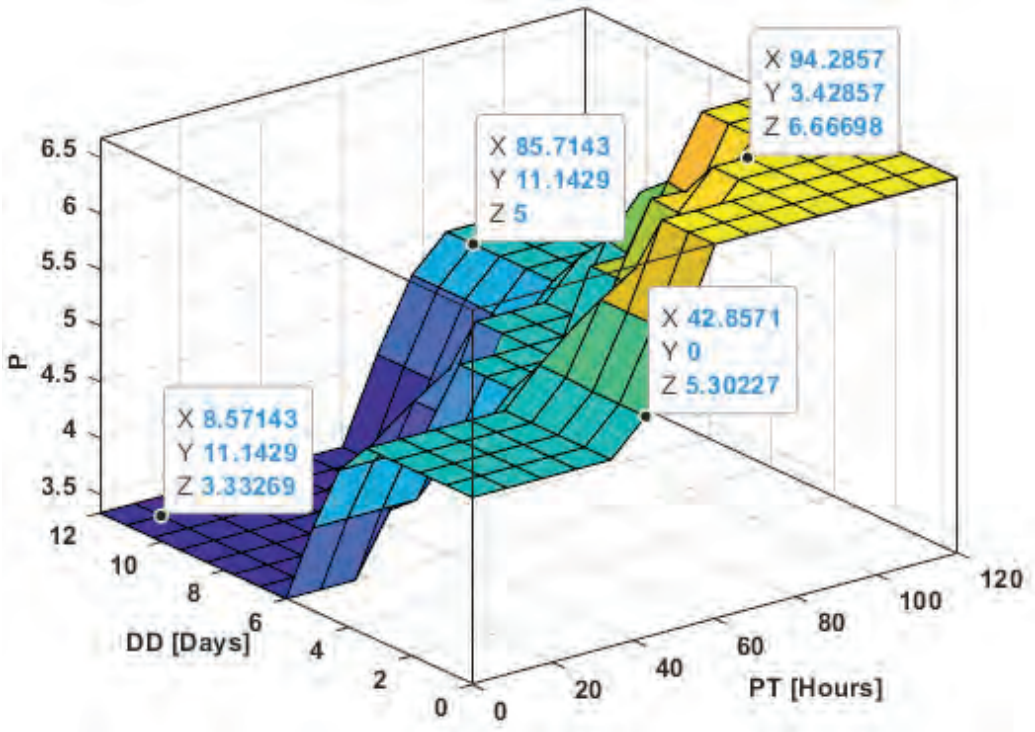

Figure 5. The variation surface of the output variable P in relation to the input variables DD and PT

Case study

To validate the functionality of the developed system, a case study will be examined. Three molds need to run in series production on an injection molding machine. Moreover, besides the series production, there is another mold for which a trial must be held, in order to send parts to the client so that the mold can be validated. The input data associated with each mold are as follows:

- For the 1st mold:
  - Production time PT*:* a series of 120 000 parts must be manufactured, with a standard time of 1.50 seconds per part. The mold has 8 cavities, so the cycle time is 12 seconds, resulting in a production rate of 40 parts/minute. Therefore, the time required to finish the whole batch is 50 hours;
  - Due date DD: 7 days;
  - Safety stock SS: 50% of a batch (60 000 pcs);

- For the 2nd mold:
  - Production time PT: a series of 18 000 parts must be manufactured, with a standard time of 12 seconds per part. The mold has 2 cavities, so the cycle time is 24 seconds, resulting in a production rate of 5 parts/minute. Therefore, the time required to finish the whole batch is 60 hours;
  - Due date DD: 5 days;
  - Safety stock SS: 100% of a batch (18 000 pcs);

- For the 3rd mold:
  - Production time PT: a series of 36 000 parts must be manufactured, with a standard time of 11 seconds. The mold has 2 cavities, so the cycle time is 22 seconds, resulting in a production rate of 5.45 parts/minute. Therefore, the time required to finish the whole batch is 110 hours;
  - Due date DD: 8 days;
  - Safety stock SS: 50% of a whole batch (18 000 pcs);

- For the 4th mold:
  - Production time PT: a series of 100 parts must be manufactured, with a standard time of 36 seconds. The mold has 1 cavity, so the cycle time is 36 seconds, resulting in a production rate of 1.67 parts/minute. Therefore, the time required to finish the whole batch is 1 hour;
  - Due date DD: 1 day;
  - Safety stock SS: 0% of a whole batch (0 pcs);

The input data for each mold will be successively introduced in the decisional system which will automatedly determine, based on the decisional inferences, the priority associated with each mold. Figure 6 exemplifies the way the system works, determining the priority of the 1st mold. Similarly, the process is repeated for the other three molds, resulting in the following priorities:

- Priority P for the 1st mold: 5.83.
- Priority P for the 2nd mold: 5.
- Priority P for the 3rd mold: 6.67.
- Priority P for the 4th mold: 6.67.

Therefore, the molds with the biggest priority are the 3rd and the 4th. A very important tie-breaking criterion could be the due date. If the 3rd mold is prioritized, then the due date of the 4th mold would be exceeded. Logically, the 4th mold should take precedence. Table 1 presents the input and output data obtained using the decisional system.

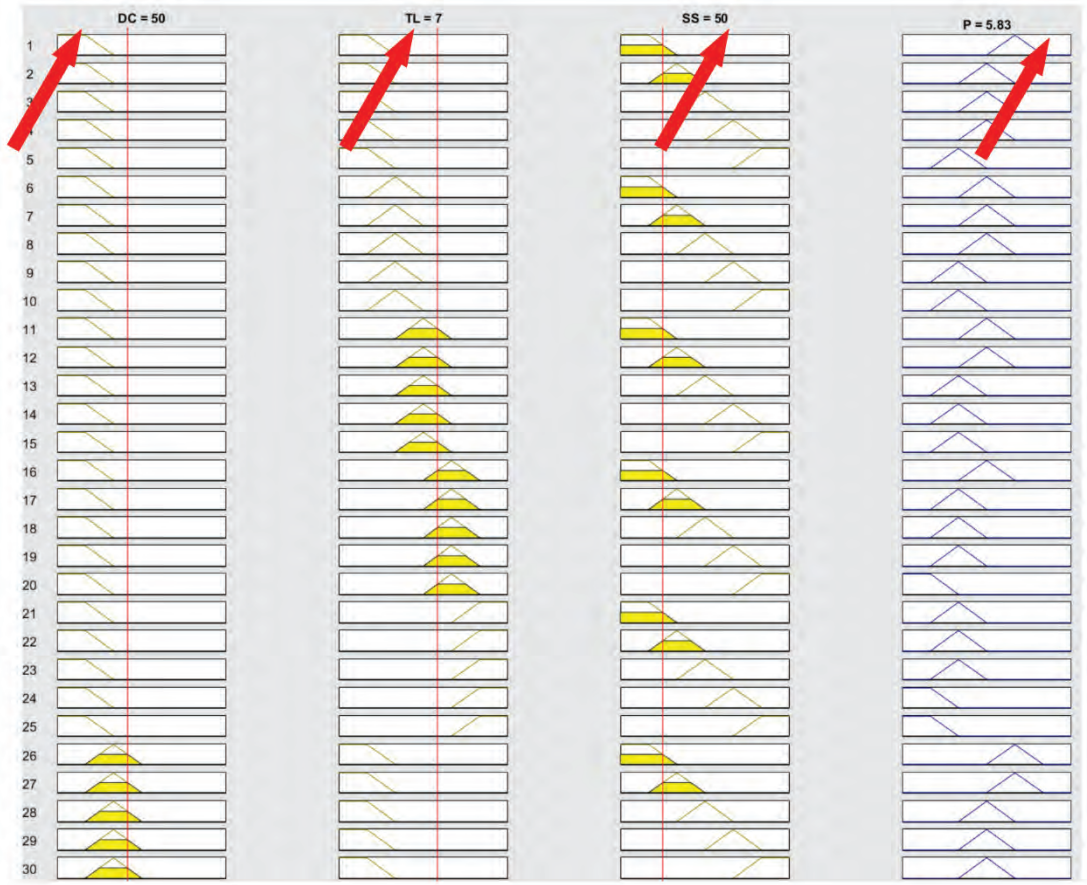

Figure 6. The priority of the 1st mold determined with the centre of gravity method

Table 1. Input and output data resulted from the case study

Mold	Production time PT [hours]	Due date DD [days]	Safety stock [%]	Priority
1	50	7	50	5.83
2	60	5	100	5
3	110	8	50	6.67
4	1	1	0	6.67

Conclusions

The results determined in this paper demonstrate that the application of fuzzy logic in production scheduling emerges as a promising direction for improving efficiency, adaptability and the overall performance in manufacturing processes. The inherent capability of fuzzy logic to adapt to uncertainties and imprecisions perfectly aligns with the dynamic nature of the modern industry. By introducing flexible decision-making framework, fuzzy logic allows production schedules to become more responsive to real-world variations, reducing disruptions and optimizing the management of resources. The capability of fuzzy logic to manage complex, multifactorial decision criteria significantly enhances the algorithm behind production scheduling. Practical applications of fuzzy logic in production scheduling emphasize its practical relevance across various industries. From manufacturing facilities to supply chain

management, the benefits of fuzzy logic extend beyond theoretical considerations, providing tangible improvements in operational efficiency and product quality.

Future perspectives include the development of a user interface for the presented system and the increase of its versatility by introducing new variables and providing the possibility of its adaptation to other applications in various industrial environments.

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RETHINKING INDUSTRIAL MANAGEMENT WITH STATISTICS AND AI: FROM BEAN COUNTING TO BUSINESS NIRVANA

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Abstract

Purpose: *This paper argues that the strategic integration of statistics and artificial intelligence (AI) can transform industrial management from a reactive practice to a proactive, predictive science. We propose that this integration will usher in a new era of "business nirvana," characterized by data-driven decision-making and optimized processes.*

Methodology/approach: *We conduct a comprehensive review of current literature and industry practices, synthesizing insights from statistical analysis, machine learning, and industrial management. This interdisciplinary approach allows us to explore the synergies between traditional statistical methods and cutting-edge AI technologies.*

Findings: *Our research reveals that the combination of statistical techniques and AI can significantly enhance industrial management in several key areas:*

1. *Descriptive and inferential statistics illuminate patterns and trends within industrial data, empowering data-driven decision making.*
2. *AI algorithms, particularly in machine learning, enable a transition from reactive to proactive maintenance, minimizing downtime and maximizing productivity.*
3. *AI-powered systems can dynamically optimize production scheduling, resource allocation, and supply chain management.*

Research limitations/implications: *While our findings are promising, further empirical research is needed to quantify the impact of these technologies across different industries and scales of operation. Additionally, the ethical implications of increased AI adoption in industrial settings warrant deeper investigation.*

Practical implications: *Industrial managers can leverage these insights to implement more sophisticated data analysis techniques, predictive maintenance programs, and AI-driven optimization strategies. This approach has the potential to significantly improve operational efficiency, reduce costs, and enhance competitiveness.*

Originality/value: *This paper offers a novel perspective on the transformative potential of integrating advanced statistical methods with AI in industrial management. By framing this integration as a paradigm shift from "bean counting" to "business nirvana," we provide a compelling vision for the future of industrial operations.*

Key words: *predictive analytics, artificial intelligence, statistics*

Introduction

For decades, industrial management has relied on intuition, experience, and the occasional spreadsheet. While these served us well, the information age demands a more sophisticated approach. Enter statistics and AI, the dynamic duo poised to revolutionize how we manage every facet of the industrial machine.

The Power of Statistical Insight

From Averages to Actionable Knowledge: Statistics unveils the hidden narratives within industrial data. Descriptive statistics paint a clear picture of current performance, while inferential statistics allow us to test hypotheses and identify trends. This empowers managers to move beyond "what is" to "what could be."

Taming Variability: The Art of Process Control: Statistical process control (SPC) techniques become the shield against uncertainty. By identifying and eliminating sources of variation, we ensure consistent product quality and optimize production efficiency.

From Averages to Actionable Knowledge: Unveiling the Hidden Stories in Industrial Data

Industrial data, once a sea of numbers, transforms into a captivating narrative through the lens of statistics. Descriptive statistics act as our narrator, summarizing the current state of affairs. Measures like central tendency (mean, median, mode) reveal the heart of the data, while dispersion (variance, standard deviation) paint a picture of its spread. Imagine a factory churning out widgets. Descriptive statistics tell us the average number of widgets produced per day, but also how much that number fluctuates.

This, however, is just the opening act. Inferential statistics, our intrepid detective, goes beyond description to uncover hidden patterns and trends. Hypothesis testing allows us to move from "the average widget weight is 10 grams" to a more powerful statement: "with 95 percent confidence, the true average widget weight falls within a range of 9.8 to 10.2 grams." This empowers us to not only understand what is happening, but also to test assumptions and identify areas for improvement.

For instance, imagine a hunch that a particular machine is producing widgets with a higher variance in weight. Inferential statistics allow us to test this hypothesis. If proven true, we can delve deeper, using techniques like correlation analysis to identify potential causes for the variation, such as machine calibration or environmental factors. This newfound knowledge empowers managers to shift their focus from simply monitoring the process ("what is") to proactively optimizing it ("what could be").

Taming Variability: The Art of Process Control

Imagine a master chef striving for consistent culinary excellence. Just as a slight variation in spice quantity can ruin a dish, variability in industrial processes can wreak havoc on product quality and production efficiency. Statistical process control (SPC) techniques become the shield against this uncertainty.

At the core of SPC lie control charts, the battle maps for process stability. These charts depict the natural variation inherent in a process, using statistically derived upper and lower control limits (UCL and LCL). As long as data points fall within these limits, the process is deemed

stable and predictable. However, any data point venturing beyond the control limits signals a red alert, indicating the presence of a "special cause" variation.

Identifying these special causes is where the magic happens. By employing statistical tools like Pareto charts and cause-and-effect diagrams, we can pinpoint the root cause of the variation, be it a faulty machine component, improper calibration, or fluctuations in raw materials. With this knowledge in hand, managers can take corrective action, ensuring consistent product quality and maximizing production efficiency.

In essence, SPC transforms industrial processes from a guessing game to a science, allowing managers to proactively maintain stability and achieve operational excellence.

Handling Big Data

Massive Datasets: Traditional statistical methods often struggle with the sheer volume of data generated in today's world. AI, particularly machine learning algorithms, can efficiently analyze these massive datasets, uncovering hidden patterns and trends that might be missed by human statisticians.

Automating Mundane Tasks:
Data Cleaning and Preprocessing: Statistical analysis often involves tedious data cleaning and preparation tasks. AI can automate these processes, freeing up statisticians to focus on more complex analyses and interpretation.

Feature Engineering and Selection:
Identifying Important Variables: Choosing the right variables for analysis is crucial. AI can automatically identify the most relevant features from large datasets, improving the accuracy and efficiency of statistical models.

New Statistical Techniques

Machine Learning as a Statistical Tool: Machine learning algorithms themselves can be seen as a new set of statistical tools. Techniques like decision trees, random forests, and deep learning models are capable of uncovering complex relationships within data that might be invisible to traditional methods.

Enhanced Hypothesis Testing:
Advanced Statistical Modeling: AI can be used to develop more sophisticated statistical models for hypothesis testing. This allows statisticians to account for complex interactions and non-linear relationships within data, leading to more robust and reliable conclusions.

Explainable AI (XAI):
Understanding AI's "Black Box": A major challenge with AI models is their opacity. XAI techniques are being developed to help statisticians understand how AI arrives at its conclusions, fostering trust and enabling a collaborative approach to data analysis.
Faster and More Powerful Analysis: AI is accelerating the pace and power of statistical analysis, allowing statisticians to extract more value from data in a shorter time frame.
Democratization of Statistics: AI-powered tools are making advanced statistical analysis more accessible, even for those without a deep statistical background. This opens doors for wider application of data science across various fields.

New Discoveries and Applications: The ability to analyze complex datasets is leading to new discoveries and applications of statistics in various fields, from healthcare and finance to social sciences and environmental research.
However, it's important to remember that AI is a tool, and like any tool, it requires careful use.

Statisticians still play a crucial role in:

Understanding the data and its limitations.
Choosing the right AI techniques for the specific problem.
Interpreting the results of AI models in a statistically sound manner.
Ensuring the ethical implications of AI-driven statistical analysis are considered.

The future of statistics lies in a collaborative approach, where human expertise and AI capabilities work together to unlock the full potential of data analysis.

The Rise of the Machines: AI in Industry 4.0

Predictive Power: From Reactive to Proactive Maintenance: AI algorithms, particularly machine learning, can analyze sensor data to predict equipment failures before they occur. This proactive approach minimizes downtime, maximizes productivity, and reduces maintenance costs.

Optimizing the Symphony: AI-Powered Scheduling and Resource Allocation: AI can become the conductor of the industrial orchestra, dynamically scheduling production runs, allocating resources, and optimizing supply chains. Real-time data analysis ensures efficient workflows and minimizes resource bottlenecks.

Predictive Power: From Reactive to Proactive Maintenance

Imagine a factory floor bustling with activity. Suddenly, a crucial machine sputters and grinds to a halt, throwing production into disarray. This reactive approach to maintenance, where we fix problems only after they occur, is costly and inefficient. Enter the hero of predictive maintenance: AI, specifically machine learning algorithms.

These algorithms act as industrial fortune tellers, analyzing vast amounts of sensor data collected from equipment. By identifying subtle patterns and correlations within this data, machine learning can predict equipment failures before they happen. Think of it as identifying a fever before the full-blown flu hits. This allows for proactive maintenance, scheduling repairs during downtime or replacing components before they cause a catastrophic breakdown.

The benefits are undeniable. Downtime is minimized, maximizing production efficiency and worker productivity. Imagine a scenario where a critical furnace is predicted to malfunction within the next week. With this knowledge, managers can schedule preventive maintenance during a planned production lull, avoiding a costly and disruptive breakdown. Furthermore, proactive maintenance extends equipment lifespan, reducing long-term replacement costs.

This shift from reactive to predictive maintenance is a cornerstone of Industry 4.0, and AI stands as the driving force behind this transformation.

Optimizing the Symphony: AI-Powered Scheduling and Resource Allocation

Imagine a complex orchestra, each instrument playing its part in creating a harmonious symphony. An industrial facility operates with similar complexity, with production lines, resources, and supply chains needing to function in perfect coordination. However, achieving this harmony can be a constant challenge, with bottlenecks and inefficiencies often disrupting the flow. Here's where AI steps in, wielding the baton as the conductor of this industrial orchestra.

AI-powered scheduling and resource allocation algorithms become the maestro, analyzing real-time data on production demands, resource availability, and material flow. These algorithms can then dynamically optimize production schedules, ensuring a smooth and efficient workflow. Think of it as automatically adjusting the tempo and volume of each instrument in the orchestra to create a flawless performance.

By constantly analyzing and adapting, AI minimizes resource bottlenecks. Imagine a scenario where a sudden surge in demand for a particular product requires a shift in production priorities. AI can analyze available resources and production lines, then automatically re-allocate resources and adjust schedules to meet the new demand efficiently. This dynamic adaptation ensures that the entire industrial machine operates at peak performance, maximizing output and minimizing waste.

AI-powered scheduling and resource allocation is not just about efficiency; it fosters agility. In today's ever-changing market landscape, the ability to adapt to fluctuating demands is crucial. By leveraging AI's analytical prowess, industrial managers can ensure their factories function as a well-coordinated symphony, delivering exceptional results.

The Human Factor: A Collaborative Future

Statistics and AI are not silver bullets, but rather powerful tools that augment human expertise. This paper argues against a dystopian vision of robots replacing humans. Instead, we envision a future where human intuition and strategic decision making are amplified by the power of data analysis.

The rise of statistics and AI in industrial management might conjure up images of robots taking over factory floors, relegating humans to the sidelines. However, this paper advocates for a different vision: a future where human expertise and data-driven insights work in harmonious collaboration.

Statistics and AI are powerful tools, but they are not replacements for human judgment. While AI excels at analyzing vast datasets and identifying patterns, human intuition remains invaluable in interpreting those patterns and making strategic decisions. Consider a situation where AI identifies a potential anomaly in a production process. The human manager, armed with experience and contextual knowledge, can then assess the anomaly's significance and determine the most appropriate course of action.

Furthermore, effective industrial management requires more than just data analysis. It demands strong leadership, clear communication, and the ability to motivate teams. These are all inherently human qualities that AI cannot replicate.

The future of industrial management lies in a collaborative approach. Humans, leveraging their experience and judgment, will guide the strategic direction. Meanwhile, statistics and AI will provide the data-driven foundation for informed decision making and real-time process optimization. This collaboration will unlock a new era of industrial efficiency, innovation, and ultimately, a more sustainable and competitive future.

The Road to Collaboration: Navigating Challenges

The path to a successful human-AI partnership is not without its hurdles. Overcoming resistance to change is paramount. Some human workers may fear job displacement or struggle to adapt to new workflows. Effective communication strategies and comprehensive training programs are crucial to address these concerns and foster a culture of collaboration.

Clear communication between humans and AI systems also presents a challenge. AI algorithms can be complex "black boxes," making it difficult for humans to understand their decision-making processes. Developing explainable AI (XAI) techniques that provide transparency into how AI arrives at its conclusions is essential for building trust and ensuring human buy-in.

The ethical implications of AI in industrial management cannot be ignored. AI algorithms can perpetuate biases present in the data they are trained on, leading to discriminatory practices. For instance, an AI-powered recruitment tool trained on historical hiring data might favor candidates with certain demographics. Ensuring fairness and bias detection in AI algorithms is crucial to uphold ethical standards.

Transparency is another key ethical consideration. When AI is used to make decisions that impact people's livelihoods, it is essential to understand the rationale behind those decisions. This necessitates ongoing research into developing transparent and accountable AI systems.

The future of industrial management lies in a collaborative approach. Humans, leveraging their experience and judgment, will guide the strategic direction. Meanwhile, statistics and AI will provide the data-driven foundation for informed decision making and real-time process optimization. This collaboration will unlock a new era of industrial efficiency, innovation, and ultimately, a more sustainable and competitive future.

By embracing this collaborative future, we can harness the power of statistics and AI to propel industrial management to new heights, achieving not just efficiency, but a future that is ethical, sustainable, and empowering for both humans and machines.

Mathematics, Statistics and AI

Unfortunately, there's no single mathematical equation that definitively proves statistics and AI will change industrial management. That's because the impact is multifaceted and depends on various factors. However, we can create a conceptual equation to illustrate the potential for improvement:

Improved Industrial Performance (IIP) = f(Statistical Efficiency (SE) x AI-Driven Optimization (ADO))

Here's a breakdown of the equation:

IIP (Improved Industrial Performance): This represents the overall positive impact on industrial performance metrics like production efficiency, cost reduction, and product quality.

SE (Statistical Efficiency): This captures the effectiveness of using statistics. It considers factors like:

Reduction in Variability (RV): Measures the decrease in process fluctuations achieved through techniques like SPC. This leads to consistent product quality and predictable production runs.

Improved Decision Making (IDM): Represents the ability to make data-driven decisions based on statistical analysis. This leads to better resource allocation, optimized scheduling, and proactive maintenance strategies.

ADO (AI-Driven Optimization): This captures the impact of AI on industrial processes. It considers factors like:

Predictive Maintenance (PM): AI algorithms analyze sensor data to predict equipment failures before they occur, minimizing downtime and maintenance costs.

Dynamic Scheduling and Resource Allocation (DSRA): AI optimizes production schedules and resource allocation in real-time based on changing demands, minimizing bottlenecks and maximizing resource utilization.

Explanation:

This equation suggests that Improved Industrial Performance (IIP) is a function of both Statistical Efficiency (SE) and AI-Driven Optimization (ADO). As the effectiveness of statistics (SE) and AI applications (ADO) increase, the overall performance of industrial management (IIP) improves.

Limitations:

Non-quantifiable factors: The equation doesn't account for non-quantifiable factors like employee morale, leadership skills, and market fluctuations, which also influence industrial performance.

Data quality: The effectiveness of both statistics and AI heavily relies on the quality and quantity of data available.

Implementation challenges: Integrating these technologies into existing workflows and overcoming resistance to change can be challenging.

While a single equation can't definitively prove the impact, the conceptual model highlights the potential of statistics and AI to significantly improve industrial management. By leveraging data-driven insights and AI capabilities, industries can achieve greater efficiency, optimize processes, and ultimately achieve a significant competitive advantage.

Discussion and conclusions

By embracing the transformative potential of statistics and AI, industrial management can transcend its traditional role. We move from bean counting to business nirvana, achieving new levels of efficiency, quality, and profitability. This paper paves the way for further research, exploring the ethical considerations, integration challenges, and best practices for this exciting new frontier.

In conclusion, the integration of statistics and artificial intelligence in industrial management represents a paradigm shift from traditional methodologies to a more sophisticated, data-driven approach. This transition from mere “bean counting” to achieving “business nirvana” enables organizations to optimize their operations, enhance decision -making processes, and drive innovation.

By leveraging the predictive and prescriptive capabilities of AIand the analytical power of statistics, businesses can not only streamline efficiencies but also uncover new opportunities for growth and competitiveness. As the industrial landscape continues to evolve, embracing these advanced tools will be crucial for companies aiming to stay ahead in a rapidly changing

market. Ultimately, the convergence of statistics and AI in industrial management not only transforms the way businesses operate but also sents the stage for a future where data-driven insights lead to sustained success and strategic advantage.

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USE OF MANAGEMENT TERMINOLOGY IN A GLOBALISED WORLD. BEYOND AN APPARENT TRANSFORMATION

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Abstract

Purpose *– The aim of the authors of the article is to identify trends in the use of managerial specialist language in its operation and expression in the current global context, with its widely accepted attributes of volatility, uncertainty, complexity and ambiguity. Subsequently, for such a topic, which is very rarely dealt with explicitly in the literature, it is desirable to identify the extent to which a standard, classical general language is being preserved and, complementarily, what are the sources of change (renewal, transformation of meaning, internationalization, regionalization, abandonment of certain concepts, etc.).*

Methodology/approach *– The research is carried out by highlighting specific aspects of the topic already manifested in the literature and practice. Various approaches found in the literature are explored. In addition, interviews of prestigious international personalities in the field of management are selected and bibliometrically analyzed in order to identify frequencies of use of certain terms and to highlight possible conceptual convergences and new trends in management terminology.*

Findings *– Globalization, and in particular the economic component, is causing changes in managerial conceptualization and expression. Important influencing factors, in terms of intensity and extent, are the digitalization of processes and the contemporary internationalization of business.*

Research limitations/implications *– The scope and validation of the findings is limited by the possibility to investigate exhaustively, in large groups, nationally and internationally, at the level of specialists and everyday language, young people and adults, etc. the ways in which contemporary management terminology is used. The diversity of areas in which management knowledge is applied should also be considered as a limitation.*

Practical implications *– The usefulness of such research can be manifested both at the academic level (how we form and cultivate a topical managerial culture, relevant to the practical work of organizations but also in terms of temporality) and at the level of organizations and business (through the need for a minimum level of semantic interoperability).*

Originality/value *– Scanning the literature produced strictly on this topic reveals an insignificant concern in terms of popularized results. Implicitly, the topic has been marginally addressed in some complementary works as a framing of the subject. This can be seen as a direction for studies and research at the national level in interdisciplinary teams (at least in fields such as linguistics and economics), the aim being to bring the topic into line with international managerial realities.*

Key words: *management, terminology, globalization.*

1. Introduction to the general framework of the proposed topic

Management has progressed in recent times (the early 2000s can be taken as a benchmark) in terms of the content of specific processes, but also in terms of scope and issues covered. From an academic point of view, in addition to the classical component, often referred to as "the basics of management", we are seeing the emergence of new trends, new meanings of concepts and different authors (from different geographical areas) who are becoming increasingly known for their approaches. The above-mentioned management foundations are becoming more comprehensive, allocating more space to emerging concepts, changing the very idea of the base, the foundation, in a narrow, limiting, restrictive sense, moving to a more flexible and permissive approach for the growth of the conceptual managerial heritage of reference. The conceptual basis of the scientific foundation of management is becoming increasingly broad, influenced, of course, by the increasingly diversified links with the practice.

Globalization, a long-standing process but with ever-changing forms of manifestation, has also brought with it challenges in the field of management. Stephen P. Robbins and Mary Coulter (2016, p. 144) point out that "As we look at managing in today's global environment, we want to focus on two important issues. The first issue involves the challenges associated with globalization, especially in relation to the openness that is part of being global. The second issue revolves around the challenges of managing a "global workforce". We have linked the main topic of the article to globalization because we believe that this is the main framework that has provided, in terms of space and time, the premises for the development of contemporary management and, implicitly, of current terminology. Digitization facilitates knowledge in the field of management and in the sense of acceptance in management of more and more concepts specific to IT, thus reaching some associations that were impossible 20 years ago, such as digital leadership (Espina-Romero, Noroño Sánchez, Rojas-Cangahuala, Palacios Garay, Parra, Rio Corredoira, 2023) or digital management (Khorsand, Peráček, 2023). Globalization has of course imposed a certain level of freedom in all areas of social and professional life, and so it was an irreversible process in management as well. In the early 2000s, Professor Abrudan Ioan (2012, p. 28) drew attention, however, to the need to find a certain balance in the specific conceptualizations of management at national level: "I am not an advocate of popularizing management through abusive associations and [...] I will not support the concepts of *literary* management or management in who knows what field for which life has already consecrated a term understood by everyone, but I argue that the current space of meaning allocated to management, is too narrow and begins to become suffocating, and those who manage it are too few in relation to the real manifestations of the *phenomenon of management* and in relation to the expectations of the Romanian public". Talking about the terms management and leadership invoked before, will it not be long before we will also see the use of *leaderment* and *managership*?

Terminology is the total body of words and concepts specific to a field, in this case management. There are differences of approach, in the sense of specialization, which subsequently becomes internationalized, of terms including at national level, depending on the dominant industry in a country. For example, one can identify a specialization of terminology in the field of quality management in Japan, which is subsequently borrowed and used in other countries. The same can be said for production management, which is specifically addressed as a high specialization of processes, and therefore of terminology, for Germany. At the level of the Romanian school of management, the idea and publication of a management dictionary, coordinated and published in 2011 by the reputed specialist Ovidiu Nicolescu, with the participation of numerous specialists from national university centers, is welcome. However, it is also necessary, simply because of its timeframe, to republish it at the same time as updating the terms.

From a methodological point of view, which is presented in detail in the next section, in order to investigate the use of managerial language, the top ten known authors listed on https://globalgurus.org/management-gurus-top-30/ were selected, documents (.doc format)

with interviews given by them were generated and processed for each of them and integrated with QDAminer software (useful for qualitative analysis).

2. Studies and research on contemporary management terminology

One trend that has emerged is the looseness with which synonymous terms for a given concept are used and accepted to a fairly large extent. This is seen both in the academic world (see contemporary scientific research) and in everyday practice. Figure 1 illustrates this for the concept of entrepreneurship. In a training session on digital education held at the authors' home institution, when asked to indicate associations for entrepreneurship, the following semantic variants were indicated among the 18 responses: business, initiative, developer, freedom of action, management.

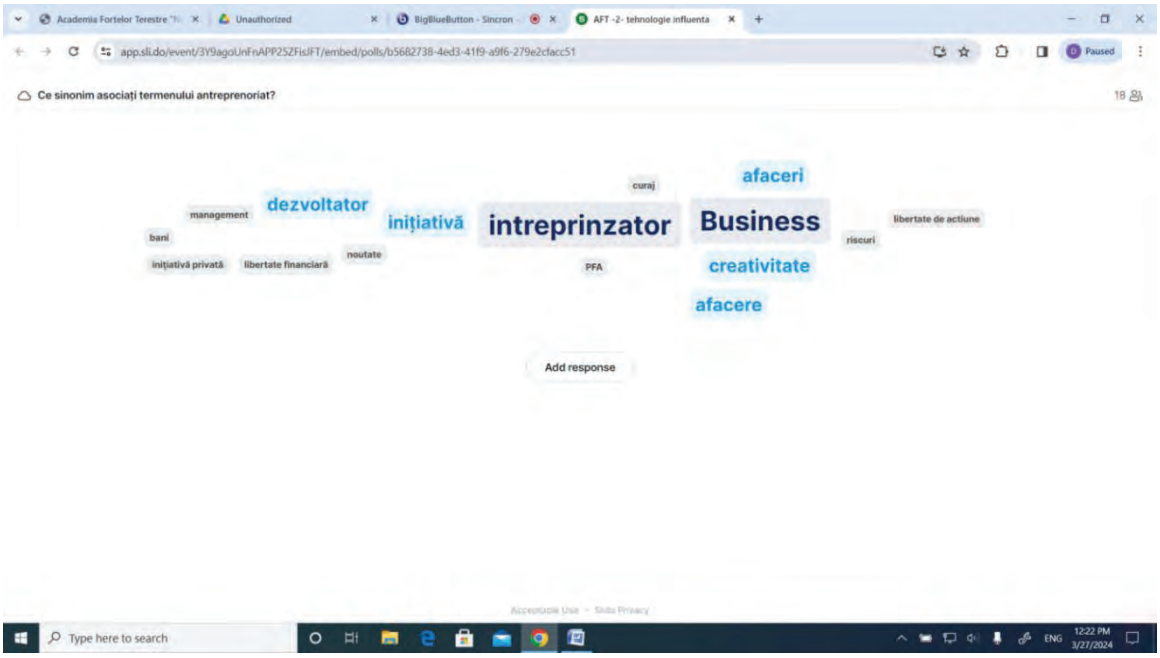

Fig. 1. Synonymous expression possibilities for entrepreneurship
Source: Authors

The evolution of terminology is peculiar to countries that for various reasons (often due to dictatorial political-military regimes) have not had access to a diversified management literature. Coupled with the lack of a free market economy, the conditions for the development of specific language have been severely limited. The development of managerial terminology can be directly related to the democratically based economic development of a state. Economic dynamics, both at the national level and in international trade relations, also determine the dynamics of specific vocabulary and the pressure for change or renewal. This is also the case of some neologisms recently accepted in the Romanian explanatory dictionary (e.g. business). The need to popularize managerial terminology so as to create semantic interoperability is also highlighted by the large number of internet resources, some of them produced by professional organizations themselves, which provide those interested with the most common or most frequently used terms and their explanations. At the level of academic literature, more specifically in the case of management manuals or handbooks, some of which have reached more than 15 global editions, comparing in the same gap of about 20 years, we

observe a diffusion of the concepts exposed and a much better expressed link to the diverse realities of the contemporary world (example - diversity management, social responsibility management, operations management, etc.). In fact, all the processes linked to the ITC industry and digitization are a real factor in the change in management terminology, both in terms of diversity and intensity of change. The issue must be seen in two senses, both in terms of the role played by the ITC industry and digitization in changing business processes and their role (and potential for change) in managerial communication.

The following are the main features of the use of managerial terminology as they emerge from the qualitative research undertaken.

Based on a ranking by https://globalgurus.org/ of the top 30 best management professionals in the world in 2024, we tried to identify the current trend of topics and directions of action by analyzing the terms used in public speeches. The analysis focused on the top 10 professionals in the hierarchy and their speeches were analyzed using the qualitative data analysis tool, QDA Miner.

Fig. 2. Word Cloud based on Bob Nelson's speeches
Source: Authors, own processing in QDA Miner

Dr. Bob Nelson's track record as president of his own management consulting and training company, which specializes in helping organizations improve their management practices, programs and systems, makes him one of the world's leading experts on employee motivation, performance, engagement, recognition and reward. Thus, analyzing Figure 2, based on the analysis of Bob Nelson's speeches, confirms the concern for employees, human resources in general, new motivation strategies, trends adapted to the global context and the practical reality in which organizations operate.

Fig. 3. Word Cloud based on Brian Moran's speeches
Source: Authors, own processing in QDA Miner

Brian Moran has extensive experience as a corporate executive and consultant to world-class companies, coupled with experience as an entrepreneur, in which capacity he has personally launched and led successful businesses and contributed to the success of many others. In this context, his speeches focus on business solutions, new markets, identifying resources, highlighting the importance of small and medium-sized enterprises in the development of the economy (fig. 3). He also implemented the concept of the "12-week year" as a better time management solution, arguing that shorter periods of time encourage a focused and specific approach to achieving goals. The 12-week year tool has also been used to develop a practical guide for writers in academia and business seeking to increase their productivity. (Thrall & Moran & Lennington, 2021)

Fig. 4. Word Cloud based on John Kotter's speeches
Source: Authors, own processing in QDA Miner

John Kotter has been a professor at Harvard Business School for over 30 years and has distinguished himself over the years as an internationally renowned author on leadership and change. Subsequently, the experience he gained while teaching has transferred to the private sector, where he has built leaders' skills in being able to meet future business challenges and react quickly and agilely to them. From Fig. Kotter's concerns with a focus on change, human resources, challenges, leadership and response strategies can be seen in Figure 4.

Fig. 5. Word Cloud based on James Collins' speeches
Source: Authors, own processing in QDA Miner

What James Collins brings to his work as a business consultant, author and leadership speaker is the concept of sustainability and directions for business growth. Another element of James Collins' competitiveness comes from his ability to gather information and present it in an easy-to-understand format so that leaders around the world can achieve a higher rate of success in everything they do. The elements that emerge from Fig. 5 highlight his qualities as a speaker concerned with inspiring with speeches emphasizing people, leaders, companies, time as a resource, success, generations, strategies, etc.

Fig. 6. Word Cloud based on Philip Kotler's speeches
Source: Authors, own processing in QDA Miner

Dr. Philip Kotler, known as the father of modern marketing, is also a world-renowned management guru. His experience of business concepts has been highlighted in this context, and he has been engaged by companies all over the world to train and develop their people to meet the challenges of the moment and ahead. Obviously, in the wordcloud in figure 6, the concept of marketing is evoked along with customers, companies, advertisements, brand, products, etc.

Fig. 7. Word Cloud based on Jeffrey Pfeffer's speeches
Source: Authors, own processing in QDA Miner

Jeffrey Pfeffer has been named one of the top 25 management thinkers by *Thinkers 50* and one of the most influential international HR thinkers by *HR Magazine*. In his research and speeches, he has focused on workplace, career, stress, organizational health, job defining, etc. (fig. 7), concerns that demonstrate a particular focus on analyzing the factors that lead to improved workplace conditions for organizational progress.

Fig. 8. Word Cloud based on W. Chan Kim's speeches
Source: Authors, own processing in QDA Miner

W. Chan Kim is a professor of international strategy and management and author of Blue Ocean Strategy, so useful in identifying potential new markets for organizations and shaping new demands. (Yunus & Sijabat, 2021) Fig. 8 concretely highlights the concerns of this specialist on the direction of innovation in companies, configuration of new business strategies for penetrating new markets, identification of new opportunities, focus on customers, competition and career. W. Chan Kim is recognized for his contributions both as an author and as a practitioner in the field of global strategy.

Fig. 9. Word Cloud based on Robin Speculand's speeches
Source: Authors, own processing in QDA Miner

Robin Speculand is a digital strategy and implementation specialist, an established consultant and keynote speaker who has founded and runs three companies. He has differentiated himself from fellow specialists on the strategy side by focusing on the implementation stage, which he believes has been consistently ignored in strategy discussions. A proponent of digital transformation, Robin Speculand has developed revolutionary methods and techniques aimed at creating a digitally oriented organization or measuring an individual's level of digital maturity. The terms used in his speeches (fig. 9) reveal his concerns. Thus, in addition to implementation, strategies and leadership, one can observe the frequent use of the elements: execution, actions, companies, employees, plan, project, communication, digital, etc.

Fig. 10. Word Cloud based on Barbara Kellerman's speeches
Source: Authors, own processing in QDA Miner

Barbara Kellerman is a leadership specialist and founding executive director of the Center for Public Leadership at the Harvard Kennedy School. Barbara Kellerman has given speeches and seminars to audiences around the world and is considered a pioneer in the field of leadership and followership. Figure 10 highlights the ideas she highlights in her speeches. We highlight terms such as leadership, people, leaders, time, followers, studies, school, books, college, etc. Barbara Kellerman is the author and editor of a considerable number of books, which she constantly quotes in her speeches.

Fig. 11. Word Cloud based on Herminia Ibarra's speeches
Source: Authors, own processing in QDA Miner

A recognized specialist in leadership, Herminia Ibarra is Professor of organizational behavior at London Business School, with a focus on analyzing career development pathways. It can be seen from Fig. 11 that she is concerned with career, leadership, people, work, professional, time, while also touching on reinvention, identity, change, perspectives, authenticity, behaviors, skills, reflections, etc. There is a multitude of terms used to outline, as defined in one of her most successful books, *Strategii neconvenționale pentru reinventarea carierei [Unconventional Strategies for Career Reinvention].*

Fig. 12. Common elements in the speeches of the management specialists analyzed
Source: Authors, own processing in QDA Miner

Fig. 12 highlights the common terms used by the 10 specialists, considered management gurus. They are highly professional in their activities (teaching, scientific writing, consultancy, company management) and all share a common concern to improve management practice and theory through people and leadership. This objective is joined by action areas such as marketing, strategy, innovation, market, research, implementation, career, customer. Recognition of the quality in these speeches comes from the results achieved by organizations that have implemented the ideas and strategies they promote. Starting from a common overall objective, they have achieved performance by developing ideas and directions for development based on different concepts and methods.

Discussions and conclusions

Globalization is a factor in the internationalization of management terminology. We are talking here about both the borrowing of concepts into management practice and their formalization in a country's vocabulary. As the English language has been an instrument of communication across the physical borders of a country, a part of the specialized vocabulary in management originates along these lines. The existence of large companies, with subsidiaries in different countries, has favored the use and transformation of management terminology in the sense described above.

Depending on the major area of practical and academic concern of the authors analyzed in terms of the terminology used, the frequency of certain terms also takes precedence in the case of each author. The integration of the ten working papers produced specifically for each author, followed by their analysis with QMiner, highlights the terms frequently used in management, trending in the current global context. The people orientation is also noted here, which is also in line with current management realities, with some interventions supporting the (re)humanization of management.

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CONTRIBUTIONS OF THE EXPERT SYSTEMS AND MACHINE LEARNING TECHNIQUES AT THE PRESCRIPTIVE MAINTENANCE LEVEL

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Abstract

Purpose *– This paper aims to present the main factors necessary for the implementation of machine learning techniques applied to intelligent systems for the development of prescriptive maintenance systems.*

Methodology *– Expert systems and machine learning systems have the capacity for ongoing updates and enhancements, enabling organizations to fine-tune their maintenance approaches in response to changing insights and feedback. Industry 4.0 has brought significant contributions in terms of re-engineering prescriptive maintenance systems.*

Findings *– Expert systems and machine learning techniques complement each other in prescriptive maintenance by leveraging historical data, real-time monitoring and adaptive decision-making to enhance equipment reliability, minimize downtime and optimize maintenance strategies.*

Research implications *– Both systems can effortlessly incorporate Internet of Things sensors for the acquisition of real-time data, improving the precision and promptness of forecasts and suggestions.*

Practical implications *– Automated expert systems enhance efficiency, precision and prompt responsiveness in maintenance operations through the application of predetermined rules, analysis of data and decision-making, all accomplished without the need for manual input at each stage.*

Originality *– This article highlights the significant contributions of expert systems in the context of prescriptive maintenance activities of organizations.*

Key words: *Prescriptive maintenance, Expert systems, Knowledge acquisition.*

Introduction

Prescriptive maintenance is a modern approach to equipment maintenance that goes beyond reactive and preventive maintenance. It uses advanced analytics to predict potential equipment failures and suggests appropriate interventions to avoid them. By combining historical data, real-time sensor information and predictive analytics, prescriptive maintenance allows organizations to take a proactive approach to equipment maintenance, reducing the risk of unplanned downtime and optimizing asset performance (Pop-Suărășan and Ungureanu, 2023). Both from the point of view of expert systems and in the case of the acquisition of technical data specific to production processes, a rapid evolution of decision-making systems can be noted.

Expert systems, a crucial branch of Artificial Intelligence, leverage domain knowledge from subject matter experts and encode it into a knowledge base. These systems excel in diagnosing equipment health, identifying root causes of potential failures and recommending appropriate maintenance actions based on predefined rules and heuristics (Milad et al., 2016). With their sophisticated inference engine, expert systems are the go-to solution for prescriptive maintenance, providing unparalleled diagnostic capabilities and decision-making support.

The combination of expert systems and machine learning techniques is an unbeatable synergy in prescriptive maintenance, delivering comprehensive solutions that leverage the strengths of both paradigms. Expert systems provide interpretability and transparency by incorporating human domain expertise into decision-making processes, while machine learning algorithms enhance predictive accuracy and adaptability by uncovering intricate correlations within data streams (Milad et al., 2016). By integrating these complementary approaches, organizations can achieve operational excellence and gain a competitive edge.

Condition monitoring and fault detection

Condition monitoring systems play a critical role in prescriptive maintenance. These systems continuously monitor equipment health, detect early signs of degradation or malfunction and capture real-time data on key performance indicators (Maillart, 2006).

By applying advanced machine learning techniques, data-driven condition monitoring systems can accurately identify faults or inefficiencies, enabling maintenance personnel to intervene proactively and prevent catastrophic failures. The schema illustrated in Figure 1 presents the flow implementation in forecasting errors. The main components are: the data acquisition phase, data preprocessing, component engineering, model development, deployment phase and model evaluation. It is very important to transform sensor readings into time series data to analyze equipment performance trends and identify patterns and seasonal variations. To forecast errors, it is necessary to select features that have high correlation with past failure events and demonstrate strong predictive performance (Scarf, 2007).

To ensure accurate error prediction, it is crucial to carefully select the appropriate machine learning algorithms, such as regression models, decision trees, or recurrent neural networks, based on the nature of the data and the forecasting horizon. Furthermore, the machine learning models must be trained using historical sensor data and corresponding error occurrences to effectively learn the relationship between sensor readings and error events.

Diagnostic reasoning and fault identification

Expert systems excel in diagnostic reasoning by methodically analyzing symptoms, observations and historical data to identify potential faults or anomalies within equipment systems (Yu et al., 2019). They use rule-based inference engines or Bayesian networks to interpret sensor readings, alarm signals and operational parameters to precisely pinpoint deviations from normal operating conditions. By correlating symptoms with known failure modes and diagnostic patterns, expert systems enable maintenance personnel to accurately identify faults and perform root cause analysis (Gertler, 2021).

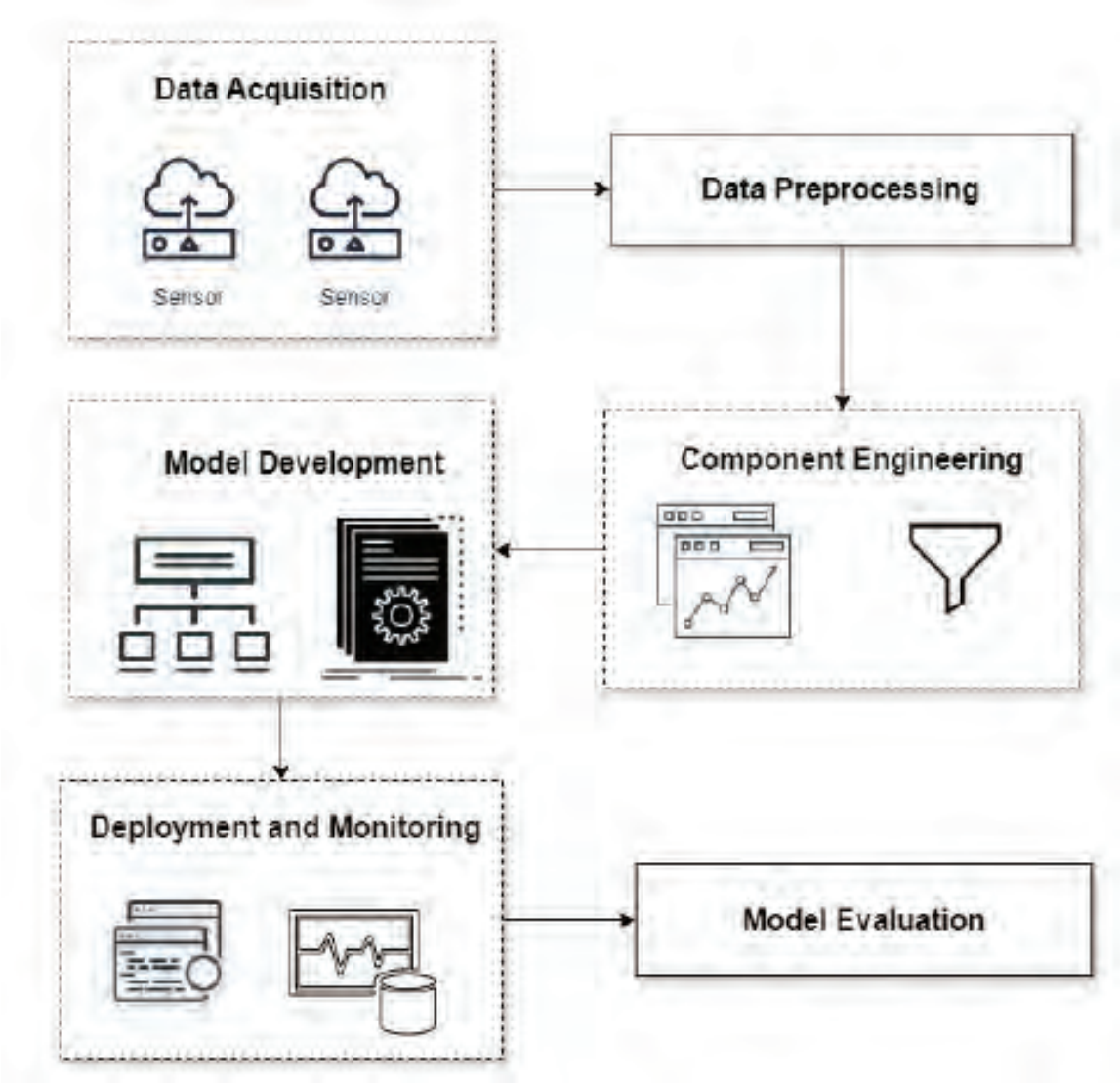

Figure 1 Forecasting errors in prescriptive maintenance

To develop and deploy expert systems for maintenance, organizations must follow a structured schema, as illustrated in Figure 2. This schema involves gathering domain-specific knowledge, encoding it into a structured format and developing rules that capture expertise. An inference engine must be implemented to apply rules, interpret sensor readings and incorporate mechanisms for handling uncertainty and ambiguity. To ensure ease of use, an intuitive interface must be designed and visualization tools provided to present diagnostic results.

The expert system must interface with data sources, establish a feedback loop and undergo rigorous testing and validation to ensure reliability and effectiveness. The expert system must then be deployed, integrated into existing maintenance workflows and continuously improved through mechanisms for continuous learning and improvement. Designing a knowledge base for anomaly detection in prescriptive maintenance involves organizing information related to equipment, maintenance activities, historical data, anomaly detection algorithms and providing maintenance recommendations.

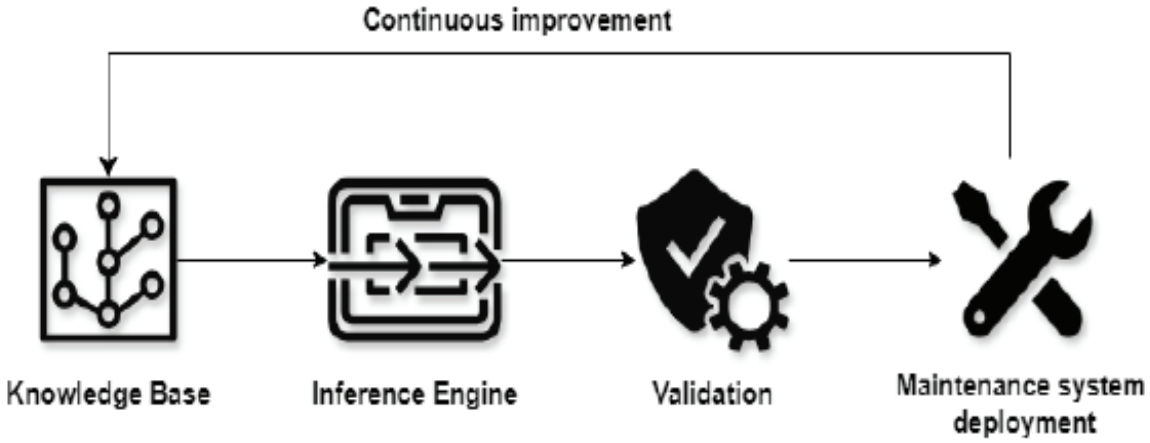

Figure 2 Integration of expert systems workflow for prescriptive maintenance strategy

It is crucial to keep track of equipment-related information, including its location, installation date and last maintenance date, as well as maintenance activities performed on each device, including inspections, repairs and calibrations. Sensor data collected from equipment over time must be stored and detected anomalies must be managed, including their type, severity and description. Anomaly detection models must be analyzed, including their algorithms, parameters and performance metrics. The knowledge base must provide maintenance recommendations to ensure optimal equipment performance and improve operational efficiency.

Integration with decision support systems

Expert systems are the key to enhancing diagnostic accuracy and improving recommendation quality. By interfacing with data sources, sensor networks and maintenance management systems, they can access real-time data streams and historical records to provide decision-makers with actionable insights, performance metrics and scenario analysis tools that support informed decision-making and strategic planning (Ungureanu and Ungureanu, 2007). The integration with decision support systems empowers expert systems to enable decision-makers to make informed decisions.

Organizations can develop and deploy expert systems for maintenance by following a specific schema that leverages domain expertise, diagnostic reasoning and decision support capabilities. The knowledge base component gathers domain-specific knowledge, encode it into structured format and develop rules that capture expertise.

The inference engine applies rules to interpret sensor readings, diagnostic information and incorporate mechanisms for handling uncertainty and ambiguity. Organizations must incorporate feedback loops, adaptive learning algorithms and model updating mechanisms to improve the accuracy and reliability of predictive models. This is crucial to ensure that prescriptive maintenance solutions remain agile, responsive and effective in supporting organizational objectives and adapting to dynamic environments.

Interfacing with Internet of Things network or with data sources establish a feedback loop to improve accuracy and relevance of recommendations. The validation and verification component ensure reliability and effectiveness. For the continuous improvement phase, it is necessary to incorporate mechanisms for continuous learning. Designing a knowledge base

for anomaly detection in prescriptive maintenance involves organizing information related to equipment, maintenance activities and historical data and anomaly detection algorithms (Song et al., 2007).

Synergistic integration

The integration of expert systems and machine learning techniques is a highly effective approach to prescriptive maintenance. It combines human knowledge and data-driven insights to optimize asset performance and minimize downtime (Carvalho et al., 2019). By leveraging the strengths of both paradigms, organizations can significantly enhance diagnostic accuracy, improve predictive capabilities and prescribe targeted maintenance actions with unparalleled precision.

Internet of Things technologies can connect various equipment and devices, allowing communication across the maintenance system strategy. Additionally, incorporating automation and robotics technologies can streamline maintenance tasks and improve overall efficiency. Automated systems can handle routine inspections, diagnostics and repairs, freeing up human resources for more complex tasks and helping to reduce the risk of human error.

The prescriptive maintenance is built on the foundation of predictive analytics, which uses historical data, real-time information and sensor readings to anticipate equipment failures before they occur. Machine learning algorithms like regression models, neural networks and decision trees analyze potential faults or performance degradation. Predictive analytics detects anomalies and deviations from normal operating conditions, empowering maintenance teams to proactively address potential issues, thereby avoiding costly breakdowns and optimizing the lifespan of assets (Zonta et al., 2020).

Advanced machine learning algorithms, including regression models, neural networks and decision trees, analyze vast datasets to identify patterns indicative of impending faults or performance degradation. The power of predictive analytics lies in its ability to detect anomalies and deviations from normal operating conditions, allowing maintenance teams to take preemptive action and avert costly breakdowns while optimizing asset lifespan.

Context-aware decision-making

Synergistic integration is essential for prescriptive maintenance systems to make context-aware decisions. Expert systems provide the framework for incorporating domain knowledge and contextual constraints, ensuring that maintenance recommendations are tailored to specific equipment configurations, operational requirements and organizational priorities.

By integrating machine learning techniques for real-time data analysis and anomaly detection, prescriptive maintenance systems can dynamically adjust maintenance strategies based on current conditions and emerging risks, maximizing asset uptime and reliability. Figure 3 presents a logical representation of context-aware decision-making in the context of prescriptive maintenance tasks.

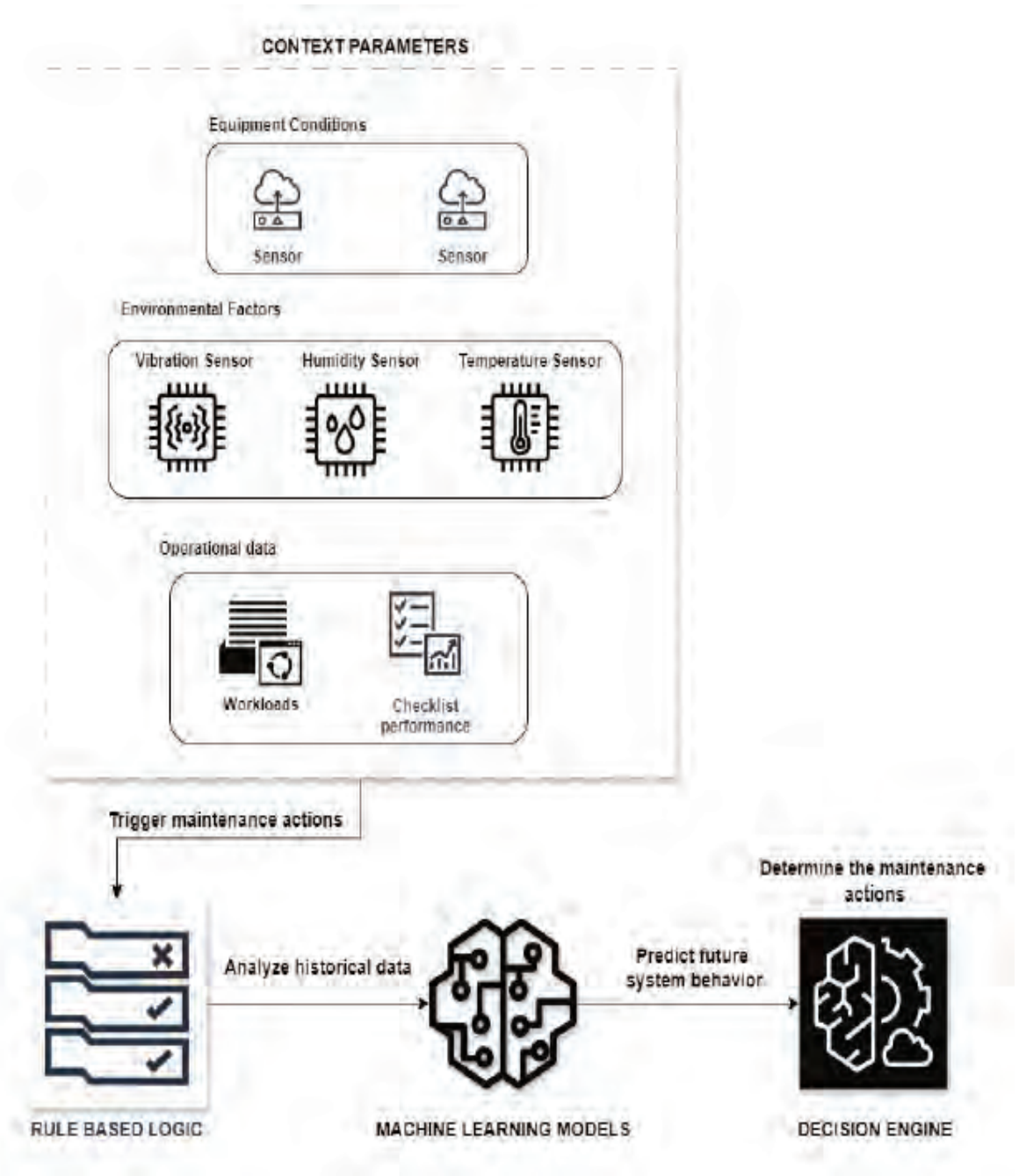

Figure 3 Logical representation of context-aware decision-making for prescriptive maintenance

Context-aware decision-making for prescriptive maintenance is a powerful approach that involves combining rules, algorithms and data-driven models. By leveraging this approach, the maintenance engineers can take decisions based on the system's current context to ensure proactive and efficient maintenance strategies. This approach comprises context parameters, rule-based logic, machine learning models, a decision engine and a feedback loop. To assess the current state of a system, it is necessary to consider various parameters such as sensor data (temperature, vibration, pressure readings from different sensors), environmental factors (humidity, ambient temperature) and operational data (usage patterns, workload, previous performance).

These parameters contribute to understanding the system's condition and identifying any potential issues. Machine learning algorithms can be used to analyze historical data and predict future system behavior (Geurtsen et al., 2023). These models can identify patterns, anomalies and trends to anticipate maintenance needs. Some common techniques include predictive maintenance models, which forecast equipment failures or degradation based on past behavior and anomaly detection, which identifies deviations from normal operating conditions that may indicate impending issues.

This engine is designed to prioritize and optimize maintenance schedules based on several factors, such as the criticality of the equipment, cost considerations and resource availability. The engine will prioritize maintenance for mission-critical components to minimize downtime and repair costs by scheduling maintenance during planned downtimes or off-peak hours.

Leveraging Machine Learning techniques

Machine learning techniques are an exceptional tool for detecting anomalies and monitoring the conditions of industrial equipment. They can identify even the slightest deviations from normal operating conditions, which may indicate potential equipment failures or performance degradation. Unsupervised learning algorithms, such as clustering and anomaly detection algorithms, analyze sensor data streams to detect outliers and anomalous patterns that may indicate faults or inefficiencies (Jordan and Mitchell, 2015). By continuously monitoring equipment health in real-time, machine learning-based condition monitoring systems enable proactive maintenance interventions and preemptive fault mitigation.

The algorithm presented in Table 1 is suitable for continuous monitoring of incoming data from a sensor. It involves maintaining a buffer to store recent data points. For each iteration, statistics such as mean and standard deviation are calculated over a set of data points. The latest data point is then compared to these statistics to determine if it is anomalous.

Table 1. Anomaly detection algorithm

Steps	Explanation
	Threshold variables
	Standard deviation *Sd*, Percentage change *Pc*
Input	Data analysis parameters
	Number of data points *Nd*, Time duration *t*
	Buffer size *Bf* for storing recent data
1.	Initialize parameters and thresholds
2.	***Loop***
	Continuously monitor incoming data
3.	*Read data point from sensor*
4.	*Add data point to buffer*
5.	*If Bf > Nd*
5.1.	*Calculate statistics Sd*
5.2.	*Check if the latest data point is atypical*
5.2.1.	*Compute deviation of the latest data point*
5.2.2.	*If deviation > threshold*
5.2.2.1.	*Log anomaly*
6.	***Repeat loop***
7.	***End loop***

If the deviation of the latest data point from the mean exceeds a predefined threshold, an anomaly is logged. This algorithm represents a basic anomaly detection algorithm and may need to be adapted or extended based on specific requirements, such as the type of sensor data, the nature of anomalies and the desired sensitivity of the detection.

Conclusion

Expert systems and machine learning have revolutionized prescriptive maintenance, empowering organizations to predict equipment failures, prescribe optimal maintenance actions and maximize asset performance. The combination of human expertise and data-driven insights has enabled industries to transcend reactive approaches and embrace a proactive maintenance paradigm that fosters resilience, efficiency and competitiveness in an increasingly dynamic environment.

The integration of expert systems with machine learning and other emerging technologies promises to unlock new opportunities for proactive asset management and predictive maintenance optimization. Machine learning empowers organizations to make data-driven decisions that drive productivity, reliability and cost-effectiveness. With the integration of data driven analytics and predictive modeling, machine learning technologies can unlock new frontiers in prescriptive maintenance optimization, promoting innovation and competitiveness in diverse industries.

As technology continues to evolve, the integration of expert systems with emerging technologies such as machine learning and Internet of Things promises to unlock new frontiers in prescriptive maintenance optimization, driving innovation and sustainable growth across diverse sectors. Prescriptive maintenance solutions harness the power of predictive analytics, condition monitoring and optimization algorithms to anticipate equipment failures and optimize resource allocation, thereby maximizing operational efficiency and minimizing downtime.

This article highlights the pivotal role of expert systems in advancing prescriptive maintenance strategies and emphasizes their significant contributions to organizational success. Also, this article represents an academic approach in the context of doctoral studies. By combining the interpretability of expert systems with the predictive power of machine learning, organizations can develop prescriptive maintenance solutions that leverage human expertise, data-driven insights and adaptive learning to enhance operational efficiency. The synergy between expert systems and machine learning will play a critical role in driving innovation and enabling proactive asset management in diverse industries as prescriptive maintenance continues to evolve. As future developments, both the development of a system model based on specific machine learning algorithms and the implementation of a routine related to expert systems will be taken into account.

Notes

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WAYS FOR ADJUSTING MANAGEMENT PRACTICE TO THE RECENT CHANGES ON THE INTERNATIONAL INDUSTRIAL LANDSCAPE

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Abstract

Purpose *– This paper aims to identify the recent research trends in the field of industrial management regarding the ability to adapt by resilience and sustainability under the new global challenges.*

Methodology/approach *- The present paper is a bibliographical study based on in-depth literature review of selected articles filtered by key words and abstract reading.*

Findings *– The current research trends are focusing on the new technologies paving the path to Industry 5.0 in order to mitigate unexpected and disrupting events affecting both the supply chains, and the environment, providing resilience and sustainability.*

Research limitations/implications *– The present research is limited to the sources published between 2023 – 2024, in Scopus database.*

Practical implications *– Understanding the current research trends in the industrial management for tackling the recent changes and events on the international landscape is helpful for both academia and practitioners in gaining resilience and sustainability.*

Originality/value *– Resting on the newest research work related to the major challenges of green and circular economy, digitization, supply change resilience, this paper provides the most updated synthesis on the subject.*

Key words: *resilience, production management, sustainability*

Introduction

Several new challenges have inhabited in the last few years the industrial manufacturing landscape on a global scale. Among these, we may point out on one hand the need to build up the capacity of resilience in order to mitigate so called disruptive events as “pandemic, peaking inflation, supply chain bottlenecks at the international level, and energy crises” (Narula et al., 2024), and on the other hand the need to keep pace with the new emerging technologies: Artificial Intelligence (AI), Industrial Internet of Things (IIoT), Big data, Cyber-Physical Systems, Blockchain (Kopeinig, Woschank, and Olipp, 2024; Mallik, 2023), to mention only a few.

Beside the above challenges, issues related to the scarcity of resources (e.g. microchips), waste management difficulties, and the environmental pollution have emphasized the importance of Circular Economy and led to initiatives known under the Industry 4.0 and

Industry 5.0 paradigms, marking the shift of the focus from optimizing performance to efficiency and sustainability (Narula et al., 2024).

Under these circumstances, it becomes more and more obvious for both academics and practitioners the need to gain a comprehensive overview about the above-mentioned challenges and to understand the up-to-date ways on adapt by resilience and sustainability.

The aim of this study is to identify the most recent trends, concepts, directions and technologies in the field of academic research related to production management. Ensuing the multiple changes and disruptions that happened globally in the recent past, the efficient adaptation of systems to the environment is most often described and analyzed through the prism of resilience. Adaptive strategies that lead to prior equilibrium after experiencing a disruption, by being prepared and acting cost-effective and at the proper moment represent the ability of a system termed resilience (Cicerelli and Ravetti, 2024). Adaptive resilience is described as a system that has the capacity to identify risks, to learn and to adapt to the uncertainty and external changes from the environment (Kiss, Hetesi, and Kiss, 2024). Therefore, analyzing resilience, identifying its expressions, components, facilitating technologies to develop strategies in the management of the manufacturing industry is of extreme significance.

This article is organized as follows: in the second section we present the research methodology, in the third section we present the results of the analysis, and in the fourth section we proceed to discuss the results and meet several conclusions and figure out future research avenues.

Methodology

The database used in this research article was Scopus (www.scopus.com), accessed on 03.08.2024. This choice was met as Scopus is considered of broader coverage and better updated by several authors (Madsen, Berg, and Di Nardo, 2023).

In order to filter the amount of available sources, the authors restricted the search by including only works published between 2023 – 2024, in English language and of open access.

By using for the search query, the words “production”, “industr*”, “management”, and “resilien*” in the Article title, Abstract, Keyword, resulted in a first stage 157 articles.

In a second stage, after thoroughly reading the abstracts, articles found as being not relevant in accordance with our research’s aim, were excluded, and as a result 58 research papers qualified for an in-depth analysis. Exclusion was conducted on the differentiation according to the field of applicability, thus articles related to agro-industry, reduction of food waste, technical description of solutions for recycling electrical and plastic components, or mining were removed. Timeline restriction to 2023-2024 is argued by the need to analyze the production management resilience to the dynamic shifts on the global landscape in the recent past outlined in the introduction,

Results

Analyzing the current state of the art in the 58 selected academic works for identifying the connection between resilience and management practice in the manufacturing industry in the recent years, findings unfold along several research aspects, namely the geographical distribution of interest, research dimensions: economic, environmental, technological, social and regulatory, focus on management level and sequence, and the applied technologies upholding sustainability and resilience opportunities in production management.

Researching resilience in the management of the manufacturing industry, results show that global interest is manifested among scholars. Although half of the analyzed studies have underlined general solutions, benefits and transferable knowledge in strategic and operational management, the other half is represented by empirical research conducted on a scattered geographical area, covering countries as Sweden, Germany, Italy, Netherlands, Ireland, Hungary, Czech Republic, Portugal, Spain, Canada, India, Russia, China, Ukraine, Thailand, Malaysia, Brazil, Japan, Taiwan, Iraq, Ghana and South Africa. From these studies, Italy stands out with a 12 percent representation, manifesting engagement in design-based industrial conversion (Bruno and Lerma, 2023), industrial agile working (Cimini, Lagorio, and Cavalieri, 2024), digital transformation and green supply chains (Carpitella, 2024), anthropology integration in systemic sustainability in the manufacturing sector (Fernández-Miguel et al., 2024), and digital system architecture (Aruvali, Marchi, and Rauch, 2024).

Resilience and production management in manufacturing industry is analyzed considering all dimensions: economic, environmental, technological/ informational, regulatory, social.

With the recent technology advancements and disruptions, most of the studies focus on the technological and informational perspective, representing slightly over one third of the selected core research papers. Academics and practitioners are aiming at delivering solutions for smart manufacturing by developing monitoring, control, metaverse integration, and management system architectures (Aruvali et al., 2024; Bujari et al., 2023; Van et al., 2023), integrating cloud-based and ERP in supply chain (Tinkov et al., 2023), cobots in end-of-line industrial applications (Dmytriyev, Carnevale, and Giberti, 2024), distributed ledger technologies in supply chain management (Asante et al., 2023; Hau et al., 2023), and matching AI technology solutions to identified problematic areas of the supply chain management (Kazancoglu et al., 2023). Highlighting technological solutions for the collaboration of production and software engineers (Bega et al., 2023) and for the supply chain disruption risk management (Fortes, Tenera, and Cunha, 2023; Fu et al., 2023; Huang, Wang, and Zhang, 2023) are also valuable insights.

Industry 4.0 enabling technologies as IoT, Machine Learning, AI, cyber-physical systems, augmented and virtual reality, Big Data, robotics, advanced materials or blockchain are creating flexibility and increasing productivity with concurrent sustainability and efficiency in smart factories. Researchers aligned to the European Commission's vision introduced in 2021 about Industry 5.0 (European Commission, 2021) are emphasizing the relevance and indispensability of human-centeredness when implementing Industry 4.0 technologies (Chabane, Komljenovic, and Abdul-Nour, 2023; Grosse et al., 2023; Wan and Leirmo, 2023).

Resilience and sustainability being mostly concurrently utilized concepts in the production management, the dimension of environmental research approach is also predominant, but mostly paired with the economic, technical or social dimension. The green transition to carbon neutrality and the circular economy requirements overlaying the economy affected by multiple international shocks claim to consider systematically the environmentally sustainable management strategies in the manufacturing industry. Various aspects of complexity in the electronics sector are analyzed in relation to sustainability to achieve resilience (Cicerelli and Ravetti, 2024), corporate social responsibility, green accounting and environmental auditing are proposed as solutions for waste management strategy development (Faieq and Cek, 2024), strategic opportunities are identified when integrating efficient resource management, sustainable production processes and new technologies (Lau, Turan, and Sazali, 2024), contribution of Industry 4.0 technologies to the environmental sustainability in production management is assessed (Kopeinig et al. 2024), ecological approach to sustainability and resilience is developed in the design of a production plant (Kiss et al., 2024). Environmental research of resilience in the production management is one basic approach, emphasizing the sustainability goals and resource scarcity awareness.

The economic dimension of the resilient production management focuses on analyzing supply chain disruption recovery amid Covid 19 (Fan et al., 2023), on sustainable and resilient management practices effects on product price and wage dynamics (Yeboah et al., 2023), on the macroeconomic vulnerability of national economies in the low-carbon transition process (Magacho et al., 2023) or on circular material employment strategies (Santos et al., 2024).

Part of the selected research articles are also investigating the resilient production management's regulatory dimension. It is found that flexibility, collaboration and resilience regarding regulatory measurements are key factors in times of sever challenges and crisis (Amaral et al., 2023; Howlett, Niarchou, and Naughton, 2024).

Regarding management level and sequence, the uttermost focus is shifted towards supply chain management. Research direction in this area is presented in Table 1.

Table 1. Supply chain research directions in the resilient production management

Approach	Assessment	Industry	reference
Green supply chain	barriers and strategies to address them	automotive	(Carpitella 2024)
	SDGs relation to GSC management	-	(Raman et al. 2023)
Supply chain disruption	Intertwined circular SC disruption	-	(Echefaj et al. 2024)
	management strategy (JIT and Lean) in SC disruption	pharmaceutical	(Howlett et al. 2024)
	SC disruption lessons – Covid 19	pharmaceutical	(Takawira and Pooe 2024)
	SC disruption recovery after Covid 19	-	(Fan et al. 2023)
	Agility in the SC disruptions	automotive	(Křenková, Procházka, and Túry 2023)
	SC disruption risk management	automotive	(Huang et al. 2023)
	Demand risk management	semiconductor	(Fu et al. 2023)
I.4.0 technology integration in SC management	circular SC management with distributed ledger technology using blockchain	-	(Hau et al. 2023)
	cloud-based technologies/ ERP in sustainable SC	construction	(Tinkov et al. 2023)
	matching AI tools as solutions to SC problematic areas	-	(Kazancoglu et al. 2023)
	conceptual planning model for managing SC in I4.0 environments	-	(Reyes, Mula, and Díaz-Madroñero 2023)
	SC security management through blockchain	-	(Asante et al. 2023)
	Metaverse impact on SC and operation management	-	(Dolgui and Ivanov 2023)
SC strategy	Resource repurposing and product substitution	-	(Villar et al. 2024)
	Complexity in sustainability management	-	(Cicerelli and Ravetti 2024)
	supply chain management knowledge graph for large-scale product manufacturing	-	(Huang and Cheng 2024)

Progress in establishing resilience measurement tools, creating digital system architecture, risk management, waste management, distributed energy resources, human-centricity, values and forecasted trends regarding Industry 5.0, sustainability of implementing advanced technologies in circular economy are also strategy-developing research interest areas.

Discussion and conclusions

This study provides a concise overview of the up-to-date academic research on production management related to resilience and sustainability, crucial for adapting to the uncertainties of fast changing environment and to achieving progress regarding the SDGs. Concluding the results of this bibliographic study it can be asserted that resilience is a key aspect of production management efficiency and quality. Resilience as an approach emerges in research studies along with other concepts as flexibility, agility, transparency, collaboration or adaptability. Adaptive resilience in manufacturing enhanced by advanced technology is shaping the future of Industry 5.0, ensuring the efficient management of complex human-centered systems.

Advanced Industry 4.0 technology is a fundamental aspect in production management resilience built on interconnectedness, offering real-time solutions, and zero-defect manufacturing opportunity. Thus, the technical dimension of this research field is very extensive and diverse. The environmental and economic dimension is also comprehensive due to the sustainability prerequisites and is often linked to the technical – informational dimension. Worth mentioning that the social dimension regarding the production management's resilience is barely discussed, although crisis management deeply affects the social domain, as we could experience it with the Covid 19 pandemic or with the war in Ukraine.

Most researched topic is related to the supply chain management, being the most affected by the recent disruptions occurred. Other compelling topics are gaining space, as distributed energy resources, human-centricity, digital system architecture, and sustainability of Industry 4.0 technologies in the circular economy. Studies developing resilience measurement tools are paving the way for a more systematic and innovative approach to the future challenges in production management.

Limitations of this study include firstly the fact that Scopus is the only database for this research, secondly the subjectivity related to selection based on abstract analysis, and thirdly the space constraint for discussing the synthesis of such a complex and multifaced phenomenon.

Understanding the current research trends in the industrial management for tackling the recent changes and events on the international landscape structured by this study is helpful for both academia and practitioners in gaining resilience and sustainability.

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ADAPTIVE ENVIRONMENTS FOR ROBOTIC ASSISTED NEURO-LIMBIC RECOVERY BY REASSESSING MANAGEMENT IN AVIATION ACCIDENTS CASE

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Abstract

Purpose *– This paper examines the potential of robotic-assisted neuro-limbic recovery in the context of aviation accidents, combined with the importance of professional training in medical robotics.*

Methodology/approach *– Rare but documented cases are presented, the Cecilia Cichan, the single survivor of a plane crash at the age of four, and the James Polehinke, co-pilot of a crashed flight. In this article, alternative approaches for robotic assistance in neuro-limbic recovery are considered, with a methodology that involves analyzing data from aviation accident injuries to explore how robotic rehabilitation could have helped.*

Findings *– Robotic-assisted rehabilitation offers significant advantages in the recovery process of motor and neurological functions, determined by precise conducted repetitive movements, real-time monitoring and customized adjustments, with great help and facilities extension for therapists.*

Research limitations/implications *– The limited availability of detailed patient data and rapidly evolving technologies may need for more accreditation data and demonstrations.*

Practical implications *– Large-scale implementation of robotic assisted rehabilitation technologies requires investment in training of medical staff and hospital infrastructure. This article contributes to understanding of how new founding may transform neuro-rehabilitation practices.*

Originality/value *– Aviation accidents cause severe injuries such as multiple fractures, burns, brain damage and amputations, requiring complex medical interventions and long-term rehabilitation. Advanced rehabilitation technologies are key to improving the quality of life of survivors, as demonstrated in the case studies of Cecilia Cichan and James Polehinke.*

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Key words: *robotic assisted rehabilitation, aviation accidents.*

Introduction

Neuro-Limbic Rehabilitation aims to rehabilitate people with severe limb injuries and neurological damage, often caused by serious accidents, including aviation accidents. In the last years the robotic assistive technologies have revolutionized the field, offering new hope for improved recovery.

This paper reveals some interdisciplinary studies considering the combination of engineering, managerial and medical explored aspects within the identification of the robotic-assisted recovery potential, highlighting the importance of professional training in medical robotics. In addition to the inhouse research, two case studies were consider illustrating the potential impact of robotic assisted technologies on patients and for guiding future research. In this paper, the authors reviewed the Cecilia CICHAN and the James POLEHINKE recovering processes.

Applied Methodology

The considered methodology includes the data analyze the aviation accident injuries, observing what was done in terms of rehabilitation during that period and what could have been achieved with today's technology.

Being happened before the exitance of the robotic assisted rehabilitation to comparative analysis is applied first to highlights the differences in severity and type of injuries, followed by the comparative analysis of the applied rehabilitation process with the actual possibilities. The actual considered robotic assisted rehabilitation process is revealed from the existing specialized literature (academic articles and research reports) and from the original research.

Research Implications

There are 3 keys elements that characterise the alternative recovering treatment processes by using assistive robotics:

- the robots itself and the treatment that can be applied
- the benefits of the new kind of applied treatment
- the perspectives of improvement that this medical technology tackle

Robotic Treatment in Neuro-Limbic Recovery was developed to enhance the doctors and physiotherapists capabilities in assisting patients during the recovery of motor and neurological functions. These technologies include:

- Hand and finger robotics to help recover fine motor skills.
- External orthoses, which stabilize limbs and assist movements.
- Robotic exoskeletons, which support patients' natural movements.
- FES (Functional Electrical Stimulation) which activates paralyzed muscles with electrical pulses or epidural electrical stimulation (EES) for spinal cord injuries.
- Anti-gravity treadmills that allow walking or running with partially supported body weight, reducing joint stress, external prosthesis which can replace not only the body part, but also the function, soft robots which can diminish the frozen effect in Parkinson disease.

The benefits that may be acquired from Robotic Rehabilitation offer many advantages, even in this enfant stage of its development. Among that the most mentioned are:

- Precise repetition of movements – which leads to a decrease in the recovery process over time, precision provides us with the assurance that tissue limits are not exceeded, the repetition of movements leads to an increase in tissue resources (resistance, strength, control), all of which led to better functionality and ensuring efficient neuroplastic recovery.
- Real-time monitoring and adjustment – We can observe the patient's vital functions in real-time during therapy, we can observe the strength, speed, and resistance that the patient applies, the rehabilitation robot can detect compensatory movements and intervene to improve them and through all this, the patient is actively involved, creating a phenomenon of biofeedback. From all of this, it emerges that robotic rehabilitation is a treatment that offers us objective monitoring and adapts to the patient's progress.
- Enable therapists to work in parallel with several patients – more patients can benefit from therapy in a shorter time and therapists can focus on other aspects of rehabilitation such as patient assessment and patient education.
- Improved patient motivation - interactivity and gamification of exercises increase adherence to the rehabilitation program, adherence that many patients lack for various reasons (immobility, depression, loss of autonomy, and functional independence). The patient's motivation will increase when they notice that all these aspects improve through robotic rehabilitation, thus the patient will be much more involved in the therapy, resulting in a favorable prognosis.

As the research activities continue, new perspectives open up:

- ❖ Rapid device development - According to "Perspectives and Challenges in Robotic Neurorehabilitation" (Riccardo Iandolo et al., MDPI), exoskeletons and FES have revolutionized neuro-motor recovery through real-time monitoring and adjustment of treatments. Combinations with personalized training regimens and brain-machine interfaces improve movement control and neuroplasticity.
- ❖ Usability of robotic and virtual reality devices - The article "A systematic review on the usability of robotic and virtual reality devices in neuromotor rehabilitation: patients' and healthcare professionals' perspective" published by BMC Health Services Research provides a detailed perspective on the usability of robotic and virtual reality devices, highlighting their strengths and limitations in clinical practice. Robotic devices are perceived as safe and effective in improving physical independence and psychosocial well-being.
- ❖ Innovations in Robotic Medicine - Dr. Mathew Thomas and Rachel Rutledge from Mayo Clinic emphasize, in an interview on innovationexchange.mayoclinic.org, the importance of interdisciplinary collaboration and continued innovation to the success of robotics programs. Mayo Clinic, through its Division of Military Medicine, supports veterans and active-duty members of the armed forces through educational programs and innovative research.
- ❖ Inclusion of rehabilitation robots in hospital centers - Over the years, the CESTER team has managed to design, model, build, test, and develop various rehabilitation robots for certification, both for the upper and lower limbs, with some of them already having significant studies conducted in hospitals. Later on, these robots can also be adapted for implementation in the patient's home.

These insights and benefits highlight the enormous potential of robotic rehabilitation technologies in transforming medical practices and improving patients' quality of life.

Cases Description

Air disasters, marking significant loss of life, induce major perception and safety crises, affecting reputation and confidence in aerospace. Analysis of the last 50 years most tragic aviation accidents demonstrates the extent of the impact on passenger and crew safety:

- 1974, Turkish Airlines Flight 981 – crashed, caused by a cargo door malfunction, resulting in the deaths of 346 people.
- 1980, Saudia Lockheed L-1011 Tristar - fire on-board fire was taking 301 lives
- **1987, Northwest Airlines Flight 255** - crashed near Detroit Metropolitan Airport on takeoff, 154 people killed; the only survivor was a four-year-old girl.
- 1988, Iran Air Flight 655 - accidentally destroyed by an U.S. Navy aircraft, killing 290 individuals
- 1996, Air Africa - an overloaded plane crashes in a populated area in Kinshasa, within the tragedy 227-348 people were killed
- 1996, Charkhi Dadri air – crashed in New Delhi, being the deadliest air collision, with a death toll of 349
- **2006. Delta Airline, Bombardier Canadair Regional Jet 100ER, Comair Flight 5191** - crashed on takeoff in Lexington, Kentucky, while attempting to take off from Blue Grass Airport in Fayette County, the runway was too short for a safe takeoff, causing the aircraft to overrun the end of the runway before it could become airborne, killing all 47 passengers and two of the three crew. It was the second-deadliest accident involving the CRJ100/200; two years earlier, China Eastern Airlines Flight 5210 claimed 55 lives.
- 2024, Tokyo Haneda Airport - five occupants of a Japanese Coast Guard aircraft were killed in a collision with a Japan Airlines passenger plane, but all 367 passengers and 12 crew members of JAL516 were safely evacuated due to the good training of the flight crew.

These accidents highlight the crucial importance of safety and reliability in aviation. Each tragic incident emphasizes the need to implement strict safety measures and rigorous regulations to protect both passengers and crew, highlighting the long-term consequences on human life. Fortunately, aviation accidents are not very often, and each case is analyzed in detail to make safer the aviation transportation. But when happens are dramatic casualties and therefore special attention must be ensured for the survivors. The rare occurrence but the intense intervention and specialization demonstrates the need for HRT (Human Resource Training), as was evidenced also in the Japan Airlines JAL516 case on the Tokyo Haneda Airport in 2024.

Importance of Human Resource Training

Effective aviation crisis management requires continuous training of aerospace personnel, ensuring rapid response times and well-defined strategies for emergency situations. This is especially essential in cases of serious accidents that will require short, medium and long-term medical care. Essential aspects of regular training:

- Training through practical simulation exercises, organized regularly with different simulated scenarios coupled with exercises that prepare staff to react effectively in emergency situations. Like FAA (Federal Aviation Administration) simulation programs, where complex scenarios prepare crews for various crisis situations.
- Effective internal and external communication, with clear established and effective channels of communication both within the organization and with external entities, including authorities and the public. The ICAO (International Civil Aviation Organization) crisis communication training programs are essential for effective coordination during incidents.

- Risk assessment and scenario planning constantly, conduct risk assessments and develop action plans for various possible scenarios. EASA (European Union Aviation Safety Agency) aviation risk management programs are models for developing well-structured contingency planning.
- Flexibility and innovation to adapt quickly to change must be cultivated within organizations, with innovation to adapt quickly to new challenges and conditions.
- Continuing education programs in medical robotics and rehabilitation at leading institutions such as Mayo Clinic demonstrate the importance of ongoing, adaptive education for improved patient outcomes.

Considering the Mayo Clinic example the Post-Accident Recovery is strongly impacted by the technological developments and the clinical staff training. The proper training of medical and aerospace personnel can directly influence patients' post-accident recovery:

- Mayo Clinic's robotic rehabilitation programs, with integrate training in the use of exoskeletons and other robotic devices, allowing therapists to provide personalized and effective treatments, increasing the chances of patients for rapid and full recovery
- Immersive educational programs for healthcare professionals that include training in emergency simulations and the use of advanced technologies, improve staff response and treatment skills, contributing to the effective recovery of aviation accident victims
- Interdisciplinary collaboration and training programs, including physicians, engineers and robotics experts to ensure a holistic approach to treatment and recovery, maximizing the benefits of robotic rehabilitation technologies.

Through continued investment in staff training and education, the aerospace and medical sectors can significantly improve post-accident recovery, thereby reducing the long-term impact on patients' lives.

Medical Impact of Aviation Accidents

Aviation accidents often cause severe injuries, requiring complex medical interventions and long-term rehabilitation processes. Resulting trauma can include multiple fractures, burns, brain injuries and amputations, each presenting specific challenges in recovery. These traumas highlight the importance of well-structured rehabilitation programs and advanced rehabilitation technologies to improve the survivor’s quality of life, locomotor as well as psychological.

Considered Cases

1. Cecilia CICHAN

The single survivor of 1987a plane crash, at the age of four who suffered severe burns and fractures. In 2024 she is 41, married and living under the name Cecelia Crocker.

Additional clarifications & Accident Details

Cecilia's medical history was largely secret, making it difficult to obtain detailed information about her recovery journey. Cecilia CICHAN benefited from a dedicated team that addressed her psychological and social needs, although specific details are scarce.

- Third-degree burns over 30% of the body, requiring skin grafts
- A fractured left leg, requiring insertion of a pin into the femur bone
- A concussion and a fractured collarbone

- ✓ Severity and types of injuries – Above is described the order in which these injuries would be treated, the approach requiring a multidisciplinary team to maximize treatment effectiveness, with burns taking precedence because they can cause various complications, both through potential infection and delayed scarring.
- ✓ Technologies that could have been used – Unfortunately, during that period, there were no robot-assisted therapies tailored to assist Cecilia's rehabilitation. However, if we consider the case in the present day, rehabilitation robots would come to aid not only in conventional physical therapy but also in psycho-social applications. In the present, there are rehabilitation robots that assist in the rehabilitation of burns, like Amadeo they can prevent scar formation that could lead to functional impairment. Additionally, there are rehabilitation robots which could be used for fracture rehabilitation, like CESTER rehabilitation robots, both for the upper and lower body which alleviate pain, improve motor function and reduce recovery time. For psycho-social support, there are robots with diverse objectives. from providing comfort and companionship (Sony's Aibo, Hasbro's Joy for All Companion Pets, PARO), reducing the feeling of loneliness, stimulating the young one through online games, video chats, suggesting sporting activities or enabling a two-way communication from distance between the patient and the caretaker

Conclusion for the Robotic Physical-Psychological-Social Assistance

Robotic rehabilitation technologies, such as external orthoses, could have help in her mobility recovery. However, these interventions seem excessive for her specific needs and are not essential for long-term recovery. Robotic assistance for burn rehabilitation, which is extremely painful and delicate, is another potential but limited application. Psychological and social support was crucial to her recovery.

2. James POLEHINKE

Was the co-pilot, as pilot flying at the time of the accident Comair Flight 5191 and was the sole survivor but who suffered multiple fractures and amputations following the plane crash.

Additional clarifications & Accident Details

- o Brain damage causing memory loss
- o Amputation of the left leg and surgical repair of the right leg
- o Two spinal fractures, broken bones in the left leg, right leg and right hand
- o A series of fractures from face to legs, including a complex fracture of the pelvis and a collapsed lung

- ✓ Severity and types of injuries - James' injuries are significantly more severe than CECILIA affecting multiple body systems and requiring comprehensive rehabilitation, in the short term, but also in the long term, some of them changing his quality of life completely.
- ✓ Technologies that could have been used – In this case, rehabilitation technology not only plays a role in restoring a previously used function but also intervenes in replacing a lost function caused by lower limb amputation. By the year 2006, there were already certain technological devices that could provide added benefits in the rehabilitation process, such as The Controlled Brake Orthosis for motor deficits resulting from spinal cord injury, and various mechanical orthoses for transfemoral amputation. In the present day, due to technological advancements, rehabilitation robots could significantly improve James's quality of life. In the acute stage, they could assist in therapy by aiding in transfers and mobilizing his lower limb at the bedside. In the chronic

stage, current external prostheses could help him resume activities such as climbing stairs or running, activities which James is currently unable to perform.

Robotic Physical Assistance

Robotic assistance can greatly benefit James, offering solutions such as improved external orthoses and mobile ramps for home use. These technologies can help in both acute hospital settings and chronic home care, improving his mobility and quality of life.

Types of robotic systems that could be helpful to James:

For the rehabilitation of the left lower limb – CESTER robot RAISE or RECOVER for mobilizing the entire limb, thus immobilizing the pelvis and eliminating risks of refracture. Initially in passive mode, followed by transition to active mode.

For the rehabilitation of the amputated limb - in the acute stage until stump healing, conventional physiotherapy is recommended. After healing of the scar tissue, an external prosthesis can be applied, for example, the Utah Bionic Leg. This lightweight orthosis can be beneficial for walking as well as for ascending and descending stairs, actions that James cannot perform due to the stairs not being adapted to his condition.

Conclusion for the Robotic Physical-Psychological-Social Assistance

He currently uses a wheelchair and is unable to climb stairs, highlighting the need for advanced rehabilitation technologies. Still, with all of this, James has adapted his environment with hand-powered bikes, adaptive skis and various ramps, demonstrating his resilience and potential for additional robotic assistance in daily living.

Unfortunately, James primarily relies on a wheelchair for mobility, likely due to vertebral fractures. His condition underscores the importance of a multidisciplinary team in implementing a robotic system adaptable to the patient's conditions. Currently, there is no exoskeleton or robotic system that is adaptable to both spinal cord injury and amputation. The ReWalk robot could be helpful, provided it could be coordinated with the amputated lower limb. All of this systems, can integrate James back in society, without having a physical disability.

And for the psychological aspect, James could benefit from remote psychological therapy through video. Additionally, a robot could listen to him, analyze the information received from James, and relay it to the medical team.

Comparative Analysis & Conclusions

The comparison between Cecilia Cichan and James Polehinke reveals significant differences in the severity and types of injuries, as well as the applicability of robotic rehabilitation technologies (Table 1).

Table 1 of Comparative Cases

Aspects	Cecilia Cichan	James Polehinke
Type of injury	Third-degree burns, leg and clavicle fractures	concussion Multiple fractures, amputation, brain injury
Rehabilitation needs	Skin grafts, orthopaedic interventions	Complex orthopaedic interventions, mobility support
Rehabilitation technologies	External orthoses, anti-gravity treadmills	Enhanced external orthoses, mobile ramps, manually operated bicycles
Psychological and social impact	Dedicated psychological and social support	Environmental adaptation for daily use and activities
Effectiveness of robotic rehabilitation	Limited - specific needs not aligned with current technologies	High - technologies have significantly improved mobility and quality of life

Conclusions

The differences in severity and types of injuries between Cecilia and James show that robotic rehabilitation technologies are more effective for extensive and varied injuries such as James'. In contrast, for cases like Cecilia's, where injuries are severe but do not require specific robotic interventions, traditional methods and psychological support may be more appropriate.

James' extensive and varied injuries present numerous opportunities for robotic assistance. Robotic rehabilitation technologies could have greatly improved mobility and quality of life, demonstrating significant potential in the recovery of patients with multiple and complex injuries.

This analysis highlights the importance of tailoring treatment and technology selection to each patient's specific needs.

Exoskeletons, external orthoses, anti-gravity treadmills, hand and finger robotics, and functional electrical stimulation (FES) offer diverse solutions for the recovery of motor and neurological functions.

Robotic rehabilitation allows for precise repetition of movements, real-time monitoring and adjustment of treatment, reduced physical effort for therapists and improved motivation for patients.

Continuous training of medical and aerospace personnel is crucial for effective crisis management and optimal use of robotic rehabilitation technologies.

Simulation and interdisciplinary training programs, such as those offered by the FAA, ICAO, EASA and Mayo Clinic, improve staff response and treatment skills, contributing to effective patient recovery.

Continued evaluation of the impact of long-term robotic rehabilitation technologies on patients' quality of life is needed.

Investigate how psychological support can be effectively integrated with robotic rehabilitation technologies to maximize benefits for patients.

Through further research and innovation in robotic rehabilitation, we can significantly improve the recovery and quality of life of patients with severe neuro-limbic injuries.

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ECO-FRIENDLY MANAGEMENT OF COOLING LUBRICANTS IN CNC MACHINES

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Abstract

Purpose *– The paper aims to present the environmental and ecological benefits as a case study on sustainable technical solutions used CNC cooling lubricants, with lifetime extension and cooling quality increase.*

Methodology/approach *– Implementing modern treatment methods such as reverse osmosis, seeking to increase the quantity and quality of recovered water while reducing environmental impact, and additionally, installing a waste briquetting press and an extra filtration system to improve waste lubricant reuse and quality ratio.*

Findings *– A tested system for increasing the quality of recycled lubricants was successfully implemented.*

Research limitations/implications *– The specific application depends on the catted materials and the lubricant increased lifetime depends on lubricant and compliance with the proposed procedure parameters. The reduction of waste amount and the capability to be reused in the process, depends on the adopted devices.*

Practical implications *– The drawn conclusions are based on a specific industrial configuration and may be different if variables as working conditions are changed or if other machine configurations are chosen. Further research can be done to validate practices in other processing environments.*

Originality/value *– The study is developed and tested in real-world settings and may serve as a best practice guide for increasing lubricant quality and lifetime.*

Key words: *CNC machining, Cooling lubricants reuse, Ecological sustainable practices*

Introduction in Cooling Lubricants

The current industrial environment is radically transforming on two directions, which will affect all aspects of consumption and production in the 21st century: the entry into the fourth industrial age and the implementation of sustainable production methods (Abubakr, et al. 2020).

One of the imperative goals of today's manufacturing sector is the implementation of sustainable practices that ensure waste reduction and optimization of processing operations (Bastas 2021). Both the optimization of machining parameters, the operation of CNC machine sharpening tools (Mohsen, et al. 2024) and the extension of cooling lubricant life are in a mutual interdependence, jointly contributing to cost efficiency, machine life extension, and environmental sustainability.

According to the considered implemented internal procedures, the cooling lubricants used in CNC machining processes are of type B-Cool 755, manufacturer Blaser Swisslube AG, following safety specifications according to Regulation (EC) No 1907/2006 (REACH), Annex II, as amended by Commission Regulation (EU) No 2020/878 - Romania, the products being compatible with the European Directives 2015/863/EC, 2011/65/EC, 2002/95/EC, 2002/96/EC, WEEE, 2003/11/EC, 2005/53/EC and RoHS, and must not exceed 12 months from the date of manufacture mentioned on the accompanying documents.

The conformity in house is coordinated by the fluid mechanics Chief Mechanic, having responsibility for the entire chain of checking from reception, labelling, storage, use, condition monitoring, treatment, waste collection, stock management.
Therefore, the use of the cooling lubricant in the machining processes is done in strict compliance with the specified intervals in the product technical data sheet (24 months from the date of manufacture), respecting the FEFO system (first expired, first out).

For the best results, the manufacturer recommends a lubricant concentration in water between 4-15%. From our research, considering the techno-economic analysis, the lubricant concentration target value in the CNC pool for machining is to be set in the range (7-9) %. In the chipping processes, the cooling lubricant is lost on the resulting chip and evaporation, therefore the lubricant quantity is checked at each change and top up the required amount, monitoring and recording the following values: amount of lubricant topped up, the concentration of the topped-up lubricant, the lubricant quantity in the machine tank, water PH, water hardness and the quantity of nitrite. The cooling-hardening lubricant is maintained at 21±1.5°C with heat exchangers.

Reducing the environmental impact of cooling lubricant in CNC

Knowledge of the various types of cooling fluids and methods to make their use more efficient is extremely important to make these sustainability measures viable in long term (Shaikh and Ali 2021), as cooling and lubrication are critical aspects when discussing the smooth operation of machinery (Kumar, et al. 2023).

In terms of the environmental impact on the cooling lubricant, it is acted upon two directions of process analysis and improvement:

1. Increasing the lifetime of the cooling lubricant
    a. Improving water quality by installing a reverse osmosis plant
    b. Improvement of lubricant quality by additional by-pass filtration with centrifugal filtration stations
    c. Daily monitoring of lubricant concentration and quality.
2. Sustainable solutions for reuse of cooling lubricant in the CNC machining process
    a. Installation of a waste lubricant treatment plant
    b. Installation of a briquetting press for aluminum alloy chips from CNC milling processes

The research, followed by the implementation was carried out following the five described steps, made in parallel for the two directions.

1.a Improving water quality by installing a reverse osmosis station

Initial situation: on the plant location the analyses carried out by an authorized laboratory, for the quality of the water used in the chipping processes showed a very high degree of hardness (14 dH), i.e. a level 3 hardness (>14 dH, total hardness >2.5mmol/l), is leading to a high risk of: high calcium deposits in the lubricant tanks, partial clogging of the cooling installations, impaired operation and a reduction in the lifetime of the tools fitted with lubricant cooling channels. For this reason, it was decided to install a reverse osmosis station.

In the initial standard conditions, the lubricant service life was only three months, followed by a complete cleaning of the lubricant basins also using bacteria removal solutions.
Once determined the yearly requirement of cooling-lubricant for the entire workshop, the idea of a reverse osmosis station came up in order to create a deep filtration and separate the water for the lubricant solution. The schematic principle of operation is shown in figure 1.

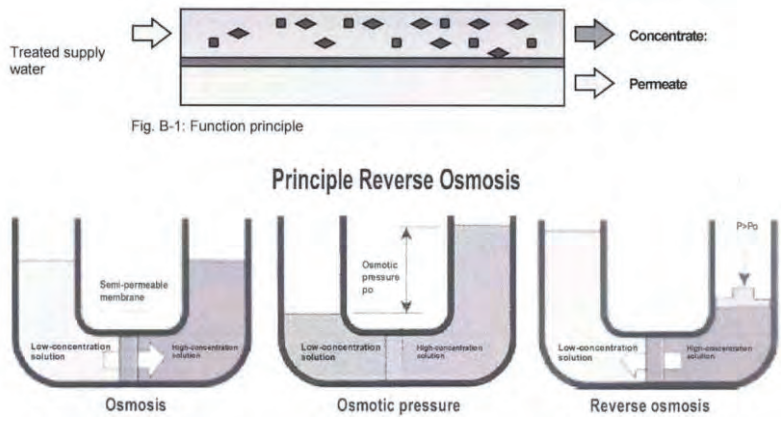
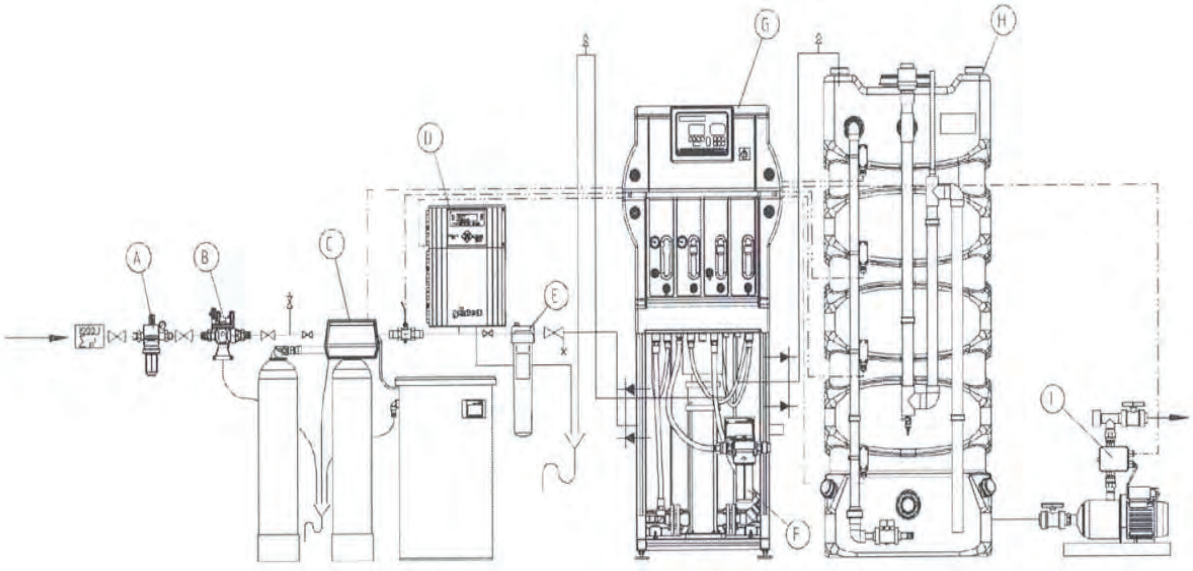


Figure 1. Working principle of the reverse osmosis station (source: Gruenbeck Wasseraufbereitung)

After analyzing different solutions and catalogs with different products specifications and characteristics, the final decision was upon a system type GENO-OSMO MSR-750, manufacturer Gruenbeck, that may offer a maximum processing capacity of 750l/h.

The core system consists of a water treatment installation that on its turn consists of three installations: the filtration plant, the softening plant and the reverse osmosis plant. The schematic diagram of the water treatment installation is shown in Figure 2.



Legend:
A. GENOr-pur fine filter;
B. Euro system separator DK 2;
C. Geno-matr duo WE softening system O. GSX I soft water monitor;
D. Water analyses auromat GENOr-control SP;
E. AKF activated carbon filter;
F. Fine filter 5um;
G. GENOr-OSMO-MSR; H Permeate filter;
I. Pressure boosting system

Figure 2. Schematic diagram of the reverse osmosis plant (source: Gruenbeck Wasseraufbereitung)

In this configuration, the operation of the water plant implies that the reverse osmosis plant to be serviced annually, based on the service sheet that is as shown in figure 3.

Reverse Osmosis Inspection Sheet		
1.MEASURING VALUES		
Raw water pressure (bar.)	2	
Working pressure (bar.) HP pump	7	
Filter pressure drop check 5um	√	
Inlet water hardness measurement (*dH)	˚dH	Ø
Pressure pump current measurement	A	IR=2.8A; IS=2.8A; IT=2.9A
2.INSPECTION/VERIFICATION OF CONTROLLER AND SUB-ASSEMBLIES		
Check controller values/settings	√	Working Hours 34160
Check permeate, concentrate and recycling meter	m2	Σf=26394; Σk=17005; Σr=26816
Conductivity measurements	µS/cm	ECin=470µS/cm / ECPE=1µS/cm
Water temperature measurements	˚C	t= 17˚C
Percentage retention of soluble substances	%	R=99.99
Check/assess osmosis membrane status	√	replaced membranes, various r.
Flow rates Production	l/h	P=780; K=556; R=708
Checking mechanical tightness	√	
Check operating hours	√	M=60%
3. PERMEATE TANK		
Level sensor check	√	Replaced 3x BR390/50 Level sensor
Check ventilation valves	√	
Operational check	√	
4.CONNECTIONS, HOSES AND SEALS		
Checking seals	√	

Figure 3. Reverse osmosis plant annual overhaul report

1.b Lubricant quality improvement

An important aspect in machinery operation, is increased attention to the cooling-lubrication quality part, as a superficial approach can lead to production defects (Noor, et al.).

The recovered cooling lubricant quality may be improved and thus increases its service life in optimal conditions. The improved quality was obtained through an additional filtration of a bypas system with centrifugal filtration stations. After analyzing different types of products, a

centrifugal filtration station type Alfie 500, from Alfa Laval manufacturer, was selected for connection. The filtration capacity of the station is of maximum of 500 l/hour.

The application procedure was determined after several series of measurements, the optimal version being considered by connecting the filtration station in by-pass mode for 7 hours at each CNC, identifying that the maximum capacity of the CNC lubricant tanks is of about 750l. By centrifugal filtration at 7500 rpm, the station is able to filter oils and fine solid particles with the help of the conical disc set, the filtered oil being collected in a 20l capacity containers, equipped with a sensor for stopping the filtration when the maximum level is reached. The principle of operation of the centrifugal filtration station is also depicted in figure 4.

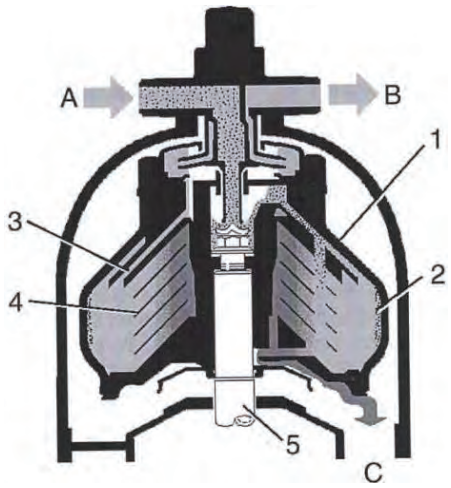


Figure 4. Working principle of the centrifugal filtration station (source: Alfa Laval)

Dirty liquid continuously enters at (A) and flows into the bowl (1). The bowl rotates at high-speed generating powerful centrifugal forces. As the liquid rotates with bowl, the liquid (heavy phase) and solid particles moves towards the periphery of the bowl. The particles (2) are deposited on the bowl wall, while the cleaned liquid enters the channels (3) and leaves the bowl at (B) at a constant pressure. The discs (4) in the bowl improves the cleaning efficiency during the separation process.

The oil (light phase) is forced towards the center of the bowl and then leaves through the underside of the bowl at (C).

1.c Daily monitoring of lubricant concentration and quality

Daily monitoring leads to identify and eliminate the elements that may influence the minimal consumption of lubricants during the normal cutting roves. The average daily quantity of cooling lubricant filled in the CNC machine-tools is about 150l. This quantity is generally lost through the resulting processing chips and evaporation.

The lubricant quantity is checked at each changeover and top up the required quantity, monitoring and recording the measured values like the quantity of lubricant topped up, the concentration of the topped-up lubricant and the lubricant in the machine tank, the water PH, water hardness and the quantity of nitrite.

The lubricant basins are equipped with level sensors, which indicate the maximum level, the warning level required to complete the lubricant and the minimum level when the CNC machine stops. The monthly monitoring of the amount of lubricant filled in relation to the number of hours produced is as shown in Figure 5.

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	YTM
Cooling lubricant cumulated consumption	2022	5,824	10,816	18,304	22,464	27,872	32,448	37,856	44,096	49,920	55,328	60,320	65,312	***65,312***
	2023	4,576	9,568	16,224	20,800	27,456	32,864	38,272	42,432	44,712	48,040	48,872	48,872	***48,872***
	2024	4,576	7,072	8,736	10,608	12,272								
Production cumulated hours	2022	16,258	33,684	53,778	68,165	87,169	104,434	121,482	140,278	158,596	174,575	194,835	211,818	***211,818***
	2023	18,609	35,565	57,551	72,702	90,894	106,452	125,164	143,617	164,077	185,343	207,829	226,065	***226,065***
	2024	21,269	44,934	69,371	94,682	117,684								***117,684***
Cooling lubricantl (liters) / Production hours	2022	0.36	0.32	0.34	0.33	0.32	0.31	0.31	0.31	0.31	0.32	0.31	0.31	***0.31***
	2023	0.25	0.27	0.28	0.29	0.30	0.31	0.31	0.30	0.27	0.26	0.24	0.22	***0.22***
	2024	0.22	0.16	0.13	0.11	0.10								***0.10***

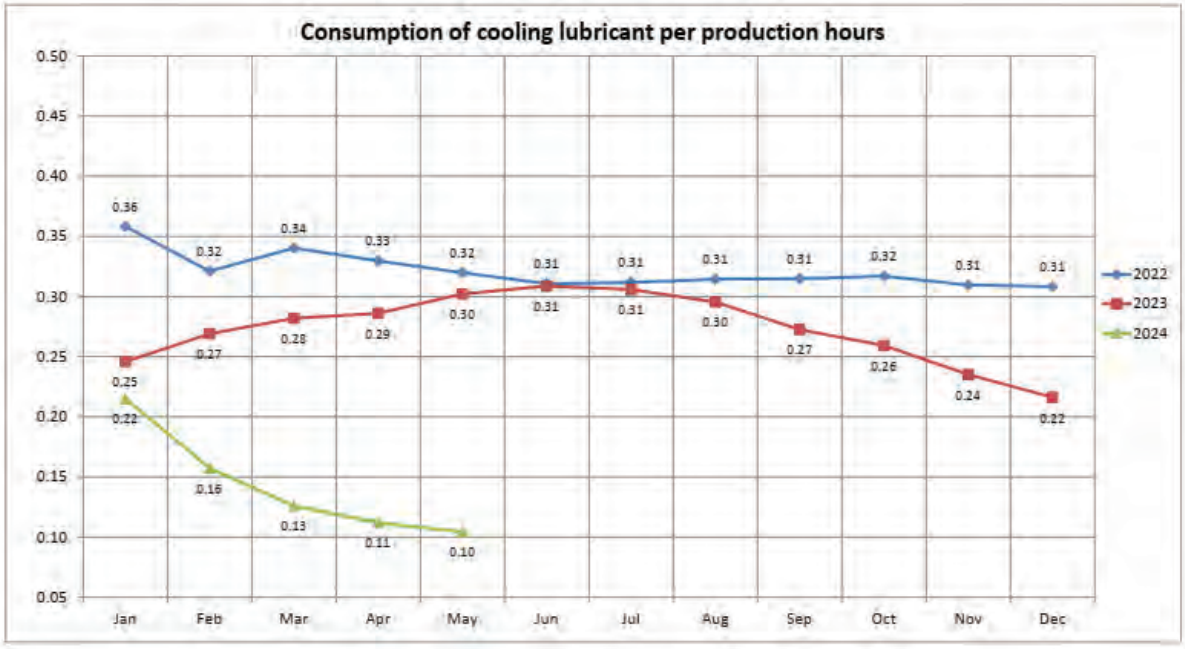


Figure 5. Monthly monitoring of lubricant consumption in relation to the number of production hours

But after designing and installing the required devices, the new monitoring and management process begins for the entire workshop of forty-five CNC machine tools. Once the system is installed, a reduction in the number of bacteria, germs, particles and other organic compounds has been recorded, and after 3 years of monitoring, a real and positive impact on the environment is observed, with a reduction of 200 tons of lubricant waste being sent to an external recycling company.

2.a Installation of a waste lubricant treatment plant

Re-use of materials in manufacturing involves finding a new use for materials after they have served their original purpose, and making every effort to avoid producing waste (Noor, et al.)

The sustainable solutions for the reuse of cooling lubricant within the machining processes was the installation of a used lubricant treatment plant.

According to the data collected over a ten-year period, the average annual amount of used lubricant waste sent to an external recycling company is 200 tons. Considering the maximum amount of waste lubricants produced in one year (320 tons), sustainable solutions were sought. According to the legislation in this field (law 211/2011, article 43) and with the environmental audit, it is mandatory to implement clear solutions for the prevention and the reduction of the amount of waste generated in the production activities.

According to the European legislation (law 851/ 2015, article 9), the amount of hazardous waste must be reduced by finding sustainable solutions and reuse the materials in industrial processes. The considered technical solution, and also implemented, treats the lubricant waste (vacudest vacuum distillation system) by a process of evaporation under negative pressure at 85°C, followed by a return to atmospheric pressure, and vaporization at 120°C. As a result of the lubricant residue distillation treatment process, a residue concentrates (max. 5%) and industrial water (min.95%) is obtained and reused into production (Figure 6).

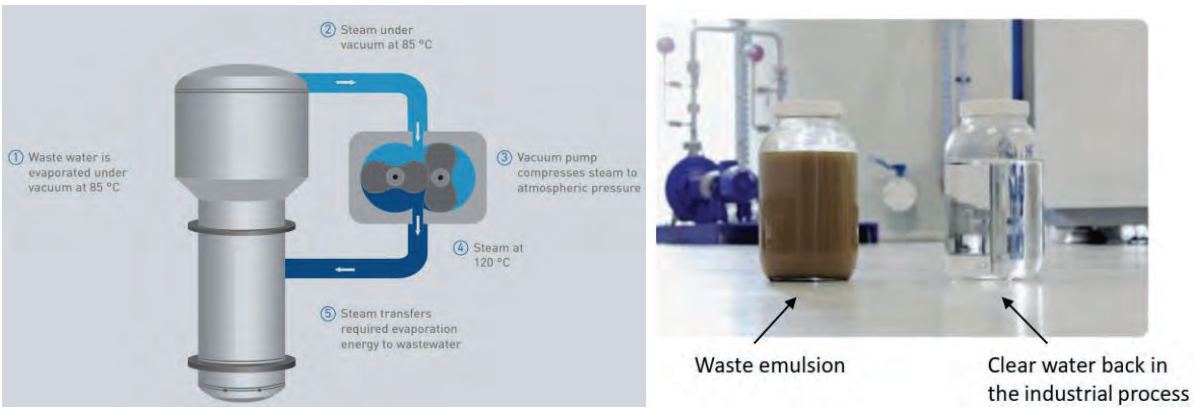


Figure 6 - Distillation treatment of cooling lubricant waste (source: H2O GmbH))

The annual results show that the installation of the lubricant waste treatment plant reduces the amount of lubricant waste by 180 tons (95%) and the resulting water from the treatment is fully reused in the processing processes by extrusion, being mixed in a proportion of 20/80 with the water obtained from the reverse osmosis plant.

The lubricant waste treatment plant is fully automated, ensuring a high technical availability (>99%). The principal scheme is as shown in Figure 7.

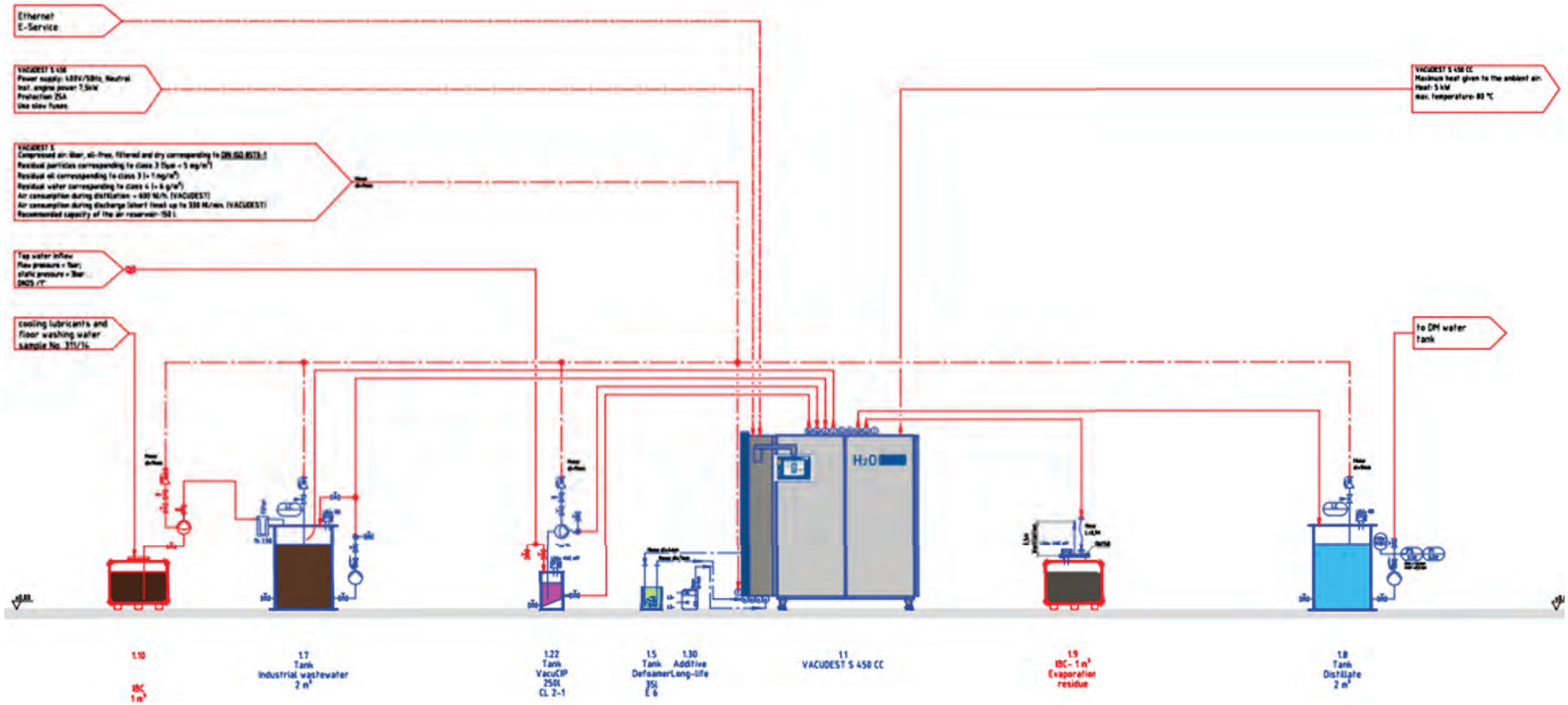


Figure 7. Principle diagram of the lubricant waste distillation treatment plant (source: H2O GmbH)

2.b Installation of a briquetting press for aluminum alloy scrap

From the CNC milling processes, the values recorded over a three-year period show an average annual quantity of 1800 tons of wet aluminum alloy scrap, with a 30% moisture content (lubricant residue) which led to a sustainable solution of installing a hydraulic scrap briquetting press (Figure 8).

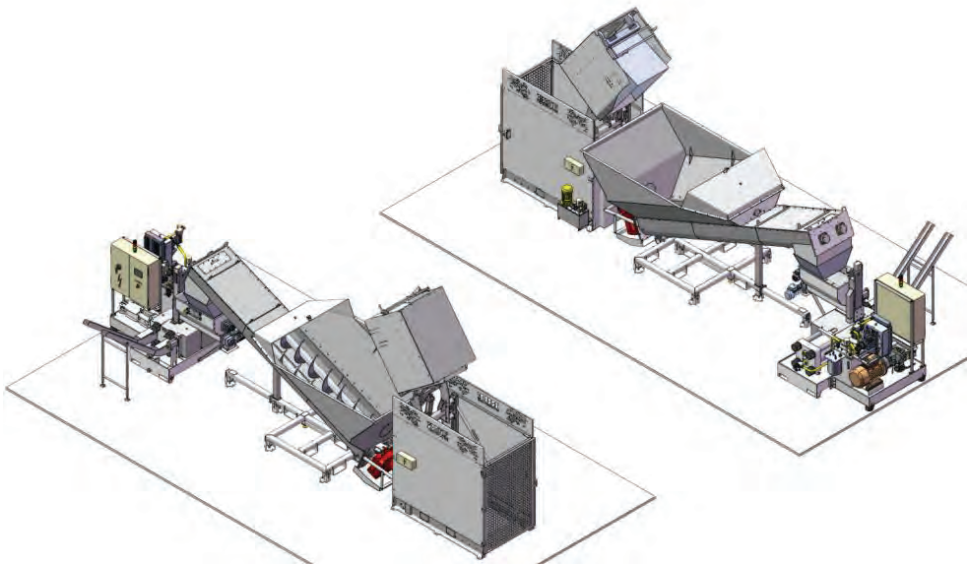


Figure 8. Hydraulic press for briquetting aluminum alloy scrap (source: RUF Brikettiersysteme)

The system also operates in a fully automatic mode, with a loading area for the chip containers, screw conveyors that loads the pre-compression area, compression area (Pmax=30 MPar) which provides 330 cylindrical briquettes/h, with maximum humidity of 5%.

The average quantity of lubricant recovered annually from the briquetting process is 33 tons of aluminum, the entire quantity being reused within new CNC milling processes.

An analysis report, issued by an analysis laboratory authorized by the producer of the cooling lubricant, is requested. Therefore, to ensure the quality of the processed used lubricant, a quality analysis is made prior to the reintroduction within the machining processes, (Figure 9).

To remove the amount of magnesium resulting from the briquetting process (49 mg/l), as is also shown in the analysis report, an additional lubricant filtration system was installed (Figure 10). The initial filtration is carried out with a roll filter with a filtration degree of 100µm, for the final filtration being used two other filter cartridges with a filtration degree of 20µm.

	Target range	Current	Previous samples		Method
Sample no.		23CH491423			
Art. no.		11755-03			
Sampling date		28.08.2023			
Overall assessment		i			
Concentration refractometer [%] *		7.6			FE.120.PA
pH value	8.7 - 9.3	9.4			FE.141.PA
pH value on-site		9.2			-
Color		gray			CS.115.STM
Odor sample		normal			CS.108.STM
Separation layer [%]	≤ 2	none			CS.118.STM
Average droplet size [µm]	≤ 0.700	0.189			CS.129.STG
Condition of emulsion		fine dispersion			CS.129.STG
Spec. conductivity [mS/cm]	≤ 7.0	3.1			FE.384.PA
Total hardness [°dH]	≤ 70	12			CS.130.STG
Magnesium [mg/l]		49			CS.135.STM
Chloride [mg/l]	≤ 150	7			CS.131.STG
Sulfate [mg/l]	≤ 400	5			CS.134.STM
Nitrite [mg/l]	≤ 20	0			CS.134.STM
Nitrate [mg/l]	≤ 150	1			CS.134.STM
HPTLC		carried out			CS.138.STM
Microbiology within tolerance?		not measured			CS.132.STG
Tramp oil [L/100L]		0.1			FE.413.PA
Other contaminations		not detectable			CS.138.STM

Figure 9 - Lubricant analysis bulletin resulting from the briquetting process

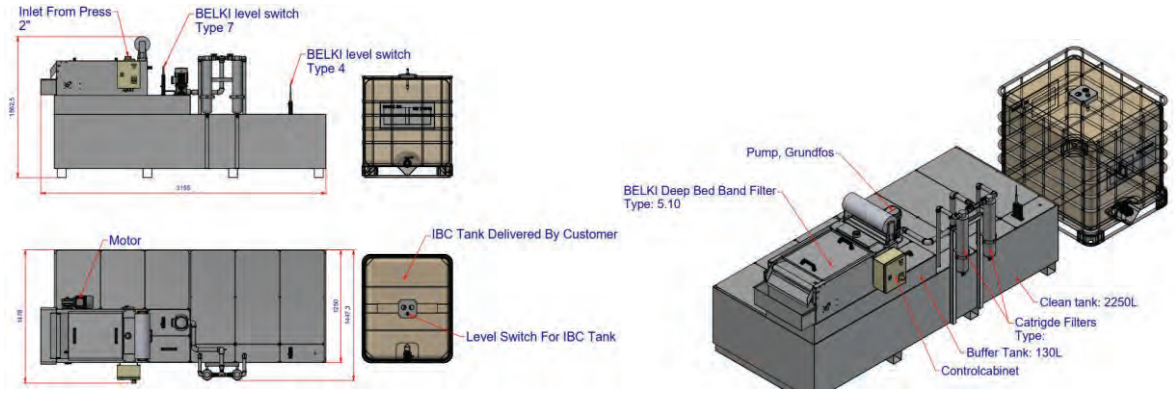


Figure 10 - Lubricant filtration system resulting from the briquetting process (source: BELKI teknik ApS)

Conclusions

In summary, the measures and objectives related to ecological, productivity and maintenance aspects have been met, as shown in Table 1, which presents the monthly monitoring, made for a period of over 3 years.

From a quantity of emulsion concentrate of 27872 liters (May 2022), the consumption has been reduced by 56%, to 12272 (May 2024), i.e. a reduction on a ramp-up of production hours by 35%, which also translates in a decrease in the quantity of lubricant by 68.8%, from 0.32l / production hour, to a current value of 0.10l / production hour.

The emulsion consumption per hour of production has been reduced by 68.8% through the use of the briquetting station and the increase in water quality. Through the filtration systems

and the installation of the reverse osmosis station, the emulsion lifetime was also increased from 3 to 12 months, resulting in a total monthly recovery of 75 cubic meters of water.

Table 1. Comparison Chart: Before/After implementation

Comparison: Initial vs. Actual Values			
Year	**CLcc**	**PCh**	**CL/Ph (l/h)**
2022 (Initial)	27872	87169	0.32
2024 (Actual)	12272	117682	0.1
+/-%	-56.0	35.0	-68.8
Legend:			
CLcc	*Cooling Lubricant cumulated Consumption (yearly value)*		
PCh	*Production Cumulated Hours (yearly value)*		
CL/Ph (l/h)	*Cooling Lubricant (liters) / Production hours (yearly value)*		

In terms of eco-friendly approach, the implemented project has achieved the desirable "6Rs" for sustainable production: Reduce, Reuse, Recover, Redesign, Remanufacturing and Recycling (Hegab, Kishawy and Darras 2019), all in accordance with Romanian and European waste management regulations.

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APPLICATION OF DECISION THEORY IN THE SELECTION OF ELECTRIC CHARGING STATIONS FOR AN SME

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Abstract

Purpose *– The research considers the application of decision theory in the selection process of the electric charging station, dedicated to inclusion in small and medium-sized enterprises (SMEs), aiming at behavioral modeling and the advantages of an SME in the use of electric vehicles. The integration of electric vehicles (EVs) into the transportation ecosystem has required the development of a strategic framework for the selection of electric charging stations, especially for small and medium-sized enterprises (SMEs) that want to increase their sustainability and operational efficiency thus the study exploring the application of theory decision in the selection process of electric charging stations for SMEs, emphasizing the importance of a structured approach in optimizing both economic and environmental results.*

Methodology/approach *– Detail the decision theory based on questioning the necessity, defining the purpose and clearly stating the advantages based on hypothesis and organization data collection. The critical interpretation is partially eclectic, using also recognized applied methodologies. Using principles of decision theory, the research develops a multi-criteria decision analysis (MCDA) model to evaluate various charging station options based on factors such as cost, location, accessibility and technological compatibility. By applying quantitative methods to evaluate these criteria, the study aims to provide SMEs with a robust decision-making framework that balances operational needs with sustainability goals.*

Findings *– A reconsidered view about the charging systems, including the accumulators, type of chargers' source of electricity and the potential environmental impact.*

Research limitations/implications *– Some hypothesis and finding testing must be continued, was difficult to report at this stage of the research, due to resources limitations and the pandemic and post-pandemic encloser and impact over a proper statistical analysis.*

Practical implications *– A new and adequate approach for inducing electromobility in SMEs, for employees and freight transport, thus generating a comprehensive approach to the trade-offs involved in selecting electric charging stations, providing practical insights for SMEs looking to make informed and strategic investment decisions in electric mobility.*

Originality/value *– A practical view over the resource's investment and advantages of electric mobility.*

Key words: *SME, Electromobility, Charging stations.*

Introduction

Lately mobility and especially individual mobility has gone through many transformations. The battle on market shares is divided between Battery-Electric, Pug-in-Hybrid, Hybrid Electric, Fuel Cell Electric, LPG, Ethanol E85, other fuels and the classical Petrol and Diesel ones.

Many discussions end in 2024 to the conclusion that in spite of the increase of the battery performance and decrease the Battery Electric cars price, the EU market remains constant slowing down the heavy increase of the former years. The only company in the TOP15 manufacturers that increase sell, but without changing the position is Toyota.

Car sales have shown mixed trends across the EU, in part due to diverging policies on green incentives. The performance development and implementation of the charging station is directly influenced by the number of users, the trend of EV implementation and the reached % of the total market.

A strong example in this sense is the business model of Europe's largest platform for consumers, the Octopus Energy's electric vehicle (EV) charging platform. With nearly 850,000 connected chargers, targeting this year the 1 million users' market, the No1 in Europe accelerates the worldwide presence.

Drivers can access Octopus Energy charging platform in 40 countries, available in 20 languages. With one tap, can be accessed one of the 80% of the chargers on Europe's public charging network.

Launched 4 years ago, in the summer of 2020, Octopus Electroverse is the answer to the frequent driver's complaint that many apps and cards are needed to use the so many different brands of EV charging stations.

So, the free-to-use app across Europe, from Octopus Electroverse expanded by integrating 950 charge point brands, among which are identified Aral Pulse, Charge Place Scotland, Free To X, InstaVolt, IONITY, Osprey, MFG, Powerdot, or TotalEnergies.

From the other side of the ocean, in the USA, the state of California has surpassed 150,000 chargers installed statewide. From that almost 10% are fast chargers. The building of a better and bigger charging network is a key part of the California Governor's agenda for delivering infrastructure upgrades across the entire state. For the achievement of these plans cannot be ignored the California expectation to receive more than $380 million from the President Biden's Bipartisan Infrastructure Law, dedicated to building out chargers, after this year 1 billion funding approved for EV charging and hydrogen refueling projects for cars, trucks, and buses.

So, the actual picture of the California electric vehicles chargers (EVC) looks like in the following picture:

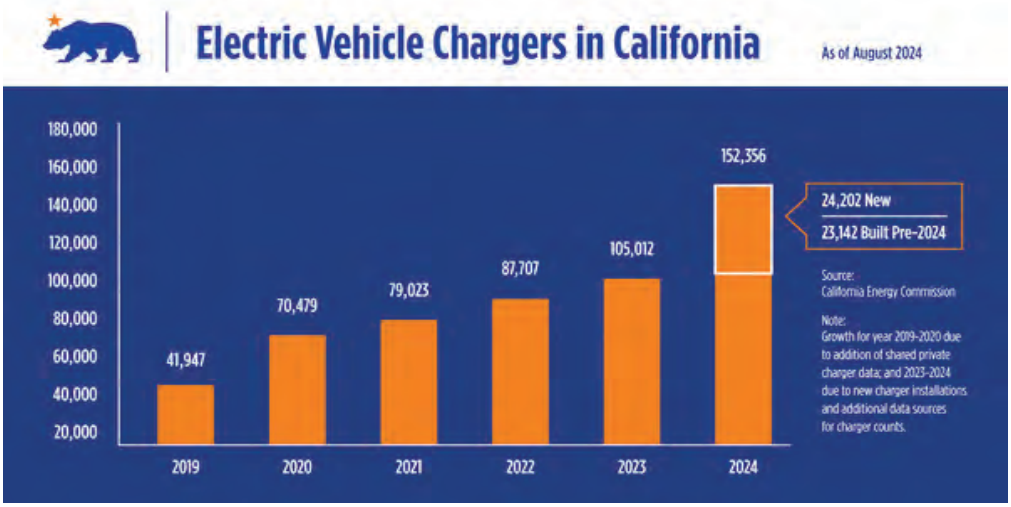

Figure 1. The California electric vehicles chargers' evolution

Looking at the local market, the purpose of the study is to apply the theory in the selection decision for electric charging station within SMEs, combined with the possibility to orient doctoral studies, aiming to have a direct use of the decision modeling implementation. By utilizing decision theory, the study provides a structured framework to make informed choices, even in complex environments.

The research explores the application of decision theory in selecting electric charging stations for small and medium-sized enterprises (SMEs). The goal is to guide SMEs through the process of decision modeling, helping them navigate the trade-offs and considerations involved in making the most suitable and profitable choices when selecting charging stations, with emphasis on practical implementation, ensuring that SMEs can adopt strategic and well-informed investment decisions that align with their operational and sustainability objectives.

SMEs attitude

The SMEs are generally dynamic economic units but within limited resources, especially in the early stage.

The dynamic component of a SME represents an advantage for large acceptance of innovation and new trends. Here is included also the electro mobility, acquisition and use. As a relatively new technology, it is still expensive, the continuous evolution and the intended mass production, together with larger companies' implication and governmental facilities, the trend is to diminish the price. China plays a crucial role in price reduction by promoting the 10.000 Euro models.

Within EU, the necessity to use EVs for business and ensure the climate change effects reduction is very much connected also with the distribution of the chargers' network and the sources of electricity, in the current research we are advocating also for the green electricity.

The Theory Components

The Decision Theory is a branch of decision sciences that studies the decision-making process under conditions of uncertainty, risk, and conflict of interest. These address how people make decisions and how their decisions can be evaluated in terms of efficiency, rationality, and consequences [Kahneman, (2011); Peterson, (2009)].

The Decision Theory has applications in a variety of fields, including business, economics, engineering, psychology, public policy, and more. It provides tools for optimizing the outcomes under diverse conditions [Gibbons, (1992)]. In this context “the decision” refers to the choice or selection of a particular option from a set of available alternatives. The decision is the result of a deliberate and rational process in which an individual or group analyzes the relevant information, evaluates the risks and benefits associated with each option, and selects the one considered the most suitable or efficient according to the established objectives.

The decision can be influenced by various factors such as available knowledge, individual preferences, risk tolerance, time constraints and social pressures. Decision theory explores how these elements affect the decision – making process and how people can make decisions under conditions of uncertainty or risk. This approach also looks at the degree of rationality in decision-making, recognizing that factors such as cognitive biases or emotional influences can intervene in the process of thought and choice.

The study of decision theory aims to enhance decision-making quality by employing models, game theories, and other analytical techniques [Tversky and Kahneman, (1974); Keeney and Raiffa, (1993)]. An analytical tool that can be utilized in the context of electric charging stations and SMEs is Multi-Criteria Decision Analysis (MCDA). This analysis can be used to evaluate various locations or types of charging stations. The criteria may include cost, anticipated usage of the charging stations, environmental impact, and installation time. By assigning scores and weights to these criteria, decision-makers can systematically compare and identify the most advantageous options for investing in the locations or types of charging stations for the SME.

Key aspects of decision theory are decision modelling which is related to understanding how individuals or groups make decisions. This involves the analysis of factors that influence the decision-making process, such as available information, individual preferences, cognitive and emotional limitations. Risk and uncertainty are related to decision theory dealing with situations where the outcome of a decision is uncertain or there is a degree of risk associated with it. This includes the identification and assessment of risks and how people manage this uncertainty in decision-making. Optimization and rationality are referring to the analysis of how decisions can be evaluated from the perspective of optimization, more exactly, finding the best possible solution according to specific criteria. Decision theory explores and analyzes how people make decisions and examines the extent to which people make rational decisions or whether they are affected by cognitive biases or other influences [Saca, Victor and Oleg, (2013)].

Formulation of the decision-making problem, clearly establishing the nature of the problem or opportunity that requires a decision is the initial most important activity. This implies the correct definition of the situation [Saca, Victor and Oleg, (2013)]. The multitude of variants is the result of the developing process to identify a set of possible alternatives to address the problem or take advantage of an opportunity [Saca, Victor and Oleg, (2013)].

The elements of the decision-making process within decision theory are particularly considered for the electromobility i.e. the charging station implementation by following a list of definitions that creates a sort of guidance limits in the decision process.

The **objectives of the decision** are clearly defining the goals and objectives that the decision much achieve. This provides a framework for evaluating options [Klöckner, (2014)], being crucial aspects of the decision-making process, and their awareness, proper management contribute to informed and effective decision-making.

The **states of objective conditions** (states of nature) are elements to be identified as possible states of nature or objective conditions that can influence the outcome of the decision [Klöckner, (2014)]. The decision maker is the person or group making the decision. The decision maker can be a single person, a team or an organization [Saca, Victor and Oleg, (2013)].

An important part of the decision is if game theory is considered. Game theory deals with the strategic interactions between different parties involved in decision making. It looks at how one party's choices can influence outcomes for other partis involved. The decision evaluation can be made by comparing associated costs and benefits. This involves evaluating the pros and cons of each available option to make informed decisions [Keeney and Raiffa, (1993)].

In Decision theory can be classified the types of decisions in a way that addresses the specific methods and models for each type. Regarding the classification of decisions there are: **programmed decisions** which are structured, repetitive and routine decisions. Both are taken in common situations and can be easily managed by a set of procedures. **Routine decisions** are taken regularly, without requiring extensive analysis. Non-routine decisions are not made frequently, are more complex and require more careful analysis. **Unscheduled decisions** that are more complex and less structured decisions that require more analysis and evaluation. They occur in less common and not clear information [Berar, (2000)].

Individual decisions are taken by a single person, who analyzes and decides on the situation. Group decisions are made by a group of people working together to reach a consensus or a collective decision [Berar, (2000)].

The operational decisions are taken at the basic level of the organization and are related to day-to-day activities. **The tactical decisions** are taken at the intermediate level of the organization and refer to how strategic decisions are implemented. **The strategic decisions** are taken at the highest level of the organization and affect the general direction and its long-term objectives [Berar, (2000)].

Certain decisions are based on clear information and the results can be known from the beginning. **Risky decisions** are related to a certain degree of uncertainty about the outcomes, but the probabilities associated with them can be estimated.

Uncertain decisions represent a limited amount of information and expected outcomes, their associated probabilities to occur are unknown [Berar, (2000)].

The set of criteria for evaluating the variants is transformed into a clear and relevant list of selected criteria for evaluating and comparing available options. The set of consequences of the criteria for evaluating the variants, evaluating the consequences of each option against established criteria to determine the impact and benefits of each choice [Saca, Victor and Oleg, (2013)].

Type of criteria:
Bayes-Laplace criterion (equal probabilities) is based on probabilities and assumes that the decision maker can estimate probabilities of difference possible outcomes of a decision. The probability assigned to the maximum result is chosen [Rebelo, et al., (2016)].
Hurwicz's criterion (optimistic): tries to find a balance between an optimistic and pessimistic approach. Multiply the maximum possible values of a result by a constant ($0 \leq \alpha \leq 1$) and the minimum value by ($1-\alpha$).

Wald's criterion (pessimistic) is also known as" maximin", involves choosing the option that maximizes the minimum possible outcomes. It is a more pessimistic approach, where the decision maker tries to minimize the maximum risk [Rebelo, et al., (2016)].

Savage's Criterion (regrets): is also known as „minimax regret" and is based on the idea of regret. The decision maker considers the possible losses associated with each option that minimizes the maximum possible regret [Rebelo, et al., (2016)].

Each of these criteria reflects different approaches to risk, uncertainty and decision-maker preferences in the process. The use of a particular criterion may depend on the specific context of the decision and the individual preferences of the decision maker [Rocha et al., (2007)].

The advantage of decision theory is the structured decision-making process on which theory provides a framework and set of tools to structure and formalize the decision-making process. This can facilitate a more systematic and clear approach to problems adding the mathematical rigor basis for decision analysis.

Related to identifying risks and consequences the decision theory helps in identifying and evaluating the risks associated with different options as well as evaluating their consequences. This can lead to more informed decisions, the flexible approach, the various methods and criteria allowing the theory adaptation to different contexts and individual preferences.

The disadvantages of decision theory are the oversimplification when some models and methods in decision theory can oversimplify complex real-world situations, ignoring important and nuanced aspects:

- The unrealistic assumptions on which some theories and models considers that decision makers have perfect knowledge for an accurate assess of the probabilities and consequences of each option.
- Lack of adaptability to human behavior: some criticism claim that decision theory does not take enough account of the emotional, irrational and social aspects of human decision-making.
- Mismatch in cases of extreme uncertainty in the case of decisions made under conditions of extreme uncertainty or in very complex decision situations, decision theory may provide limited guidance or not flexible enough.

Annually, a report on electric mobility is produced by the Roland Berger global consulting company. Romania being one of the target markets in the 6th edition of the "Romania E-Mobility Index" study shows that the growth rate of plug-in hybrid (PHEV) vehicle registrations being at heigh altitudes. Thanks to a 70% increase in EV and PHEV registrations, Romania succeeded in 2022 for the first time to surpass countries such as Italy or Spain, having a 12% from the new car registrations, when Spain indicates 10% and Italy 9%.

In addition to these performances of ERV and PHEV vehicles, is considered also the situation of the charging stations. As a rule, is an approach of insufficient increase in the number electric charging stations. In 2022 were 1,350 stations in Romania, 58% (785) are of 22 kW AC type, 40% (540) above 22kWAC up to 150kW DC, and 2% (25) ultrafast, above 150kW. In 2024 are already over 5000 charging stations.

On an amount up to 30% of cases, the charging station can be already found in the shopping centers area, in 2022 the number increased 374 from 270 in 2021, mostly with fast or ultrafast loading DC loading systems. One of the biggest increases was in the gas stations area, existing about 3000 in Romania in 2024, so at the end of the year, from the new 164 new charging station 74% (121) was of fast type.

The car dealers contribute to the increased number of charging stations, by creating a direct pressure or true the increased number of EV sold, but also by delivering some models with an included charging station.

Already from 2020, Roland Berger offers an important detail that EVs end up equaling the thermal engine after approximately 8,000 km traveled. According to Roland Berger's reports, this point of equilibrium is because the CO2 emissions saved by using an electric vehicle equal the pollution generated from its production, including the production of the batteries used by electric vehicles. This study also emphasizes the importance of transitioning to renewable energy sources for charging electric vehicles, thereby maximizing the environmental benefits. Depending on the energy mix required for vehicle production, electricity, and the vehicle's efficiency, this point of equilibrium can vary. However, an approximation suggests a value around 8,000 kilometers driven, establishing a general threshold [(Berger, R. et al., 2015)].

Connection with development of doctoral studies in the technical field

The approach of different topics depends on the “forces” that are requesting of considering the studies. If the social component, the public, the population needs to be informed in an as neutral manner as possible then we must consider the doctoral studies as the most appropriate to identify a viable model that demonstrate the dimension of a problem at the possibilities in solving it. Doctoral journey is not only about gaining and disseminate knowledge, but also about building relationships and joining prestigious specialists, universities collaborating with international institutions, allowing the engagement with a global community of experts, that may become pivotal connections, opening doors to collaborative research projects.

In this category is entering also the application of the Decision Theory, especially because is addressed to the important problem of climate change that impose a lot of ideas and regulations, not all useful, not all scientifically based or sustainable having in site only o short period of time or a narrow horizon. Electromobility benefits from populist support. In the selection and operation of the EVs and the electric charging stations there are not really green solutions, but the most pecuniary elements are in the front.

Due to the doctoral studies, endorsement for green, sustainable and end users’ money efficient solution the acquisition, the placement, and operation of the charging stations will promote real green electricity for EV using, based on scientific validated results. Especially due to apparently contradictory data and information from the considered reliable sources.

Based on the doctoral studies that we are advocating, the contradiction appears from the geopolitical different situations, the biggest player being Europe, USA, China, Rusia and India, followed emergent countries.

China, Rusia and India are playing a double role due to the large regional development discrepancies. In the present and future studies, we will focus on the Europe – USA and the others impact on this connection, China, Rusia and India are not to be ignored.

An analysis from the USA Department of Energy by Bloomberg Green estimates the number of fast-charging public sites will be greater than gas stations by 2030 if the current pace continues. In 2024 is expected that operators will double their 2023 investment to reach a collective $6.1 billion (Full Story: Bloomberg 7/18). Only in Q2 of 20204 were added about 700 new public fast-charging stations for electric cars in the second quarter, bringing the nationwide total to nearly 9,000. But the US greenhouse gas emissions are not falling fast enough, So, they will not meet the Biden administration’s goal of cutting greenhouse gas pollution by at least half in 2030, compared with 2005 levels, according to new analysis by research firm Rhodium Group.

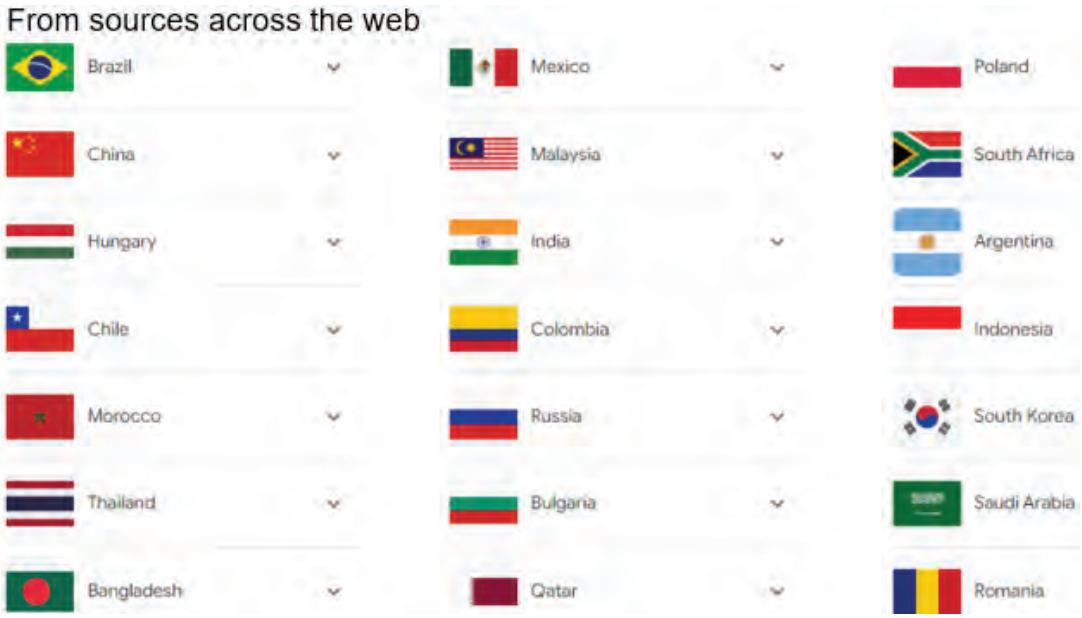

Figure 2. List of the emergent countries, players in the environmental impact reduction and promotion of the electromobility

The Inflation Reduction Act, passed in 2022, has helped create a pathway for deep decarbonization across the energy and transportation sectors – but the US is still only on track to achieve as much as a 43% emissions reduction at the start of the next decade, the unexpected reality is that the skyrocketing electricity demand from artificial intelligence and other data center uses as one of the key obstacles. And in this market, electricity and especially green electricity demand, is playing also the electromobility.

This kind of news came just days after (July 2024) new figures indicated that China, as the world's biggest polluter seconded by the USA, have peaked its output of greenhouse gases in 2023. Only a rapid pace of emissions reductions in China and the US, would play a critical role in meeting the Paris Agreement's goal of limiting planetary warming to below 2C above the pre-industrial average, and ideally to 1.5C. But the latest evolutions shown that is hardly to believe that with no China commitment and US's commitment to the agreement, the Biden administration pledged the country will achieve net zero emissions no later than 2050, is contradicted by the current trajectory to 2030, the country is off track for this mid-century goal, in spite of some recorded progress in emissions reductions that fell (as the economy expanded) with 1.9% year-over-year, in 2023 being recorded 18% lower than they were in 2005, but they raised in the two years before, after the pandemic drawbacks.

The Inflation Reduction Act (IRA) makes historic investments in climate action that are expected to reduce U.S. emissions ~40% by 2030 while supporting disadvantaged communities and the clean energy industrial base, but the passage of the IRA has also made further cuts look more likely as it supports the expansion of wind, solar and electric vehicles. An estimate of energy and transportation emissions in the U.S. is presented in Figure 2, showing a significant decrease in these emissions across various sectors such as transportation, industry, power, buildings, and agriculture.

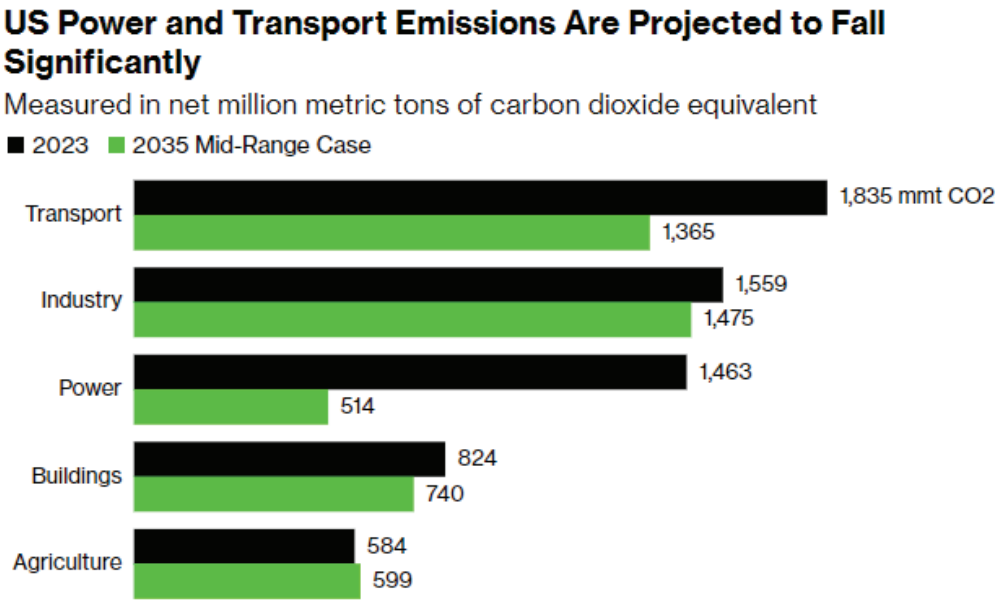

Figure 3. An estimate of energy and transportation emissions in the U.S. through 2035

The zero-emitting sources like wind, solar and ***nuclear*** could account for 62-88% of total electricity generation in 2035, due to support from IRA subsidies and new Environmental Protection Agency (EPA) limits for power plant emissions, depending on how quickly cleaner power generators can be built to match growing electricity demand from EVs and data centers.

The doctoral studies advocating electromobility are sustained by the capacity of transportation sector emissions to decrease by 25-35%, aided by stringent EPA standards for vehicles, the studies made by the Rhodium Group, as an independent research provider, combining policy expertise and data-driven analysis to help decision-makers navigate global challenges, sees EVs representing as much as 74% of light-duty vehicle sales by 2032, but a lot could change depending on the results of elections in November, a win for former President Donald Trump might lead to policy rollbacks.

Thes kind of statements from USA" by 2030 the number of charging station will exceed the number of gas stations" seems to be considered differently in EU, and as mentioned are obsolete in Romania, had existed a ratio of 5 to 3 in the favor of charge stations. It is true that under 50% of these are fast chargers and the actual distribution is not offering the expected satisfaction, because their type, placement, access and waiting times are not creating a synergy of charging facility.

Therefore, the doctoral studies orientation is also a research topic, the actual our doctoral research revealing that the development of PhD students' skills is as important as the research carried on by the PhD student and that the interdisciplinary approach of the research will offer greater benefits for the student and the student results. Pursuing these concepts, doctoral studies can have a stronger positive impact on the research field and on society, generating new insights, solutions, and innovations. Sharing the new gained e your knowledge, contribute to the development of knowledge, policy, practice, and technological culture.

Discussion and conclusions

US will miss Biden’s ambitious 2030 goal for cutting pollution

SMEs' adaptability and receptiveness to new technologies enable them to implement electromobility despite ongoing budget constraints and technological hurdles. The need for green energy, technological advancements, and government incentives—particularly from China and the EU—are expected to lower electric vehicle prices, increasing public confidence in transitioning from conventional to electric vehicles. While Multi-Criteria Decision Analysis (MCDA) and Decision Theory may sometimes oversimplify complex real-world scenarios and human dynamics, they provide SMEs with structured tools to evaluate investment opportunities. Despite the notable expansion of charging infrastructure, challenges related to distribution and charger types persist. Policy developments such as the U.S. Inflation Reduction Act and global perspectives on electric transportation highlight the importance of integrating green solutions and adapting to regional variations. Doctoral research may offer better and honest solutions, different from media marketing. Electromobility can be green and sustainable and can reduce the climate impact if it is used in an appropriate manner, and the source of electricity is green. The charging stations can make a difference in the exploitation of the EVs and the way in which will be largely and efficient adopted from personal locomotion system to large fright transports, the smart component of the electric charging station leading to money and time saving, together with the CO2 footprint reduction.

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COBOTS IMPLEMENTATION IN REHABILITATION PROCESS

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Abstract

Purpose *– The aim of the presented research is about the needs identification for implementing rehabilitation robotics and some requirements for an effective implementation.*

Methodology/approach *– Through an initial bibliographic study, conducted by interrogation specialized, but accessible, databases to find the most considered robotic systems dedicated for rehabilitation, leading to an adequate centralized synthesis.*

Findings *– The considered result shows that most applied upper limb rehabilitation robots, implemented in clinics, but used mostly in clinical studies. Furthermore, was identified that the type of clinical used training mode is dedicated to the predominant employed joint. The components dedicate to the data analysis, the ones used by the robot and the ones used within robot assisted rehabilitation applications, were also processed for a centralized overview.*

Research limitations/implications *– At this stage, the conducted research implies only data available in English, German and Romanian languages, with the examples from these languages covering area.*

Practical implications *– The practical use of research refers to the identification of a possible practical approach for implementing new robotic systems for assisted rehabilitation within specialized clinics and then to increase the number and the quality of the robotic rehabilitation procedures.*

Originality/value *– The up to now original funding shows that robotic therapy may benefit from more date that displays reasons that facilitates the rise of the robotic rehabilitation usage, and the new addressability based on the increase in neurologic burden in parallel with the decreased number of qualified personnel/1000 patients. At the same time, the paper tackled partially the technological developments, financial dimension and administrative issues that are hindering a larger implementation.*

Key words: *Cobots, Rehabilitation, Robotic assisted rehabilitation*

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Introduction

Medical rehabilitation involves the recovery of a person to the highest possible physical, psychological, social, vocational, professional and educational potential in accordance with the deficit caused by the condition and the limitations that may arise as a result.

Rehabilitation includes the maximization of physical capacity, preventing deterioration due to secondary illnesses, the optimization of the patient's environment, facilitating psychological adaptation to disability, and encouraging social reintegration. The robots (Cobots) that can be included in the rehabilitation process, are defined by a dynamic mechatronic system that provides physical and informational assistance during therapy sessions for the rehabilitation of sensorimotor deficits caused by central nervous system, peripheral nervous system, or musculoskeletal system impairments, or for assistance in daily life activities.

Through these two mechanisms,robotic rehabilitation and conventional rehabilitation, a multidisciplinary team can positively contribute to the patient's quality of life improvement by increasing independence and functionality. During the rehabilitation process, individuals undergo all three processes outlined in the ICF model implemented by the World Health Organization: MPS – the motor, the psychological, and the social process. Like most of the research teams, we recognize that the obtained results may describe only a sort of early phase of the assisted robotic rehabilitation implementation, where the technological solutions introduced by Industry 4.0 have not reached their full potential and have not compensated for the encountered rehabilitation deficiencies related to their use. (Asia-pacific-rehabilitation-robots-market, 2021)

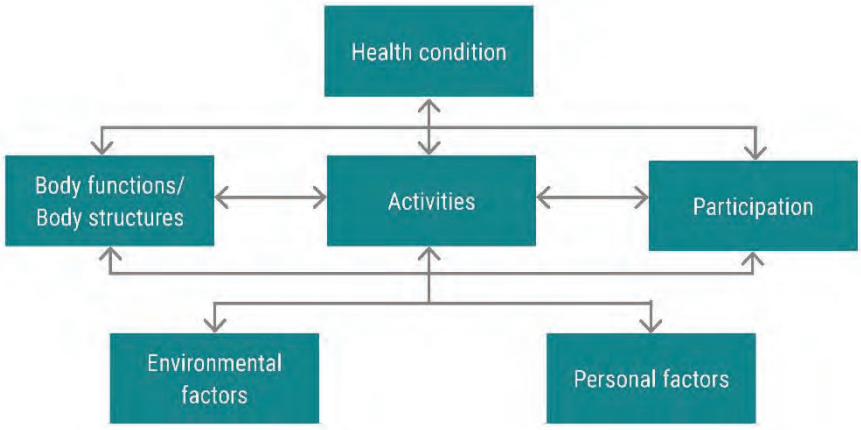

Figure 1. Biopsychosocial model of care

General Types of Robots used in Rehabilitation Process

Robots intended for assisted rehabilitation, are actually Cobots - Robots designed to work alongside humans and not instead or isolated form humans -, that can be classified into two categories based on their intended role:

1. Segment recovery robots
2. Segment compensation robots

In the recovery purposes, the role of the robotic device is defined as restoring the individual's ability to perform tasks using previously used movements. For compensatory purposes, the role of the robotic device can involve atypical approaches to meet task requirements, and using alternative mechanisms that are not commonly

used by a person. The considered devices can be of the following types: prostheses, orthoses, or complementary rehabilitation systems:

A. A prosthesis is an artificial replacement for a missing limb.

B. An orthosis is an external device aimed at stabilizing movement or protecting the affected segment.

C. Complementary systems for rehabilitation include systems or devices controlled by the physiotherapist or by the patient's still-functional components.

Segmentation of the Robotic Assisted Therapy Applications

A. Assistance in therapy clinics

For the robot-assisted interventions, that refers to the conventional therapy modes used in clinical practice and characterizing the patient's state during interaction. three main types of physical human-robot interaction applications have been defined: the Passive, Assisted, and the Active.

In the Passive mode application, the Cobot performs all kinematic-dynamic activities, independent from the patient's response, but in direct monitoring with the patient’s condition.

In the Assisted mode application, the patient's voluntary activity is required at all times throughout the therapy movements, while the Cobot provide assistance only in completing the performance of the tasks.

In the Active mode application, the Cobot is used as a “*movement parameters measuring device*”. Performance results solely from the patient's contribution, based on the defined three working types:

- The A: "***active***", basic type - the system does not provide mechanical work to the patient's limb.
- The AA: "***active-assisted***" type – the system assistance for completing tasks is offered only when the patient is unable to perform them.
- The R: "***resistive***" type - the Cobot is generating an opposing force to the movement, to increase the patient capability.

In therapy clinics, robotic assisted systems could be used in the process of assessing capabilities, providing precise and neutral data on evaluated movements range and angles. This can help both the patient and the therapist.

In case of re-evaluation, the evolution and specific differences for a considered period of time can be objectively highlighted, leading to the optimization of the rehabilitation process and the evaluation procedures, increasing the well-being and optimism of patients.

B. Minor assistance at home

The specialized literature mention and describes various robotic systems intended to support ADLs (Activities of Daily Living), aiming the increase of the living quality and ease the performing of daily activities, differentiated by the type of limb. (BROKAW et al., 2011)

For the upper limb, is exemplified the HandSOME (Europe Rehabilitation robots Market, 2021) glove, which helps for the patient's hand opening and the extension of the finger movements.

HandSOME uses a series of elastic cords and springs to apply the extension moment to the finger joint, together with adjustable stoppers as a safety measure to control the range of motion.

For the lower limb, "electric driven orthoses" are used, with a dual role in stabilizing the lower limb functionality and assisting in the locomotion process.

C. Assistance with ADLs

In the cases where the patient cannot go down the stairs and the location does not have the possibility of a ramp, a lift attached to the handrail can be used. Transfer with the help of robots, such as the Robot for Interactive Body Assistance (RIBA) – developed by the RIKEN-SRK Center for Human-Interactive Robot Research and Sumitomo Riko Company in Japan – transfers patients by lifting them from the bed or wheelchair to new positions. (Diaz, Gil, and Sanchez, 2011)

The global status of rehabilitation dedicated Cobots

According to the Market Analysis Report, the global rehabilitation robots' market was valued at USD 226.0 million in 2021 and is expected to expand at a compound annual growth rate (CAGR) of 17.3% from 2022 to 2030. Rehabilitation Robots Market Size & Share Report, 2022-2030. (Machando, 2023)

Considering their applicability, rehabilitation robots are predominantly used for lower limb pathologies compared to upper limb pathologies. Among the reasons cited are the ease of the rehabilitation process for the lower limb, which has a much lower degree of complexity compared to the upper limb, the much more easily appreciated recovery speed visibility for the lower limb, and not least, the fact that there is a much larger bibliography in the specialized literature presenting studies showing the increased efficacy of lower limb rehabilitation compared to the upper limb. From an anatomical and physiological standpoint, another reason is the motor engram held at the cerebral level, an engram dedicated to functional motor processes. In this engram, the brain has a larger "imprint" on some segments (the hand) compared to others (the foot). The engram can be affected by various pathologies but can also be modified through neuroplasticity with the help of rehabilitation.

Factors contributing to the rise of robotic rehabilitation

- Development of intelligent robotic systems capable of adapting to provide personalized multimodal therapies for patients with neuromotor deficits.
- The increasing prevalence of central nervous system pathologies (such as stroke, Parkinson's disease, multiple sclerosis) as indicated by the Asklepsios team (Khan, Siddique, and Lee, 2020), along with the rise in orthopedic, cardiovascular, and endocrine pathologies.
- An insufficiency in qualified personnel, that have to be compansated

Region	Population	Prevalence of neurological diseases	Deaths due to neurological disease	DALYs	Number of neurologists[3]	Number of EAN associate members
European Union (EU28)	512,355,000	307,859,199	1,116,038	21,046,899	43,306	19,166
Western Europe	432,969,000	260,827,756	892,162	16,499,342	36,009	15,465
Central Europe	114,803,000	67,368,506	300,317	6,024,036	9,031	5,529
Eastern Europe	210,199,000	130,372,328	604,144	13,110,119	29,016	11,024
WHO Region Europe	925,631,000	542,935,521	1,981,463	41,319,938	83,397	35,798

Figure 2 insufficiency in qualified personnel in relation to neurologists

- The growing geriatric population coupled with an increase in injuries. The rising prevalence of pathologies is the dominant factor driving the development of rehabilitation technologies. According to the WHO (Musculoskeletal Conditions. WHO, 2022), in 2021, there were approximately 1.71 billion people globally suffering from musculoskeletal disorders. This growing number of individuals with such conditions results in the necessity of using rehabilitation robots for physical, psychological, or social conditions.
- Presently, the Asia Pacific region represents the fastest-growing market in the utilization of rehabilitation robots. The aging societies in the Asia-Pacific region, particularly Japan and China, are driving the growth of the medical technology sector, thereby creating a huge market for rehabilitation robots. (Maciejasz, P. et al., 2014)
- In the North America region, the increasing prevalence of spinal cord injuries fuels the growth of the rehabilitation robot's market. The growing geriatric and disabled populations are among the factors driving the adoption of rehabilitation robots. (Rehabilitation-robots-market, 2024)
- In the European region, the aging population and the increasing cases of myocardial infarction, stroke, and spinal cord injuries propel the rehabilitation robot market in Europe. Heart attack and stroke, being major causes of death among the elderly population, often lead to disabilities requiring rehabilitation, with many patients suffering from chronic conditions requiring continuous attention and care. (Rehabilitation Robots Market Size & Share Report, 2022-2030)

The global implementation status of upper limb robotic rehabilitation

Following the bibliographic study conducted through online accessible databases from December 2023 to February 2024, 132 robotic systems dedicated to the upper limb were identified, for which a dataset was centralized, leading to the following conclusions:

Most of the robotic systems were developed in the United States of America, and not all of them are available on other continents, with some not even available in the regions where they were implemented for study purposes. This is true for certain systems in Europe or Asia as well. This aspect is justified by various reasons such as price, testing stage, and lack of clinical evidence of effectiveness.

The predominant focus segment is the elbow joint, as it is a "hinge" joint with a single degree of freedom, performing only flexion and extension movements, making the implementation of a robotic system at this level much simpler. The thumb is the least involved in robotic systems due to the complexity of movements, especially opposition and types of grips.

The predominant training mode is passive-active, allowing patients to initiate the movement and then the robot to continue it. The inclusion of multiple types of training in recently built rehabilitation robots has been observed, thus diversifying rehabilitation, and the robots can more easily adapt to the patients' needs.

The predominantly analyzed data by the robotic systems were the range of motion, force, and velocity. Few of them considered coordination or spasticity, but there is not an standardized accepted method for evaluation.

The global implementation status of lower limb robotic rehabilitation

In an article (Inaki, 2011), 43 lower limb rehabilitation robots were identified, half of which were not available on the market. The reasons cited were similar to those found for the upper limb robots: high costs, lack of clinical evidence, and the need for a well-implemented protocol.

The status of robotic implementation in Romania

During the article's development, an investigation into the situation in Romania was conducted, particularly through the analysis of official data posted online and accessible databases, supplemented by information gathered from the network of active doctoral students. As a result, the following information regarding rehabilitation centers with robotic rehabilitation services could be centralized:

Bucharest

- University Hospital offers a website discussing robotic rehabilitation, without being able to identify information about their actual use within the hospital.
- Hipocrat Medical Clinic uses the "G-EO Evolution" robotic system for gait rehabilitation, a system used in neurological and orthopedic conditions.

Cluj-Napoca

- Kinetoteam uses a robotic system for the evaluation and functional training of static and dynamic balance.
- MedicCover Hospital offers patients the possibility to use the "Lokomat" system, a robotic exoskeleton for gait re-education for patients with motor deficits to regain lower limb functions.

Iași

- Arcadia Medical Recovery Hospital has the most diverse range of rehabilitation robots (Rehabilitation Robots Market Size & Share Report, 2022-2030): Lokomat; Andago, for gait rehabilitation; Armeo Spring, an exoskeleton for upper limb rehabilitation, treatment, or active training to increase mobility, muscle strength, control, and coordination; Indego, a modular exoskeleton for regaining and retraining ground walking.
- Iasi Clinical Recovery Hospital - the website describes various robotic systems, exoskeletons, and upper limb rehabilitation systems (without specifications).

Târgu Mureș

- Hyperbarichospital implements a robotic exoskeleton system for lower limb rehabilitation services.
- OFK Medical Center uses the Kineo robotic system for medical treatment and rehabilitation and lower limb training, as well as the "Alter G" anti-gravity treadmill, which can reduce body weight by up to 100%, allowing athletes or patients to start rehabilitation much earlier.

Timișoara

- No clinic implementing robotic systems was identified.

The rehabilitation robots used in the mentioned clinics are predominantly for the lower limb, and the pathologies for which they are used are neurological (stroke) and orthopedic (fractures).

Requirements, demands and barriers for implementation

Both regionally and internationally, robotic rehabilitation systems are continuously evolving, focusing more on the active component of movements, involving increased patient participation in rehabilitation. The integration of multiple body segments by the robotic system assists patients in their daily activities, thereby facilitating their reintegration into social environments.

SWOT Analysis Regarding the Implementation of Rehabilitation Robots

Strengths	**Weaknesses**
• Administering rehabilitation for multiple patients • Collecting data through objective methods • Assisting with the patient's daily activities • Enhanced precision and consistency in therapy delivery	• High cost of technologies • Lack of resources for in-depth research in the field • Absence of in-hospital testing • Requirement for specialized training for healthcare professionals to operate and manage the robots effectively
Opportunities	**Threats**
• Adapting systems to different symptoms, such as tremors in Parkinson's disease • Using robotic systems at patients' homes • Integrating multiple body segments in rehabilitation • Growing demand for innovative rehabilitation technologies, driven by an aging population and increasing prevalence of chronic conditions.	• Although accidents were not mentioned during the studies, they can occur due to errors from the rehabilitation robotic system • Patients' dependence on the robotic system may lead to a decrease in achieving independence • Lack of motivation from either the patient or the therapist • Economic uncertainties and budget constraints within healthcare systems, potentially limiting investment in robotic technologies.

To make robotic-assisted rehabilitation much more accessible and tailored, several measures are proposed:

1. Using robots in various motor phases of the body, not just in standing.

Most of the robots are used only in favorable positions for the patient (sitting, standing). Some robotic orthoses could be integrated to increase independence in bed turns or lifting from bed, then the orthosis could be used while sitting and then standing. An adaptable rehabilitation robot to the body position and not just situational.

2. Using robotized structures that are easy to assemble and use.

Developing synergy and collaboration between the rehabilitation team professionals and designers, with the realization of shared projects and properly designed.

3. Applying standardized protocols

The implementation of standardized protocols specifying the objectives of the rehabilitation process, with a well-defined assessment at its core, demonstrating both quality of life and daily functionality, and a rehabilitation involving everyday activities.

4. Improving the stability, agility, and resistance of movements, so that the system is:

• More agile and faster, by increasing relative strength capacity and reaction speed.

• More stable against disturbances, by modulating the sensorimotor response of the neuromuscular system.

• More robust, by dissipating mechanical energy to prevent injury during high-impact activities.

5. Operator safety is one of the most important requirements when implementing rehabilitation robots, as the operating staff, medical practitioners and the patients are in close proximity with the robot. As the operators of rehabilitation robots are medical practitioners and not engineers, these robots need to be easy to handle, operate and maintain (Khan et al., 2020)

6. In terms of power requirements these depend on the robot utilized and the hospital they are implemented in. In general, constant access to power should be ensured to recharge the robot, however in field hospitals renewable energy sources are also used for operating medical robots. A solution currently under development is the wireless power transfer, which would minimize the need to charge the robot (Khan et al., 2020)

7. The cost factor is a further requirement to be considered at implementation, with the author stating that for a large-scale deployment of robotic solutions in the healthcare sector the robots need to be affordable (for developing countries as well) (Khan et al., 2020)

To make these improvements, engineers will need to continue the redesign of the robot's structure, physiologists will need to refine human performance evaluation, physiotherapists will need to consider how different systems can further rehabilitation interventions, psychologists will need to better understand how technology interacts with and embodies the user, and designers will need to consider the robot's creation plan.

Conclusion

From what has been outlined, it emerges that robot-mediated treatments need to be studied, leading to the development of new methods and procedures for appropriately stimulating the factors that compose the nature of movement. Therefore, an interdisciplinary rehabilitation process could consider the physical, psychological, and social deficits of the patient, generating a corresponding protocol in approaching robotic therapy, a protocol composed both in the use of complementary systems and in the approach of conventional physiotherapy.

As can be seen, robotic rehabilitation is continuously growing, and unfortunately, the prevalence of pathologies is also on the rise. There is a need for an increasing number of electronic devices for assessment and interventions in the healthcare domain. More efficient rehabilitation services are necessary, and technology can provide improved assessment and monitoring accuracy, facilitating independent practice and self-management. Clinical adaptation is limited, and factors influencing the use of rehabilitation technology are still underexploited. Both regionally and internationally, robotic rehabilitation systems are continuously evolving, and we should pay attention to the functional needs of patients, strengthen multidisciplinary communication and cooperation, and promote rehabilitation robots to better serve the rehabilitation medical field.

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COMPARATIVE ANALYSIS OF 2G AND 5G TECHNOLOGY IN THE FRAMEWORK OF EMERGENCY SITUATIONS

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Abstract

Purpose *– The paper aims to compare the radio 5G technologies coverage instead of actual 2G by using MATLAB simulations facilities, with focus on the equipment and coverage area in emergency situations, by comparing performances in ideal conditions and promote the characteristics of the new technology, considering the real case data from the plane crash in Transylvania Apuseni Mountains.*

Methodology/approach *– The analysis is based on the two different scenarios: 2G and 5G transmitter antennas, using MATLAB software and a free-space ideal propagation model for the coverage areas evaluation.*

Findings *– The simulations resulted displayed that coverage area with 2G antennas is higher (10,000 meters) compared to the 5G antennas (5,000 meters). Nevertheless, 5G antennas delivered a higher data transfer and a much lower latency, which made them prone for using fast data transmission and the possibility of artificial intelligence embedment.*

Research limitations/implications *– The case study analysis is based on a simplified MATLAB propagation model. Future work should incorporate more real geospatial data to validate the findings revealed by this initial study.*

Practical implications *– The findings suggest that implementing a 2G-5G technology hybrid system in mountain regions leverages 2G's broad coverage and 5G's high-speed data transmission. This integration involves placing 2G base stations in valleys, and 5G stations on peaks for optimal coverage.*

Originality/value *– This study uniquely combines the context of a real-world emergency scenario with a theoretical comparative analysis of 2G and 5G technologies using MATLAB simulations.*

Key words: *2G, 5G, emergency.*

Introduction

In the last 2 decades the wireless industry has seen an incredible development. More precise, ”10,672 articles that mention “5G” in the title, abstract or keywords. These records were authored by 23,695 individuals (estimated) from 108 countries between 2005 and 2020. Items were published in 697 journals (unique ISSNs) and contain 372,623 references to other documents.” (Mendonça et al., 2022) Advances in mobile communication technologies from 2G to 5G have significantly enhanced data transmission speeds and reduced latency. "The First generation has fulfilled the basic mobile voice, while the Second generation has dealt with

capacity and coverage. The third generation focused for higher data rate, multimedia support and spread spectrum followed by Fourth generation providing access to wide range of telecommunication services including advanced mobile services, along with a support for low to high mobility application." (Garg, 2014. 186). Now this is very important in emergency situations, such as the plane crash in the Apuseni Mountains that happened on January 20th, 2014. The reliability of these technologies are put to the test, this study delves into a comparative analysis of 2G and 5G antennas using MATLAB simulations, aiming to illustrate their performance and effectiveness in emergency scenarios. “MATLAB is one of the most widely used simulation platforms for academia and research. It contains a powerful 5G toolbox for performing both link-level and system-level simulations.” (Xue et al., 2022)

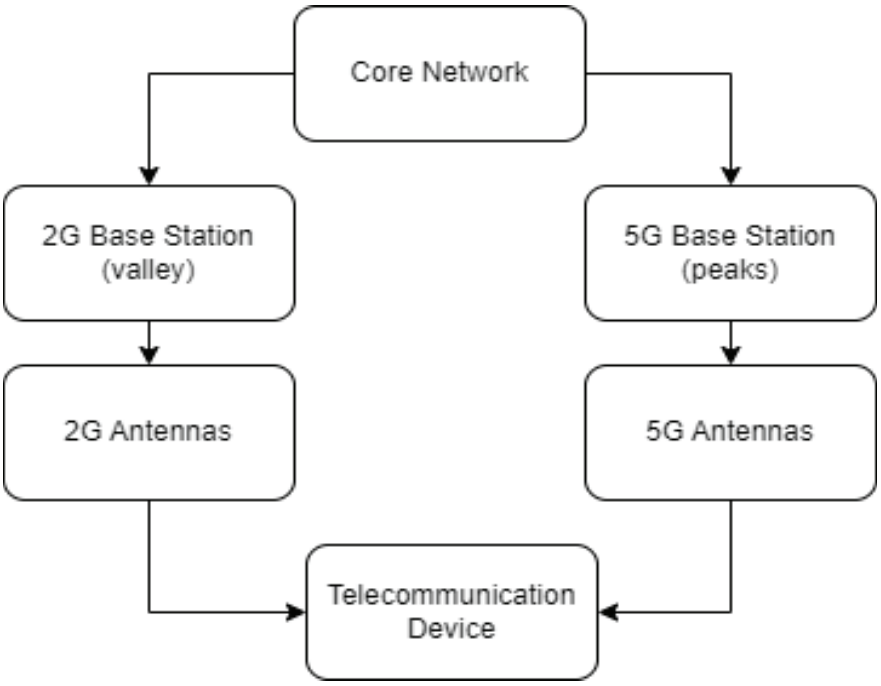

Figure 1. 2G - 5G Hybrid Network

Context of the Apuseni Mountains Plane Crash

On January 20, 2014, at 4:16 p.m., it was announced that an air accident had occurred, announced by one of the passengers at no. 112. The plane accident occurred at an altitude of 1400 m, on the border between Alba and Cluj counties, in conditions of lack of visibility due to fog, but also due to other causes that could not be attributed to the aircraft commander or any other crew member. The aircraft involved in the event belonged to the Civil Aviation Higher School and took off at 13:35 from the "Aurel Vlaicu" International Airport in Bucharest with the destination Oradea International Airport, where it should have landed at 16:35. On board the YR-BNP aircraft, there were 5 people and the pilot, who were traveling from Bucharest to Oradea in order to perform some medical procedures (CIAS. 2014)

Figure 2. YR-BNP plane

The incident highlighted the limitations of the existing emergency communication infrastructure. The area was covered by four 2G antennas but pinpointing the crash site proved challenging due to outdated technologies and inaccurate location data.

Methodology

In order to simulate the coverage area for 2G and 5G antennas, this paper used the MATLAB software to set up the radio transmitters. In the software was created a free-space propagation model, more of a theoretical simulation. The reason for using this methodology was to illustrate the need of new technology implementation in the key domain, especially in emergency response. Panagiotis Gkonis, Panagiotis Trakadas and Dimitra Kaklamani (2020) discussed the importance of accurate channel modeling for MIMO wireless orientations in 5G networks, emphasizing the use of both stochastic and deterministic models. These models are vital for simulating dynamic network configurations, and addressing the complex propagation environments of 5G, thereby supporting diverse applications and improving overall network performance. The following simulations should be a replica of the 2014 incident

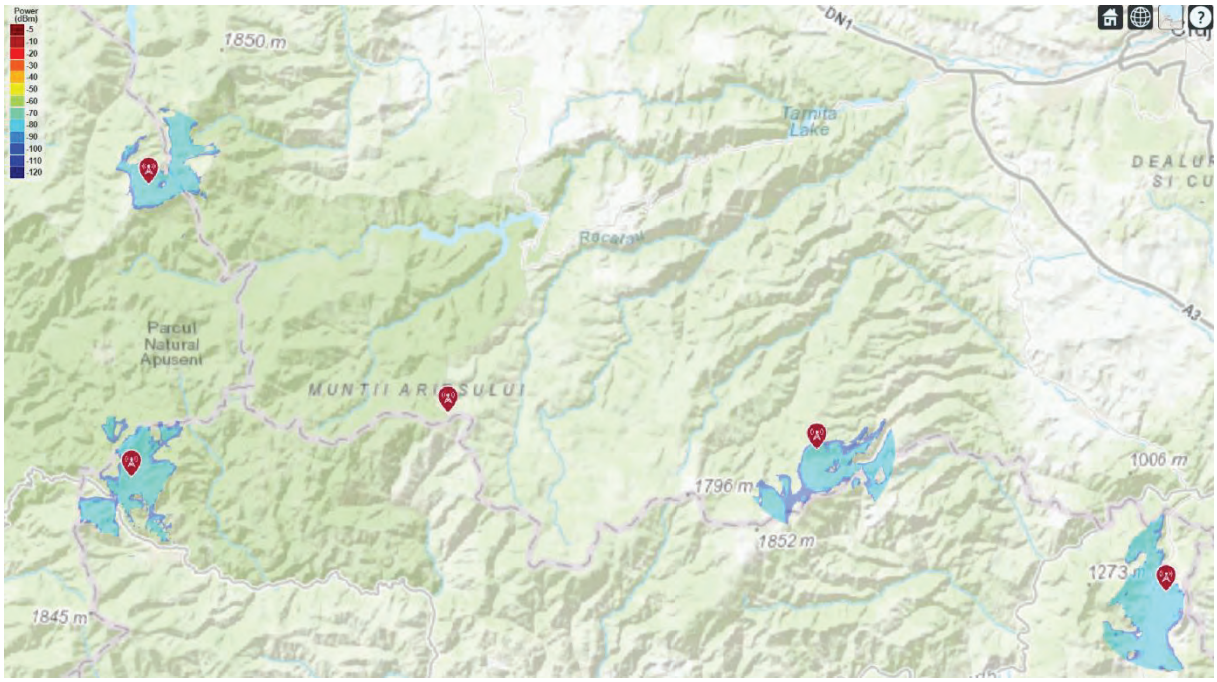

Figure 3. 2G Antenna Radio Coverage

2G Simulation Results

- **Frequency:** 900 MHz
- **Reliable Coverage Range:** Up to 2000 meters with strong signal strengths (-80 dBm**).**
- **Maximum Coverage Range:** Up to 10000 meters with weaker signal strengths (-100 dBm)**.**
- **Advantages:** 2G's lower frequency allows for broader coverage, making it suitable for remote and rugged terrains like mountains**.**

Figure 4. 5G Antenna Radio Coverage

5G Simulation Results

- **Frequency**: 3.5 GHz
- **Reliable Coverage Range**: Up to 1000 meters with strong signal strengths (-80 dBm).
- **Maximum Coverage Range**: Up to 5000 meters with weaker signal strengths (-100 dBm).
- **Advantages**: 5G's higher frequency provides higher data rates and lower latency, ideal for rapid data transmission and real-time communication.

The results from the above simulations suggest that 2G technology should be used for ensuring wide-area coverage in mountainous regions, maintaining communication in remote areas. On the other hand, given that 5G technology is limited by its range, it should be used in areas where high-speed data transmission is absolutely necessary.

Hybridisation

In valleys and remote areas, 2G base stations provide broad coverage, maintaining connectivity even in challenging conditions. On peaks, 5G stations offer rapid data transmission and low latency, facilitating real-time information sharing and advanced applications like AI. This dual-layer network enhances emergency response effectiveness, ensuring that rescuers have the communication tools they need when every second counts. In this regard, this paper provided a theoretical space-free MATLAB simulation of a 2G – 5G hybridization.

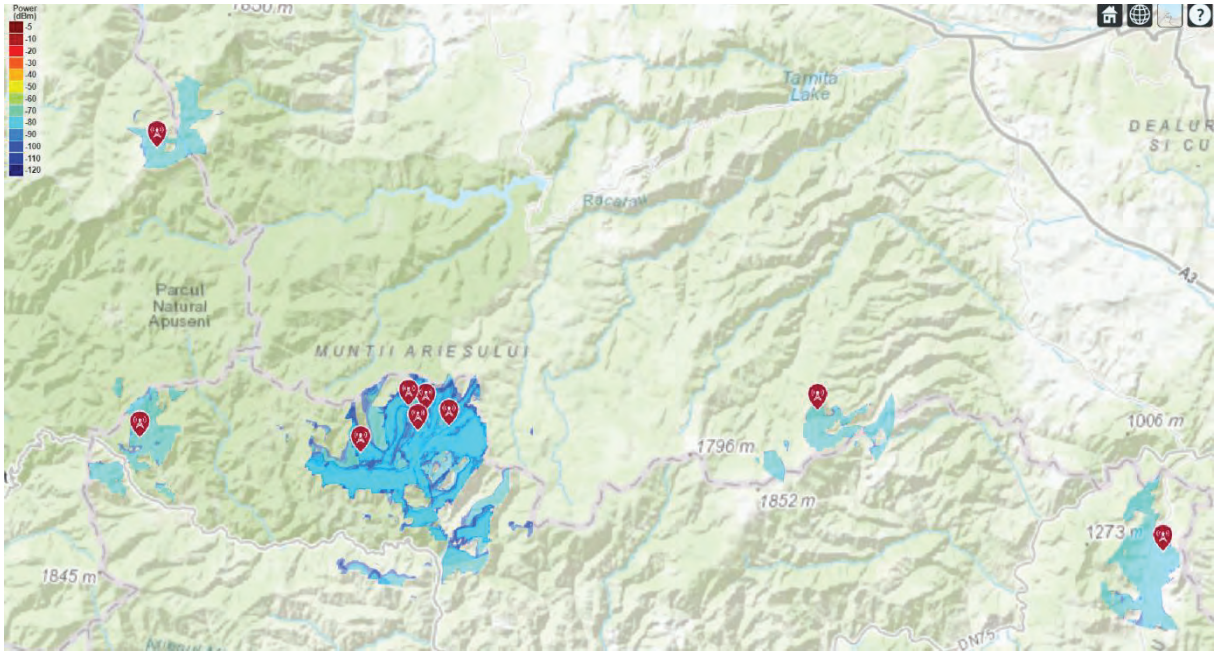

Figure 5. 2G - 5G Hybridisation

After running the simulation, a Coverage Analysis was used - a MATLAB function that can programmatically check if coverage areas intersect or are within a specific distance from each other; featuring the following fig., the result was positive.

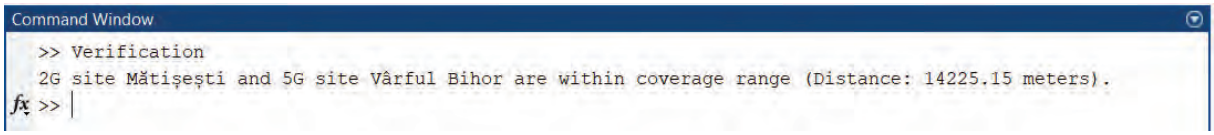

Figure 6. Checking if the network mesh has connection

Conclusion

This study provided a comparative analysis of 2G and 5G technologies using MATLAB simulations to evaluate their performance and coverage in emergency situations. The findings demonstrate the critical advantages of each technology: 2G offers extensive coverage, making it suitable for ensuring communication in remote and rugged terrains, while 5G provides higher data rates and lower latency, ideal for rapid data transmission and real-time applications. The concept of 2G - 5G hybridization leverages these strengths, suggesting that a dual-layer network can optimize emergency response systems. By placing 2G base stations in valleys and 5G stations on peaks, this hybrid approach ensures broad, reliable coverage with high-speed data capabilities. Implementing such a system in mountainous regions, as illustrated by the Apuseni Mountains plane crash case study, can significantly enhance the effectiveness of emergency responses, ensuring that rescuers have the necessary tools to communicate and act swiftly in critical situations. “5G is a developing technology that would allocate substantial resources to enhancing QoS and system accomplishments” (Gutierrez, Caicedo, Campos-Delgado. 2021). Future research should validate these findings with real geospatial data and explore the broader applicability of this hybrid system in different terrains and scenarios.

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ADAPTING THE MANAGEMENT OF THE JIU VALLEY COMPANIES FOR THE TRANSITION TO A SUSTAINABLE, CLIMATE-NEUTRAL ECONOMY

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Abstract

Purpose *–The study aim is to find employment solutions for young and able-bodied workers from unemployment of many families in Jiu Valley, left without a job and failing to benefit from local opportunities, and also for parents that must left their children in care the community or other families and choose the path of migration outside the Jiu Valley or even the country.*

Methodology/approach *- The Jiu Valley is distinguished as one of the most suffering regions in Romania based on the problems stemming from the negative impact of layoffs following the closure mines since 1995, which generated high unemployment, the dislocation of young people and adults, poverty and exclusion. The research methodology was based on an analyses of the past 30 years management of the mining industry, and finding a recovery plan for this region.*

Findings *–The global economic context but also the inadequate management of the mining exploitation for the last 30 years in the Jiu Valley, led to a tragic situation, and the only solution for the recovery of the Jiu Valley may be the use of non-refundable funds in developing viable economic alternatives for the maintaining of the economic activity.*

Research limitations/implications *–Even if the proposed solution are developed in the technologies from the field of energy from renewable sources, the solutions may be generalized in production of rechargeable batteries or the production of hydrogen and hydrogen-based synthetic fuels.*

Practical implications *- The population of the area is heavily affected by the decline of the mining industry and exposed to severe risks on the social dimension due to low economic development which does not allow the attraction of investors and determines the lack of a positive evolution at all the important levels that contribute to the quality of life, especially education, medical services and social assistance. The study represent a basis for fixing these structural problems of this former mining region.*

Originality/value *– The purpose of this research is to find the best method for adapting the management of the Jiu Valley companies for the transition to a sustainable, climate-neutral economy, but also to propose a solution to stop the population decline and to continue the economic activity in the Jiu Valley.*

Key words: *Adaptive management, Transition, Renewable sources*

Current global mining issues

The last 30 years have meant the decline of world mining and the closure of numerous mining fields, that have led to huge economic and social problems, fact reflected in numerous studies. (Dale B., 2002), (Haney M., 2013), (Horvath G., 2012), (Cardoso A., 2015) and (Radu B., 2016)

A recent study of Deloitte shows that 50% of the mining engineers will be retired in 10 years. In USA the 220.000 workers from the mining sector will be retired until 2030, and in Canada 100.000.

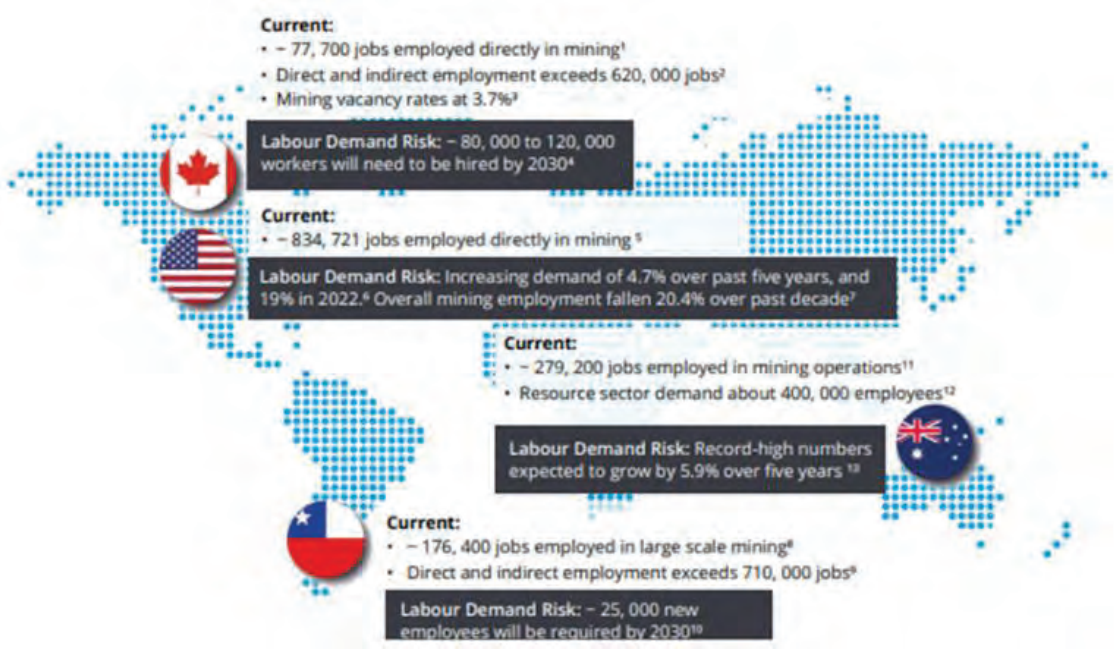

Figure 1. The labor shortage in the mining industry of developed countries

Source: Deloitte - https://www.deloitte.com/content/dam/assets-shared/legacy/docs/gx-Tracking-the-trends-2023_Digital_V2.pdf

Another report, presented by McKinsey demonstrate that teenagers are certainly no more interested to work in the mining sector or in the oil gas sector.

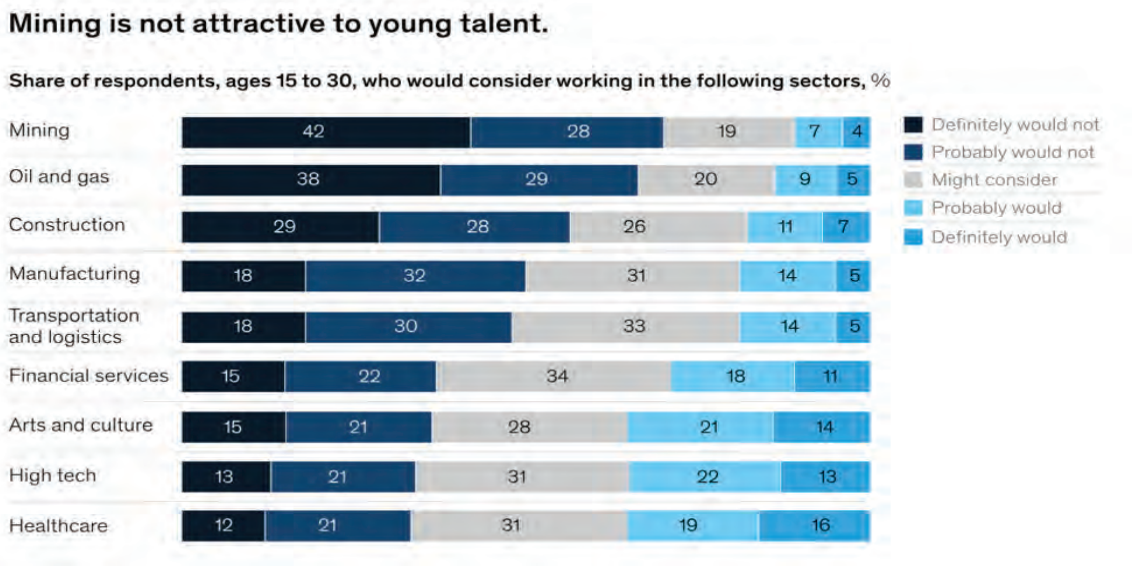

Figure 2. Has mining lost its luster? Why talent is moving elsewhere and how to bring them back

Source: McKinsey - – https://www.mckinsey.com/industries/metals-and-mining/our-insights/has-mining-lost-its-luster-why-talent-is-moving-elsewhere-and-how-to-bring-them-back

The decline of Hunedoara County and the mining industry extinction in the Jiu Valley

The economic-social impact until 2030 of the transition of the Hunedoara county was analyzed in a study carried out by the Frankfurt School of Finance and Management financed by the Support Program for Structural Reforms of the EU. The study used a macro econometric model for the analysis of the effects of the transition at the territory level, but the modeling was carried out before the timing and extent of the measures, through which the PNRR considerably accelerated the implementation of the PNIESC.

Even so, in terms of expected changes in employment, the model shows a considerable imbalance between loss (7.400 jobs) and generation (1.700 jobs) in occupations requiring a level of training basic or medium. In terms of gross added value (GVA), however, the impact of the transition leads to an increase in this indicator in most of the analyzed sectors. Along with the job losses, the county was also selected as a result of the socio-economic context marked by persistent disparities that will deepen if the acceleration of the transition to climate neutrality is not accompanied by mitigation measures:

Population decline - The resident population in 2019 was 379,987 inhabitants. The territory showed a sharp downward trend of 8.9% in the period 2012 - 2020 of the global population, while the downward trend of the working-age population was in the same period of 13.8%.

Three quarters of the population in deprived areas - In the disadvantaged areas of the county, identified at the UAT level, initially in accordance with GEO 24/98 and, later, according to GEO 75/2000, live approx. 250,000 people. Disadvantaged areas include, along with rural localities, the cities of Jiu Valley: Lupeni, Petroșani, Vulcan, Petrila, Aninoasa and Uricani.

Incomes consistently below the national average and energy poverty - Regarding the average net salary, it was in the period 2010 – 2020 below the national average by approx. 18%. In the last 4 years, it was 19% below the national average. The territory records an energy poverty rate of 70% in winter and 45% compared to the whole year.

High level of unemployment - In December 2021, 6,231 unemployed people were registered in the territory, of which 2,978 were women. The unemployment rate was 3.64% in December 2021 compared to the national average of 2.69%. Hunedoara is the territory affected by the transition that had the most dramatic decrease in the active population (13.8%) in the period 2012-2020.

The high share of exposed labor in industry and the modest technological level of the production of goods and services - The labor force employed in the industry represents 28.7%, with a pronounced trend of 30% decrease between 2008 and 2019. Regarding the technological level of the production of goods at the county level, in 2019, high technology was used in 1.2% of the total production, and medium high technology was used in 24.08% of the production.

Insufficient development of renewable energy production capacities - According to the latest data published by Transelectrica in May 2020, in Hunedoara county, the production capacity of photovoltaic energy in operation (power with PIF, according to issuers) totaled only 1.51 MW, respectively 0.11% of the entire installed capacity of photovoltaic energy .

Considering the above, Hunedoara county was selected for mitigating the effects of the transition to climate neutrality.

EU Commission and Romanian Government solutions

The Just Transition Fund represent an essential tool for supporting the territories most affected by the transition to climate neutrality and avoiding the deepening of regional disparities.

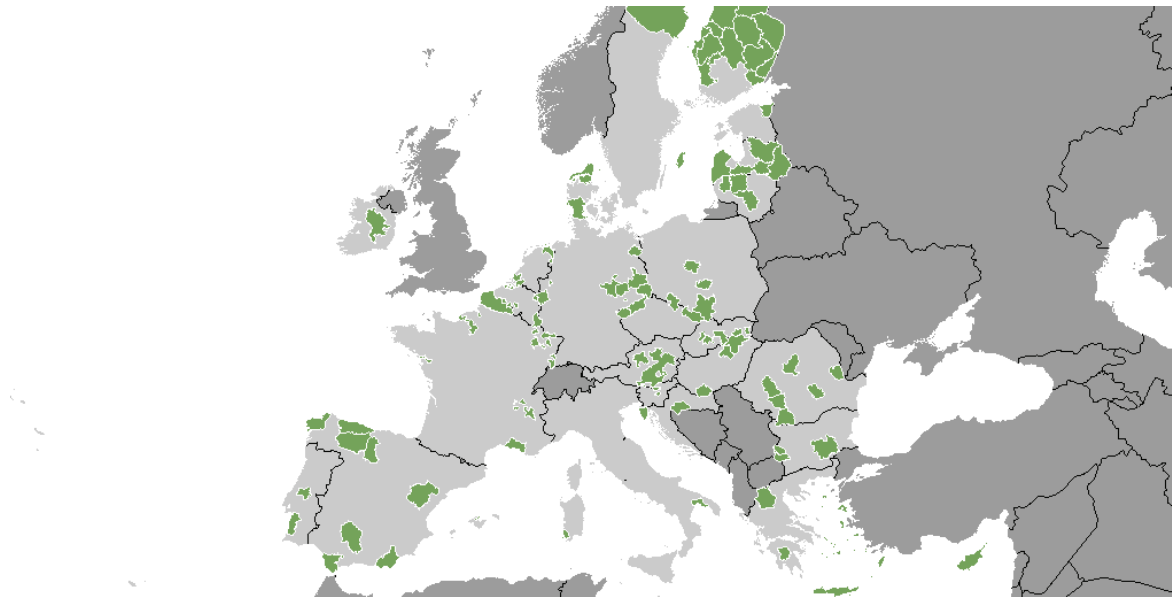

Figure 3. Just Transition Fund Territories

Source https://ec.europa.eu/regional_policy/funding/just-transition-fund/just-transition-platform_en

Figure 4. The twelve functional areas from seven EU countries

Source https://functionalareas.eu/

The Just Transition Program (JTP) aims to mitigate the impact of the closure or transformation of dominant economic activities in the local economy of 6 counties in Romania – Gorj, Hunedoara, Dolj, Galați, Prahova and Mureș and to facilitate their transition to climate neutrality.

Methodology

Our study is based on the solutions offered by the project “Strategy for the transition from coal of the Jiu Valley”, where PwC developed ten concept project and selected in consultation with key stakeholders. There is also an additional ten project concepts that has been developed by START.

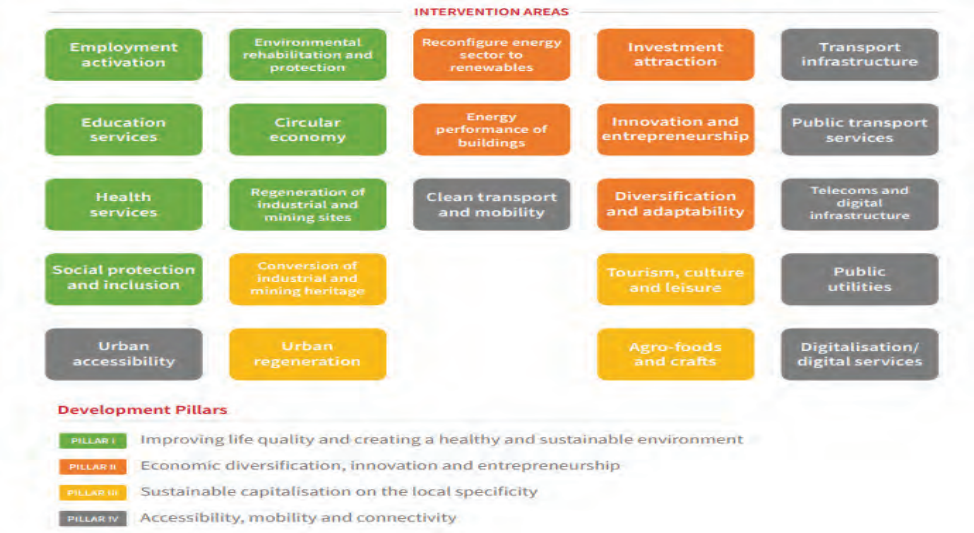

Figure 5. Jiu Valley Development Strategy – overview of themes and intervention areas

(source - From Strategy to Action: Delivering a Just Transition in the Jiu Valley, today and tomorrow- Initiative for coal regions in transition Supporting a just transition)

Given the limited potential for the creation of jobs only through investments at the level of SMEs, at the level of the territory were identified a series of economic activities

- Manufacture of rechargeable batteries, battery packs and accumulators for transports
- Manufacture of hydrogen and hydrogen-based synthetic fuels, an equipment for the production and use of hydrogen
- Manufacture of equipment for the energy efficiency of buildings such as pumps of heat, windows, doors, exterior wall systems, roof systems, products insulators, household appliances, hot water systems housekeeping and cooling / ventilation systems
- The manufacture of technologies in the field of energy from renewable sources
- Manufacture of biogas and biofuels intended for use in transport, such as and bioliquids;
- Production of electricity from non-fossil gaseous and liquid fuels from sources
- Sorting and processing non-hazardous waste streams collected separately for the purpose transformation into secondary raw materials

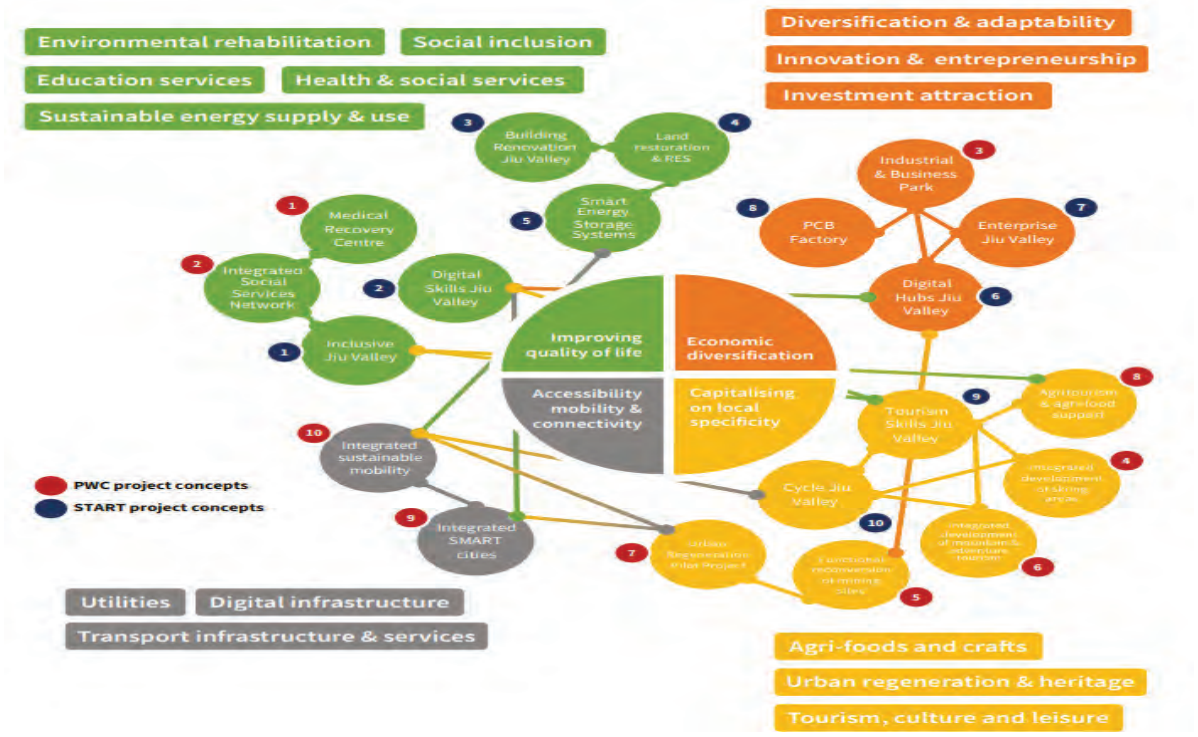

Figure 6. Overview of proposed transition projects

(Source - From Strategy to Action: Delivering a Just Transition in the Jiu Valley, today and tomorrow- Initiative for coal regions in transition Supporting a just transition)

Findings and discussions

The last 27 years, led Jiu Valley, a former pillar of the Romanian mining industry to disaster.

Management in Jiu Valley mining industry during the period 1997-2024. RAH – CNH – SNH – SNIMVJ – CEH – CEVJ a managerial disaster of the mining industry

After 1990, the inefficiency of mining activities was masked by subsidies, but even so the numerical decline of the mining industry could not be halted.

Figure 7. 24 years of evolution of the Romanian extractive industry measured in number of employees

(source – Romanian National Institute of Statistics)

In figure 6 it is obvious that in 25 years, the number of employees in the mining industry was reduced 5 times.

The Romanian management of bituminous coal mining in the last 35 years has been a disaster. Thus, even if this economic activity carried out in Jiu Valley took place under several names, they were only branches of the same poorly managed activity. Bituminous coal exploitation carried the logo of Autonomous Bituminous Company (RAH), immediately after 1990, then, starting with 1998, it was called the National Bituminous Company (CNH), transformed into the National Bituminous Firm (SNH) in the 2010s, and immediately divided in 2011 into The National Society of Mine Closures Jiu Valley (SNIMVJ) and into Hunedoara Energetic Complex (CEH), and finally in 2022 SNIMVJ transformed into Jiu Valley Energy Complex (CEVJ). The longest-lived mining companies in the bituminous coal mining field, CNH and CEH, disappeared along the way, having a history of 26 years out of the 35 years of post-communist mining in the Jiu Valley, but they disappeared leaving behind a hole of 7 billion lei at the state budget of Romania, i.e. 35% of the total debts that the Romanian state companies have to the state budget.

In 1998 by Government Decision no. 806/1998, Autonomous Bituminous Company (RAH) was transformed into the National Bituminous Company (CNH). The disappearance of CNH was revealed in 2011 by the first author of this paper, in several dozens of journalistic investigations that revealed empty promises, damage to the state budget and lack of managerial vision.

As an investigation journalist for over 20 years, the firs author of this paper, Ramona Rosulescu, has documented the management of the mining industry from Jiu Valley.

The debts of the National Bituminous Company (CNH) reached 4.67 billion lei, increasing by 13% compared to the level registered at the end of December. The National Bituminous Company no longer benefited from state subsidies. It has been operating from its own resources for 10 months.

(11.10.2011**-** SNLO registered a profit of 41 million while CNH continues to "burn empty")

A Romanian delegation led by Minister Ion Ariton participated, for three days, in China in a series of meetings with companies interested in investing in the Romanian energy sector. The general director of CNH, Constantin Jujan, and the general director of Termoelectrica, Florin Mârza, were part of the Romanian delegation.

(22.10.2011 - China Coal Equipment and Engineering, interested in investing in the Jiu Valley mines)

"On Monday, October 31, 2011, National Bituminous Company will make the payment of the first installment of compensatory salaries due to the laid-off persons who left the system at the beginning of this month, following the application of the CNH Reorganization and Restructuring Program for 2011", says a press release of CNH Petroşani.

(30.10.2011 - Week with money for laid-off miners 900 former miners will receive compensatory wages, unemployment benefits and supplementary income this week)

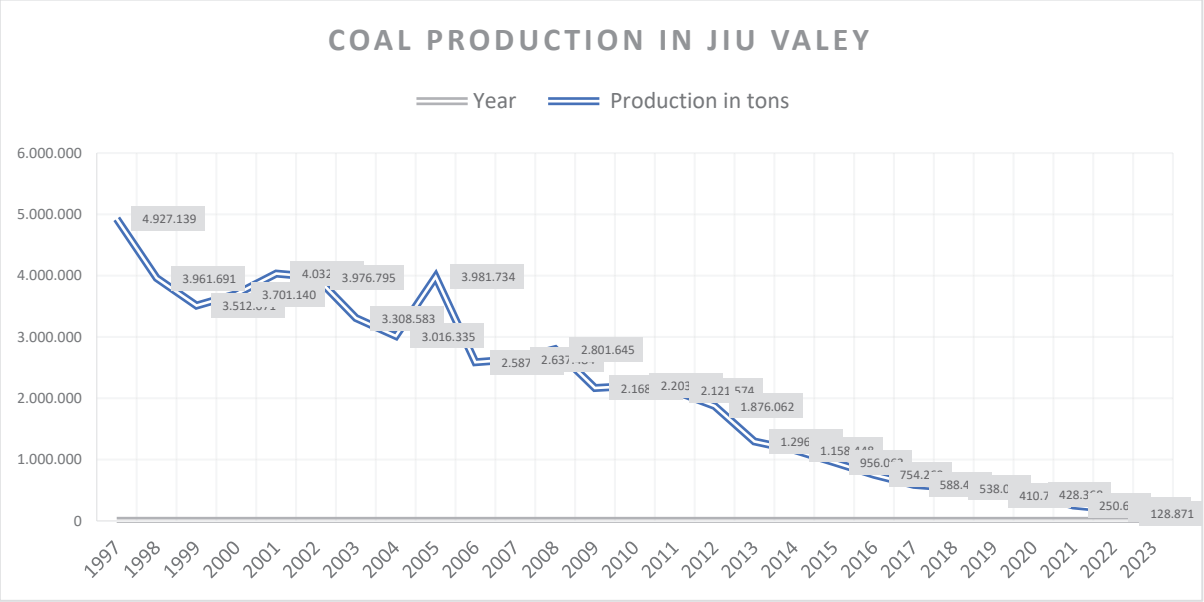

Figure 8. 26 years of evolution of the Coal Production in Jiu Valley measured in number of tons

(source – Hunedoara Energetic Complex)

Thus, if in the fall of 1997, almost 20,000 miners from Jiu Valley were left without a job, after the first and hardest series of collective layoffs in Romania, later numerous layoffs of thousands of other miners reduced the number of employees, so the company reduced its staff over 10 times in 26 years. But the decrease in production was much more dramatic than the reduction in personnel, with numerous subjective factors contributing to its decrease.

Hunedoara Energetic Complex was established based on Government Decision no. 1023/2011 (12.10.2011) following the merger procedure between Electrocentrale Deva S.A., Electrocentrale Paroşeni S.A. and the National Society of Huilei S.A. Hunedoara Energetic Complex (insolvent since 2019) - has debts of 1.8 billion lei and ranks third in the list of debtors to the Romanian state. State companies have debts of almost 20 billion lei to the budget, according to ANAF information, it is about 1,718 economic operators, so 35% of the total belongs to CNH and CEH. CEH's disappearance in the fog lasted almost 5 years (2019-2024), and the first author of the work identified and documented through journalistic investigations during the years 2022-2023, some of the causes that aggravated the economic situation of the company, a situation that finally led to the disappearance of CEH.

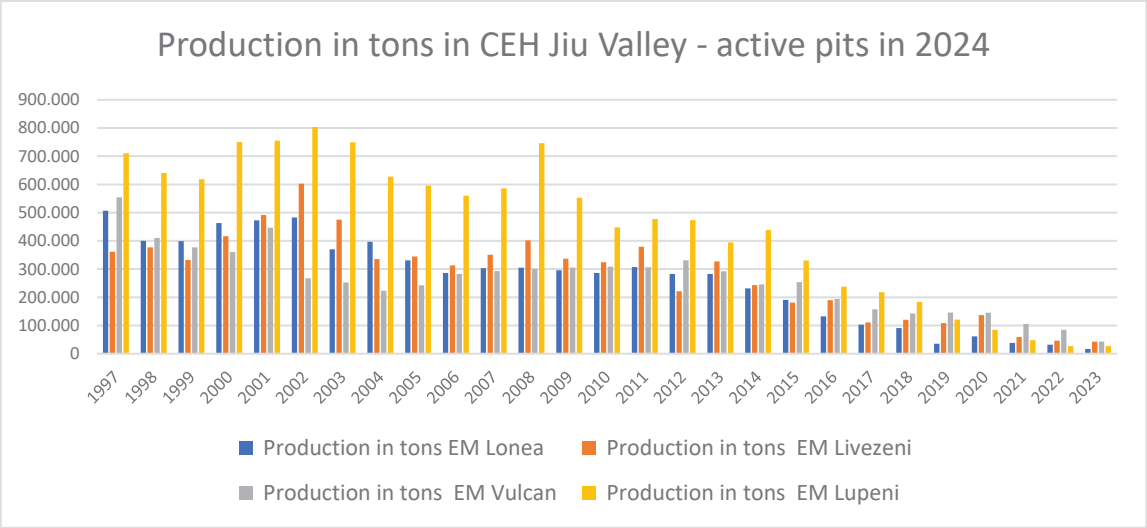

Figure 9. 26 years of evolution of the Coal Production in Jiu Valley for the remaining mines in year 2024, measured in number of tons

(source – Hunedoara Energetic Complex)

Clean dirty! Absolutely sensational realization of a mining operation in Jiu Valley *that will remain in the annals of the Hunedoara Energy Complex with a production of "-90 tons" of coal mined in a day. In other words, for all the rest of us non-specialists this could mean that the miners have "glued the coal back into the deposit"*

(27.11.2019 - Absolute record. A mine in Jiu Valley exploited "-100 tons" of coal in one day)

After distinguishing itself in economic theory by restructuring (with compensatory payments) "retirees or pensioners", not positions, CEH manages manage to ironize any calculation with a ridiculous coal production. One day in November 2019, a mining unit was listed with "-100" tons of coal". Yesterday - Wednesday, the same unit managed to register a new record. The miners took the coal out of the underground with their pockets. That is exactly 16 tons. Why?

(24.03.2022 - The 624 employees at the Livezeni Mine produced, in one day, 16 tons of coal. The director's brother, newly hired at CEH)

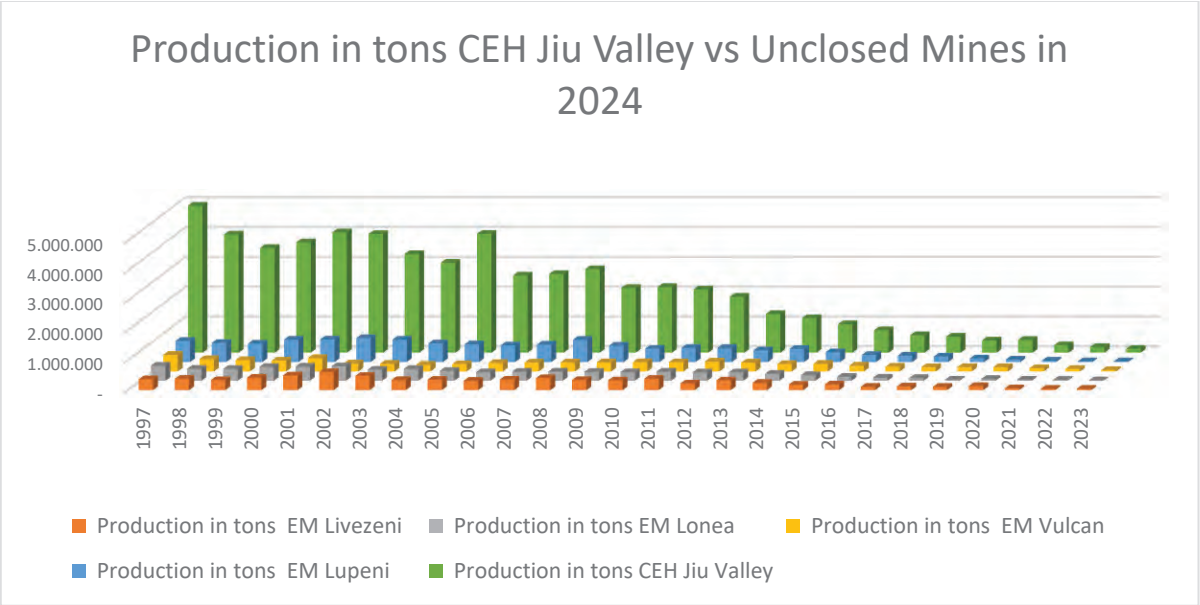

Figure 10. 26 years of evolution of the Coal Production in Jiu Valley containing the remaining mines in year 2024, measured in number of tons

(source – Hunedoara Energetic Complex)

The special administrator of CEH, Cristian Roșu, stated, on Monday, for Gazeta de dimineață, that the Ministry of Energy is currently continuing negotiations for CEH to obtain state aid and for the "closure of the underground" which in this procedural phase is not put into safety. That is, until now, no underground closure works have been carried out either at the Lonea mine or at the Lupeni mine.

(28.03.2022 - The aid given by the Government to CEH cannot be used for underground works. The normative act only refers to "surface works")

The energy company from Jiu Valley will receive 50 million lei from the budget reserve fund to cover some operating expenses. The money will be used once the state completes the payment of the viable assets of the CEH and the Jiu Valley Energy Complex becomes operational. It is not the first time that the state gives money to CEH. Last year, from the salary receivables guarantee fund, the company received millions of lei for the payment of salaries. This despite the fact that CEH, an insolvent company, did not contribute even one leu.

(22.09.2023 - State piggy bank, opened for CEH. The energy company receives over 60 million lei. Another 300 million lei are prepared)

A stone's throw from DN66A, across the road from the Paroșeni Thermal Power Station, the coal found on the surface, on private land, is exploited. The "miners" are supported in their activity by machines that remove the first layer of earth. The police from Vulcan caught some workers and the machines on the spot. The approximately 50 bags of coal were found in the area. The land belongs to a man from Vulcan, Viorel Moga, and the machines belong to the Răscol Transport company, managed by Florin Răscol. The latter is the son of PSD senator Cristian Resmerita. Florin Răscol stated for Gazeta de dimineață that he was carrying out work on private land.

(14.12.2023 - Coal mining across the street from the Paroșeni Thermal Power Station. The police found the coal in bags)

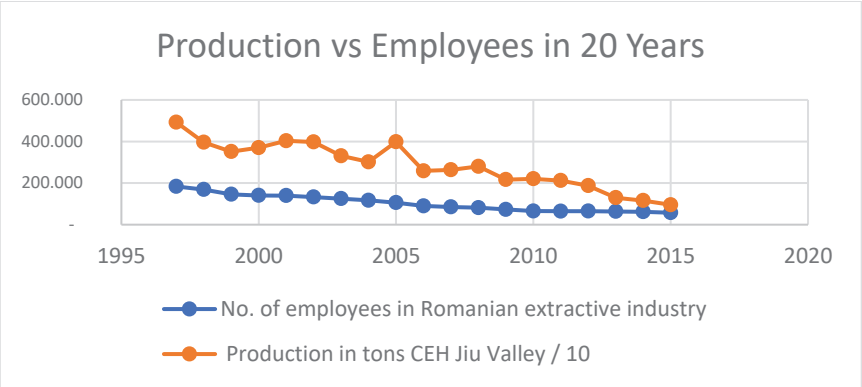

Figure 11. 18 years of comparative evolution of production and employees in the mining industry

(source – Romanian National Institute of Statistics and Hunedoara Energetic Complex)

The Ministry of Energy decided to amend and complete the constitutive act of the former Jiu Valley National Mine Closure Company and created the Jiu Valley Energy Complex Company. The new CEVJ society started its activity under extremely gloomy auspices, let's see what the end will be...

Ion Nemeș, the director of the Livezeni mine, was detained on Thursday by DIICOT prosecutors. The detention of the director of the mining unit comes about two weeks after the DIICOT prosecutors and the police from the fight against organized crime descended on the Jiu Valley Energy Complex, the Livezeni mine, the Lonea mine, the Prestserv headquarters and the residences of some employees, including the home of the general manager . Miners talk about illegal practices, established over time. Employees who no longer had their cards, which were kept by their bosses. Businessmen who were employed at the mine for seniority, but whose money was collected by the bosses. DIICOT confiscated large sums of money, phones, and gold from the homes of CEVJ employees.

(18.07.2024 - Director of the Livezeni mine, detained by DIICOT)

Probably this is the cause why in the last 18 years, the production decreased five times, while the number of personal decreased only 3 times!

Solutions for the Jiu Valley Companies for the 2025-2040 years - Adaptive management proposed for the energy transition in Jiu Valley region

The wind industry and the photovoltaic industry in Romania have the ambition to contribute to a fair energy transition and propose ambitious training and professional conversion projects for people from areas dependent on the coal energy production sector and beyond. (The Jiu Valley and the Oltenia basin and other counties where renewable energy is developing. During the courses, the reconversion of technicians and specialists in wind, photovoltaic and electricity distribution is targeted.

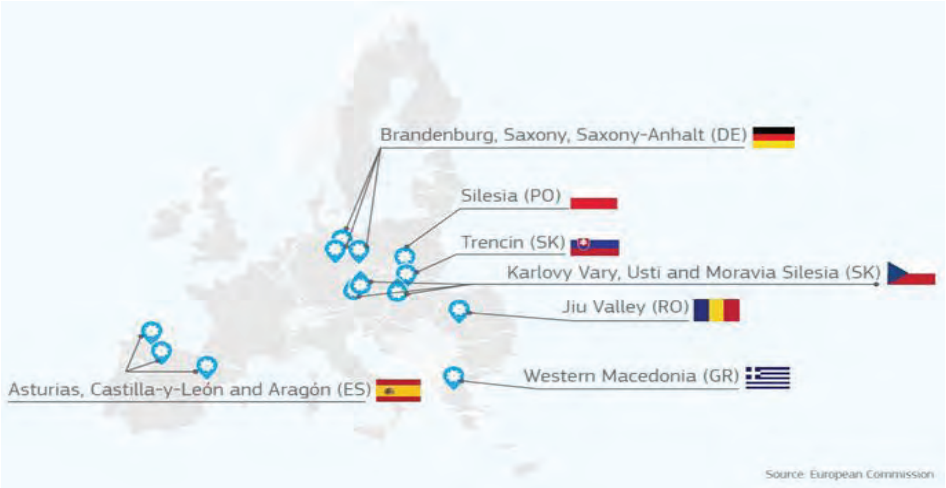

Figure 12. Platform for Carboniferous Regions in Transition

The technical and professional skills of the technicians in the mining sector, but also those employed in other industries, are easily transferable to the renewable energy and energy distribution sector, and the certifications obtained following the training and conversion courses will allow them to work in the installation, operation and maintenance of renewable projects and electrical networks around the world, with attractive salary benefits.

According to European statistics and trends, the installed capacity of renewables doubles every year, there is an immediate but also medium and long-term need for the training of new specialists. The RENEWACAD initiative has so far trained around 10,000 people, to international standards (it is a member of the GWO-Global Wind Organization), a figure that also includes those whom the standards force to return to training every year for some specializations. More than 95% of the specialists in renewables - mainly wind energy - from Romania, work on a project basis abroad and return to Romania monthly, generating incomes well above the average of the areas they come from.

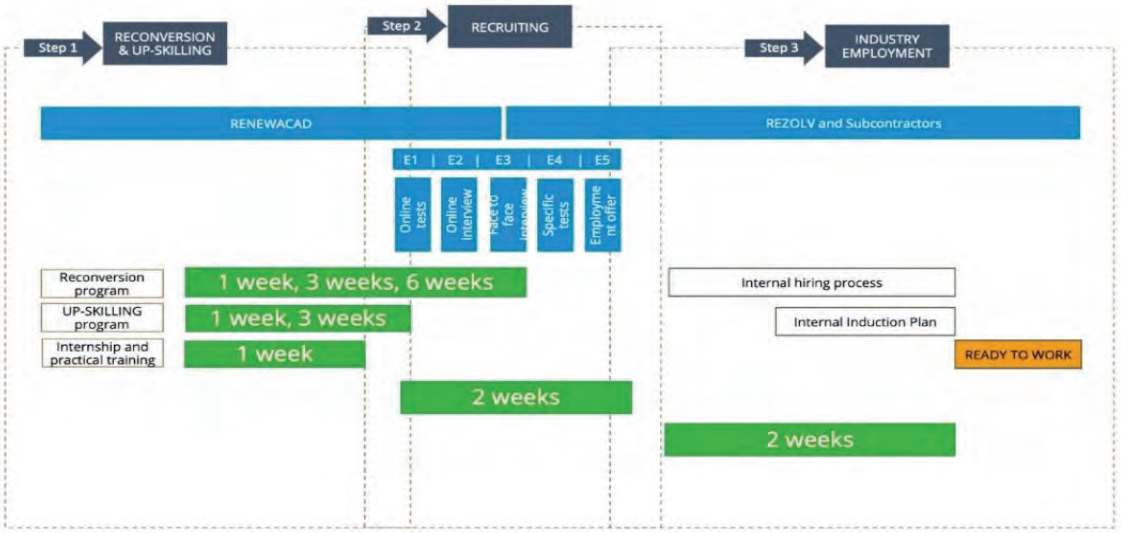

Figure 13. Training time schedule in the field of renewable energy (reconversion of technicians and specialists in wind, photovoltaic and electricity distribution)

RENEWACAD projects in the Jiu Valley area are part of an integrated development strategy, aligned with the development plan of the Jiu Valley microregion. There is submitted for financing, through the Just Transition Program, a project for the construction of an assembly plant for equipment components in the renewable energy industry. This project aims to build a factory in the town of Petrila, which will create 42 new jobs and contribute to the urban regeneration of the former Petrila Mine. Another project, financed from RENEWACAD sources, focuses on building an energy storage system in batteries, intended to help balance the national energy system. This investment will also take place in the city of Petrila, Hunedoara county.

Conclusions

Even if the world trend from the recent years did not support coal mining, Jiu Valley was the example of the managerial disaster. The 9 passages from the numerous journalistic investigations carried out by the first author of this paper in the last 15 years, can indirectly demonstrate the decrease of coal production to an almost insignificant level. Rusty products, lost money from the state budget, possible thefts are just some of the aspects identified that definitely led to the present situation. Maybe the future of Jiu Valley would have been the same, but certainly this managerial disaster has made coal no longer definitely a source of income for Jiu Valley, and the only solution can be offered by a transition from mining to another industry.

The solution for the transition of Jiu Valley from mining as a mono-industrial activity to other industrial activities can be offered by a plan coordinated by the municipalities of the Jiu Valley, taking into account both local peculiarities and global perspectives. The opening of production facilities in the field of renewable energy can generate jobs, but this measure represent only one direction of development for a just transition. Jiu Valley needs dozens of such concrete projects that provide the conditions for the transition to green energy but also to save the inhabitants of this area.

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RETHINKING ROMANIA'S ROAD FREIGHT EMISSIONS FROM A SUSTAINABILITY CONTEXT

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Abstract

Purpose: *This study estimates Romania's road freight transport emissions and explores the efforts of managing these.*

Methodology/approach*: By examining key themes —such as energy transition, technological solutions, and climate change regulations—through a bibliometric analysis the study sheds light on Romania's role in the European road freight transportation landscape.*

Findings*: Despite efforts outlined in national programs, challenges persist, including data limitations. The findings show Romania's overall emissions falling, putting the country apparently on track for net zero, but transport emissions have been rising over the last decades.*

Research implications*: This underscores the importance of continued investment in infrastructure, adoption of cleaner technologies, and policy initiatives to achieve meaningful emissions reductions.*

Practical implications*: Ultimately, the study highlights the need for sustained efforts to achieve environmental sustainability in Romania's road freight sector.*

Originality/value*: This study fills a crucial gap in the literature, providing valuable insights on the Romanian road freight transport within the European context.*

Key words*: Road freight transport, emissions, Romania, decarbonization strategies, bibliometric analysis, sustainability.*

Introduction

Global road transport emissions account for about one-fifth of global CO2 emissions. Passenger vehicles, including cars and buses, contribute around 45.1% of these emissions, while trucks carrying freight contribute approximately 29.4% (Ritchie, 2020). The rise in tailpipe CO2 emissions from heavy-duty vehicles, especially trucks, since 2000, accounts for over 80% of this increase (IEA, 2024). Addressing emissions from this sector is crucial for global climate change mitigation efforts.

Numerous strategies and frameworks aim to decarbonize road freight transportation through technological innovations and operational measures (Meyer, 2020). However, research often focuses on specific areas, lacking a comprehensive view, especially on regional aspects. To fill this research gap and assess green road freight transportation, this paper uses bibliometric and network analysis for a comprehensive literature overview. This study uniquely examines Romania's road freight transportation decarbonization using a replicable, scientific, data-driven

review approach. It employs cocitation analysis to identify and cluster research streams. Following the research target of "Assessing and Managing Romania’s road freight transport emissions," the paper addresses these research questions:

1. How has Romania's road freight transportation progressed over time in the European context, and what is its current emission level?

2. What specific challenges and measures are taken in Romania concerning road freight transport decarbonization?

After a literature review on road freight decarbonization, the paper captures specific data on Romania's road freight and analyzes decarbonization measures. It concludes with a discussion summarizing contributions and offering recommendations for future research.

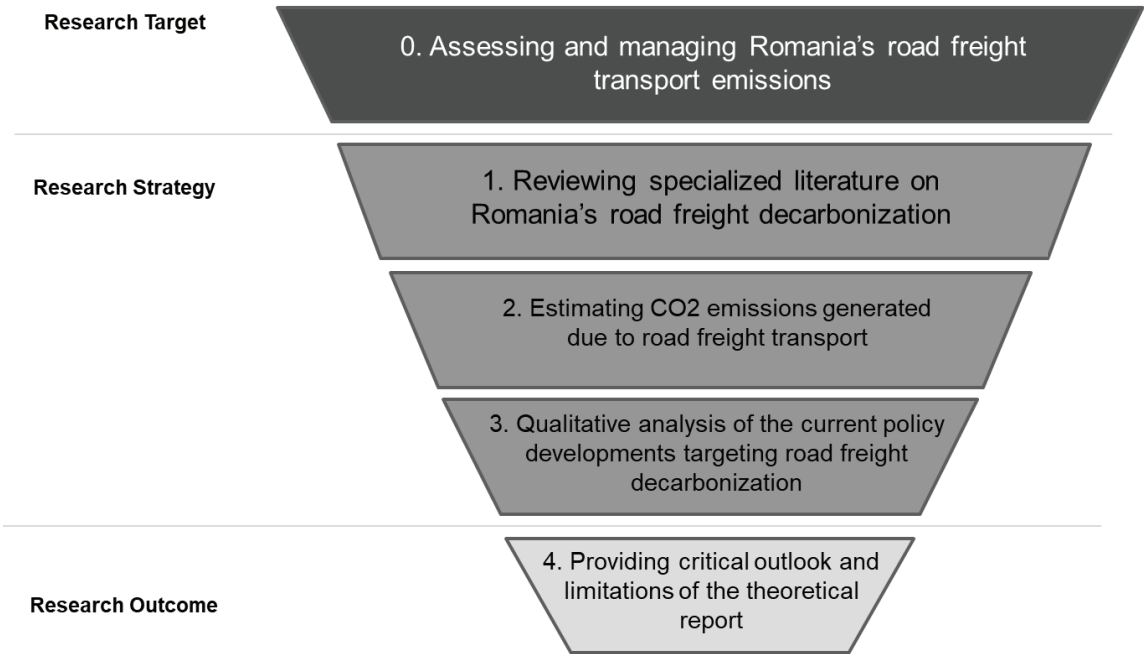

Figure 1: Research Design

Road Freight Decarbonization Literature Review

A structured framework (Figure 2) helps understand the evolving landscape of sustainability research. This study, conducted January-May 2024, analyzes the current state, evolution, and management of sustainability in the road freight transport sector. Using bibliometric data and visualization tools like VOSviewer, we examine trends, influences, and interconnections in this multidisciplinary field. Network maps depicting keyword relationships provide insights into the intellectual structure of "decarbonization" up to early 2024.

The interdisciplinary nature of sustainability, spanning environmental science, economics, business, and social sciences, makes the Web of Science's(WoS) multidisciplinary coverage ideal for bibliometric analysis. To map the development of "Sustainability," we used WoS, filtering results in Management, Business, and Economics. We reviewed selected articles, focusing on abstracts and full texts, to examine road freight decarbonization and to explore the academic evolution of "transport sustainability" concepts. The bibliometric analysis, based on

the WoS Core Collection, retrieved 1799 publications on transport decarbonization, with less than 5% focused on road freight decarbonization.

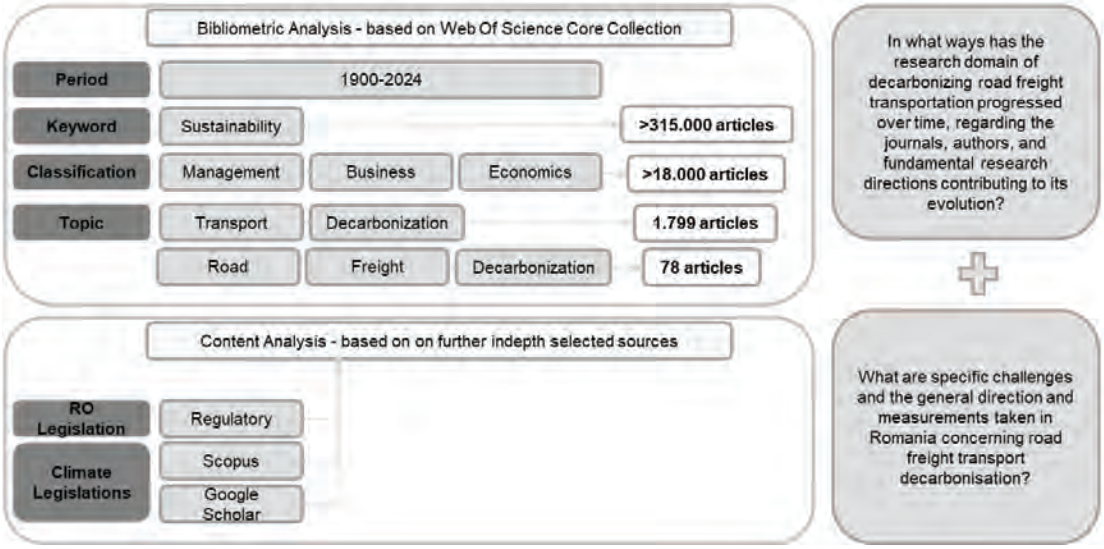

Figure 2: Literature Review Structure

Figure 3 highlights core clusters of the selected articles:

- Energy Transition (red) requires meticulous planning to integrate various renewable sources into the energy system, with a focus on sector coupling, especially within transport. Advancements in smart grids and energy storage are essential for managing and utilizing renewable energy for transportation.
- Technological Solutions for Decarbonization
    - Electrification (purple) is a promising decarbonization pathway, leveraging renewable energy to charge batteries.
    - Hydrogen (green) particularly green hydrogen in the truck segment serves as a versatile energy carrier, with applications in fueling stations and grid stabilization.
- Climate Change Regulations and Energy Policies (light blue and yellow) to mitigate climate change requires effective prioritization and renewable energy. By aligning energy and transport policies and investing in infrastructure and technology, nations can significantly reduce emissions and foster sustainability.

The evolution of road freight decarbonization research has progressed from broad conceptualizations to detailed examinations of specific regions and technologies. Initially, studies such as "(Mattila & Antikainen, 2011) and "The long haul towards decarbonising road freight - A global assessment to 2050" (Mulhollanda, et al., 2017) set ambitious goals for emissions reduction. As research advanced, more focused analyses emerged, including investigations into national contexts like "Driving down road transport CO2 emissions in Scotland" (Melo, 2016). Furthermore, studies delved into specific technologies like electrification and alternative fuels, as seen in "Prospects for Electrification of Road Freight" (Nicolaides, et al., 2018) and "Market diffusion of alternative fuels and powertrains in heavy-duty vehicles: A literature review" (Kluschke, et al., 2019). Overall, the evolution reflects a shift from broad objectives to nuanced approaches tailored to distinct contexts and technologies as

“Decarbonising road freight: Is truck automation and platooning an opportunity?” (Paddeu & Denby, 2020), highlighting the complexity of decarbonizing road freight transport. As the urgency of addressing climate change becomes increasingly evident, the publication of studies on road freight decarbonization has surged, with a notable rise in publications from 2018 onwards. This trend reflects the growing recognition of the significant environmental impact of road freight transport and the need for immediate action to mitigate emissions.

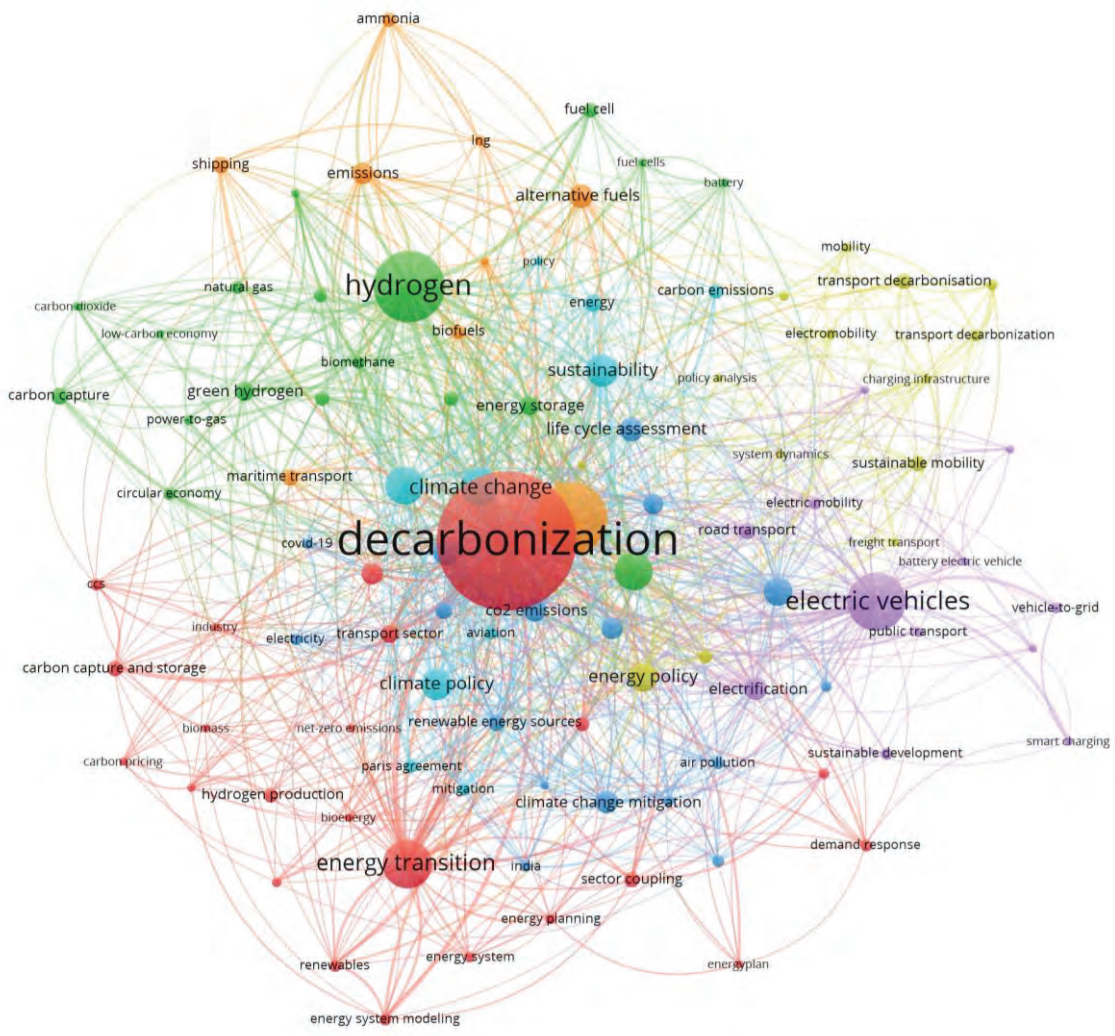

Figure 3: VoSViewer Networkmap of Transport Decarbonization Articles

Deep dive into Romania road freight decarbonization measures

To better understand the current state of transport policies in Romania, we examined legislative sites of local governments, extending the research to legal aspects for a comprehensive view of sustainability and to provide high-quality sources. At the national level, Romania integrates measures from European programs (European Green Deal, EU climate policies, the 2030 climate targets, and the European Strategy for Sustainable and Intelligent Mobility) into various governmental strategies. The key ministries and organizations defining and implementing sustainability objectives in freight transport are:

- Ministry of Transport and Infrastructure: Central to defining sustainability objectives in freight transport, it develops policies and strategies to promote energy-efficient transport, reduce greenhouse gas emissions, and improve infrastructure.
- Ministry of Environment, Water, and Forests: Develops policies and strategies for environmental protection in freight transport, promotes less polluting transport modes to reduce environmental impacts.
- Romanian Road Authority (ARR): Regulates and supervises road transport, develops and implements regulations to reduce emissions, and improve commercial vehicle energy efficiency.
- National Agency for Environmental Protection (ANPM): Monitors and controls compliance with environmental protection laws in freight transport, contributes to defining sustainability objectives by monitoring and reporting emissions.

The Transport Programme (TP) 2021-2027 outlines Romania's "Vision for 2030," aiming for a high-quality transport infrastructure network that ensures connectivity within Romania and the EU, aligning with climate neutrality and environmental protection goals. Specific legislation targeting CO2 emissions in the truck or haulage sector is currently limited.

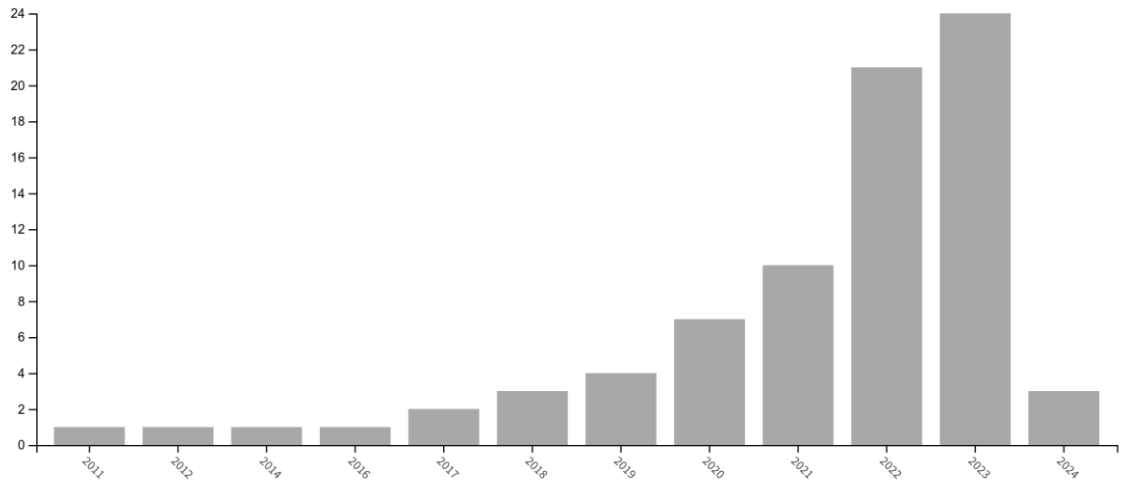

Figure 4: Road freight decarbonization articles as per Web of Science

Figure 5 encapsulates a comprehensive climate change mitigation approach, combining global agreements and regional policies with local and national implementation. International panels like the IPCC provide guidance, while regional alignments ensure consistency. National policies and laws, such as Legea 57/2012, support these efforts. The ultimate goal is global impact, including meeting the 1.5-degree Celsius target from agreements like the Paris Agreement and the Sustainable Development Goals. In line with other government programs, Romania's specific objectives include:

- Modernizing and expanding transport infrastructure.
- Improving connectivity of urban nodes to transport networks.
- Increasing rail transport market share
- Implementing traffic management and digitization systems to optimize flow.

- Maintaining road infrastructure to reduce congestion and accidents.
- Aligning with EU policies on sustainable, climate-friendly transport.

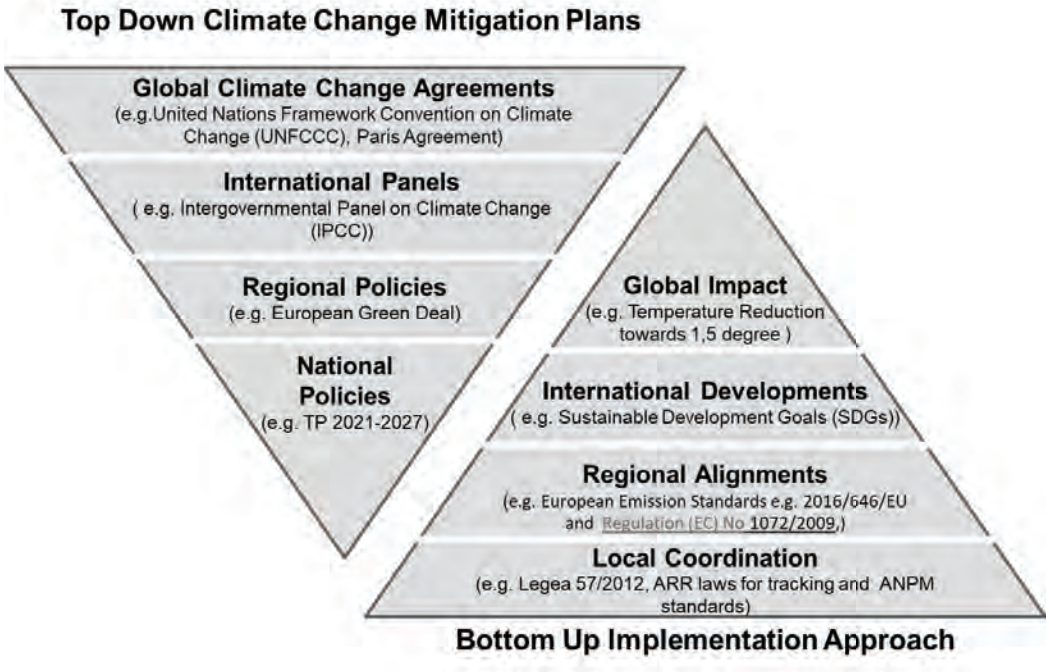

Figure 5: Top down climate change plans and bottom up coupling approaches

Romania's Emissions in the European Road Freight Transportation Context

The EU27's transportation infrastructure is notable for its extensive road network and efficient commercial freight operations. While it ranks third globally in motorways and paved roads after China and the US, the EU27 leads in commercial freight transport with 36.5 million commercial vehicles, surpassing China in operational capacity. Since 1995, the EU27's road freight transport has grown significantly from 1127.2 billion tkm to 1862.5 billion tkm in 2021, ranking third after China (6908.7 billion tkm) and the US (3129 billion tkm) (Commision, 2023).

The Romanian transport sector is a key component of the EU, employing about 383,400 individuals in 2020, or 2% of the country's population (Carlier, 2024). Romania ranks seventh among EU nations in transport industry employment and the number of enterprises. Road freight transport is crucial, particularly for international long-distance transport between third countries in the region. In 2021, Romania recorded 20.5 billion tkm in national haulage and 41.4 billion tkm in international road haulage, considering only heavy goods vehicles (>3.5 tonnes load capacity). As of December 2022, Romania had 155,351 registered HDTs over 3.5 tonnes, with majority of 154,700 being diesel (Statista, 2023).

To estimate road freight transport emissions in Romania, we combine transport volume with average emissions per tonne-kilometre (tkm) based on European data. Although local road conditions and traffic impact emissions, these details are simplified for estimation purposes, based on following:

- Emission Function: $f(x)$ be the function calculating average CO2 emissions of heavy-duty trucks in grams per tonne-kilometre (g/tkm) based on the truck's weight x in tonnes, where 3.5<x<40 (Gesellschaft, 2024).

- Freight Transport Volume: In 2021, Romania's freight transport totaled 20.5 billion tkm national and 41.4 billion tkm international haulage, including cross-trade and cabotage.

- Emission Calculation: Total CO2 emissions for national and international haulage are calculated by multiplying emissions per tkm by the sum of haulage

Based on these inputs estimated emissions reach ~5.3Mt CO2e in 2021. For comparison, Romania's total transport emissions in 2020 were 18.2Mt CO2e, with transport being the second-largest emissions source after energy and heat, which emitted 22.04Mt CO2e (Ritchie, Our World in Data, 2023). In 2021, total transport emissions reached 19Mt CO2e, with road transport accounting for over 90%. Consequently, road freight transport emissions constituted 26% of Romania's transport emissions and 4.5% of the country's total emissions in 2021, a significant proportion compared to other European countries, highlighting Romania's crucial role in the European logistics network.

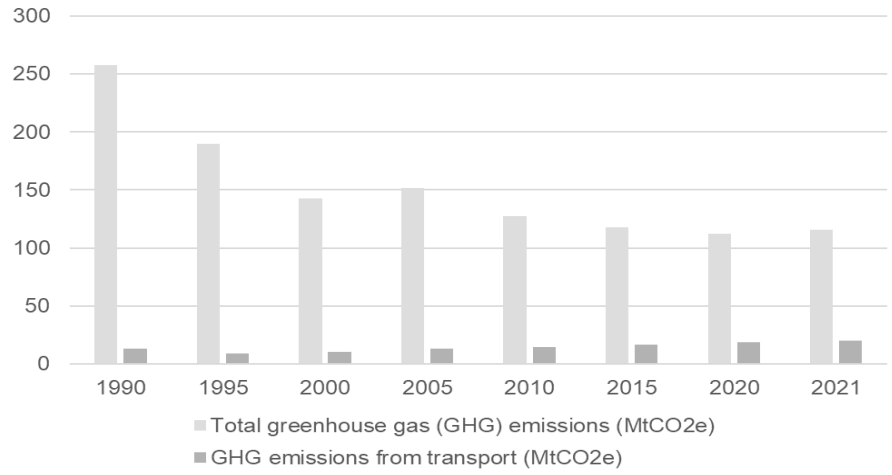

Figure 6: Romania's Emissions as total and transport GHG emissions

Findings & Limitations

With over 5Mt CO2e estimated for road freight transport in 2022, the road freight transport represents a significant contributor to greenhouse gas emissions specifically for Romania. As a primary freight transport mode road freight vehicles heavily relies on fossil fuels representing Romanias second biggest oil consummator. Given the reforms initiated, the targets set in the programmes analysed seem to be in line with EUs ambitious CO2 standards - aiming for 90% emissions reduction by 2040 most new trucks and coaches- and reflecting a comprehensive decarbonization approach clustered into:

1. *Energy Transition* (IMF, 2023): Romania is making significant strides towards an energy transition, boasting a renewable energy share of 23.6% in 2021, surpassing the EU average. This transition is evident in the shift towards low-carbon electricity generation, with hydro, biomass, nuclear, wind, and solar sources comprising 64% of Romania's electricity mix. However, challenges persist, particularly in the transport sector, where high oil dependency

fuels a continuous rise in emissions. Emissions in this sector are projected to surge by 84% by 2030, exacerbating the divergence from the EU's downward emission trend.

2. *Technological solutions* for decarbonization electrification and green for hydrogen are available yet not readily applicable and depend highly on infrastructure. Adoption of electric vehicles remains low, necessitating further investments in charging infrastructure and incentives such as 'Rabla Plus Program'. Energy efficiency measures for road freight include aerodynamics, low rolling resistance (LRR), tyres/Tyre pressure systems (TPS) as well as light-weighting assuming as per (Mulhollanda, et al., 2017) that “all HDV vehicle types -except utility trucks- could cost effectively reduce weight >7% within the next ten years” or intramodal transportation as suggested by (Kaack, et al., 2018)

3. *Climate regulations* progress towards EU's Fit-for-55 target, with current emissions relatively low even projected to exceed the 55% reduction target before 2030 (IMF, 2023). Achieving the longer-term net-zero target by 2050 is uncertain despite EURO-VI&EURO-VII strict emission limits (Climate, 2024) (Comission, 2024). Despite decarbonization efforts, Romania's energy and emission intensity remain high, and while the transport sector is diverging from the EU's declining trajectory, demanding a transition towards greater electric mobility fueled by renewable energy sources might pose several challenges, ranging from social-technical (energy transition) to economical (return on investments) and environmental (emission measurement) which per (Neagoe, et al., 2024) seem unlikely to be resolved in near future.

Overall emissions in this study have been constrained by insufficient data, high-level statistical estimation based import and export haulage activities. Figures for road freight vehicle emissions base on CO2 averages obviously omitting other harmful pollutants such as nitrogen oxides for simplification purposes. Further studies could focus on a detailed modelling with comprehensive and accurate dataset.

Discussion & conclusions

Road freight transport in the EU27 is integral to the region's economy representing a major primary energy consumptor e.g. 2015 road freight oil consumption required 18 % of the total energy and European road freight activtities have nearly quadrupled during the last 3 decades (IEA, 2017). Despite challenges posed by environmental pollution, policy efforts and operational efficiency have contributed to progress in emissions reduction and environmental sustainability. Moving forward, continued investment in infrastructure, adoption of cleaner technologies, and policy initiatives will be essential to ensure the continued efficiency and sustainability of road freight transport in the EU27 as e.g. lately approved a 60.7 million euro scheme to support haulage and bus companies in the country within the context of 'Russia's war on Ukraine.

Considering the coupling of economic growth and road freight carbon emissions achieving tkm reduction seems exceedingly challenging, therefore efforts to decarbonize need to concentrate on decreasing carbon intensity of freight transport to a fraction of its present level (McKinnon, 2016). Global assessments indicate 56% increase in road freight GHGs between 2015 and 2050 in face of limited prospects of maximum potential reduction over the same timeframe which was found to be 60% (Mulhollanda, Teterb, Cazzolab, McDonald, & Gallachóira, 2017).

Overall, while global road transport emissions present a significant challenge in the fight against climate change, there is growing momentum and commitment from various stakeholders to address this issue. Continued collaboration, innovation, and policy support will be essential in driving meaningful reductions in emissions from road transport worldwide. There are promising developments show countries and regions implementing ambitious

policies and initiatives to promote the adoption of electric vehicles and reduce emissions from road transport, but these efforts need financial incentives and proper infrastructure.

Despite the widespread acknowledgment of the environmental impact of road transport emissions, significant challenges remain in reducing these in Romania. The steady increase in transportation demand, coupled with economic expansion, poses challenges to achieving substantial reductions. Moreover, the transition to cleaner technologies and alternative fuels faces barriers such as infrastructure limitations, cost considerations, and consumer preferences.

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OVERVIEW ABOUT THE MOST IMPORTANT THEORIES/MODELS OF ECONOMIC GROWTH

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Abstract

Purpose *– the aim of this paper is to present the specific elements of the most important teories/models of economic growth.*

Methodology/approach *- the data sources used in the study are numerous: papers, books etc. This information has been analyzed and interpreted by the authors.*

Findings *– the study shows that the models of economic growth have been developed according to the economic realities of the period in which they have been advanced.*

Research limitations/implications *– the limitations of this study refer to the fact that we did not use an exhaustive approach and we considered only a limited number of theories of economic growth.*

Practical implications *– the practical implications of this study derive from our conclusions, and it refer to the fact that a model of economic growth, in order to be viable, it should take into account the economic realities of the analyzed period.*

Originality/value *– the originality of this study is reflected by the fact that we employ a comparative approach on the most important models of economic growth, from their characteristics' point of view and not from the point of view of the mathematical models used to develop those theories.*

Key words: *economic growth, growth models.*

Introduction

Economic growth has been, and it continues to be, a very important topic in the literature and a highly debated one. This is, mainly, due to the benefits of it on society, in general, and on individuals, in particular. The economists that have studied the process of economic growth formation, have considered the identification of factors that positively or negatively affect this process. Each model of economic growth that has been developed over time has identified one or more determinants of economic growth, either endogenous or exogenous, considering the economic realities of the period in which the model has been developed and the economic thought that characterized their proponents.

The most important theories/models of economic growth

During the time have been proposed many theories that try to explain the economic growth process. From the point of view of the moment in time they have been advanced, these theories may be classified in four main categories: Classical theories, Keynesian theories, neoclassical theories and modern theories.

In the category of classical theories of economic growth are included, especially, the theories developed by Adam Smith, Thomas Malthus and David Ricardo. The first ideas that contain aspects regarding economic growth have appeared in the mercantilist period, between mid XV-th century and mid XVIII-th century, before the apparition of the classical school of economic thought (end of XVIII-th century). As stated by McDermott (1999), mercantilist theory advanced the idea that the welfare of a nation resides in its economic power and that the accumulation of wealth represents the main source of economic growth. In a chronological order, other ideas regarding economic growth have been also formulated by some representatives of physiocracy, a current of economic thought that precedes mercantilism. The most representative exponent of this current of economic thought is considered to be François Quesnay. As stated by Muller (1978), during the period in which F. Quesnay lived (18th century), the level of economic development of a country was determined almost entirely by the level of output achieved in agriculture. Starting from the reality of those times, Quesnay considers that obtaining a production surplus in agriculture and reinvesting it in the following year to obtain a higher production represents a way to ensure economic development.

Adam Smith is considered both the father of classicism and liberalism, he is the one who postulated the "laissez-faire" principle in economic theory. In his most famous work "Wealth of Nations", written in 1776 during the industrial revolution, A. Smith tries to identify and analyze the factors that contribute to the growth of the wealth of nations. If the physiocrats considered that nature (land) is, if not the only, than the main factor of production and that economic development derives from agriculture, A. Smith emphasizes the determining role of industry in obtaining economic growth based on the efficient use of three factors of production: nature, work, and capital (considered as inputs). To obtain the highest possible output (that will further take to an increase in economic growth) it is necessary to increase the inputs. The first factor of production (nature/land) being finite, it follows that we must act on the growth of the other factors of production, namely labor and capital. In fundamenting his theory, Adam Smith started from the hypothesis that profit should be reinvested in increasing production, thus avoiding accumulation. Thus, according to Adam Smith, economic growth is based, in particular, on the growth of capital and on the division of labor (specialization). As stated by Ucak, A. (2015), Adam Smith also considered technical progress and ensuring an appropriate economic framework in which the invisible hand of the market can make its mark as important determinants in achieving economic growth.

Thomas Malthus remained in the history of economic thought, mainly, due to the principle of population formulated in his famous work entitled “An Essay on the Principle of Population”, which essentially postulates the fact that population growth, if not controlled, will exceed our ability to produce enough food for the entire population, thus generating hunger and poverty. As stated by Unat (2020), Malthus's pessimistic vision was based on the limited character of the land available for agriculture, which cannot provide sufficient agricultural production to cover the entire demand. Thomas Malthus argued that there was an inconsistency between the population growth rate (which increases in geometric progression) and the growth rate of agricultural production (which only increases in arithmetic progression). In other words, the population growth rate is higher than the economic growth rate and measures must be taken to decrease the population growth rate and to reduce poverty.

David Ricardo tried and succeeded in taking the economic ideas of Adam Smith and Thomas Malthus to a higher level, transforming and integrating them into a true theory of economic growth that he presented in his reference work entitled “Principles of political economy and taxation”. As stated by Narasimhuiu (1977), for D. Ricardo economic growth is a null variable and the active variable is the distribution of income (determining the way in which profits are distributed is a challenge to which economic theory and practice must respond as precisely as possible). The premise from which D. Ricardo started was that in agriculture, profitability is decreasing, while in industry profitability is considered to be constant. In D. Ricardo's view, economic growth depends on the accumulation of capital and this depends on the reinvestment of the profits obtained both in agriculture and in industry. In agriculture, the accumulation of capital depends both on the productivity of the agricultural land and on the technical level of the machines used.

John Maynard Keynes was not only a famous economist, but also the one who created an important school of economic thought: Keynesism. Unlike most classics, Keynes was in favour of state intervention in the economy to ensure/restore economic balance, especially in times of crisis. Keynes claims that if the saved part of the global income were equal to the investments, economic equilibrium could be reached. However, in the real economy, not everything that is saved or accumulated is invested, which explains the presence of imbalances in the economy. Alone (without the intervention of the state), the free market fails to create the favorable conditions to ensure an economic growth that leads to the well-being of the population.

Roy Harrod and Evsey Domar are not only two followers of the Keynesian theory, but also outstanding personalities who contributed to the development of the theory of economic growth. They remained in the history of economic thinking as developers of a model that bears their name (the Harrod-Domar model), even if the efforts made by the two to develop the theory of economic growth were independent. This model tries to transform Keynes' model, presented in the work "The General Theory of Employment, Interest and Money", which took into account a short time horizon, into a model that is valid over a longer time horizon, starting from the assumption that savings are the source of investments. The Harrod-Domar model, which is part of the category of so-called exogenous growth models, postulates the fact that the economic growth rate depends, directly proportionally, on two important factors: the saving rate in the economy and the productivity level of the capital.

The Harrod Model considers 3 categories of rates: the warranted growth rate, the actual growth rate, and the natural growth rate. The guaranteed rate ensures the expected profit to the investors, the real rate is the one resulting from the accounting calculations and the natural rate is the one that assumes the full use of all the other production factors. Among the three rates, the guaranteed one is considered by R. Harrod to be the main determinant of balance and economic growth.

Neoclassical theories of economic development were developed, in particular, by Trevor Swan and Robert Solow. The exogenous economic growth model proposed by the two economists, known as the Solow-Swan model, is a development of the Harrod-Domar model. As stated by Moroianu, N., and D. Moroianu (2012), the particularity of this model is that it accounts for a new element: the productivity growth. In this model, which starts from the assumption of a perfectly competitive economy, new capital is more valuable than old capital due to the improvement of technology over time. The conclusion reached by R. Solow and T. Swan is that in the absence of technological development, the economy goes towards a steady state, therefore long-term economic growth is determined by technical progress. Thus, the difference between rich and poor countries is due to existing differences at the level of technology (a higher rate of technical progress in developed countries compared to other countries). In opposition to R. Harrod and E. Domar, R. Solow believes that the savings rate has no influence on long-term economic growth, but only on the income level. Regardless of the level of savings

and implicitly of investments, sooner or later, the process of economic growth reaches the "steady state" stationary stage.

Another neoclassical model of economic growth, known as the Cass-Koopmans-Ramsey model, combines the contribution of Franck P. Ramsey, David Cass and Tjalling C. Koopmans to the development of economic growth theory. This model is a modified form of the Solow-Swan model, which starts from the premise that the saving rate is endogenous, optimally chosen by households, unlike the Solow-Swan model which considers that the saving rate is an exogenous and constant variable. The Cass-Koopmans-Ramsey model considers that there are two categories of agents acting on the market: firms and households, each of them trying to optimize their profit, respectively utility. The model analyzes the performance of the economy considering the rational behavior of individuals who seek to maximize their utility. According to this model, in the long run, the economy tends toward a state of equilibrium in which capital, production, consumption, and investment grow at the same rate as the actual labor force.

The modern/new models of economic growth appeared as a reaction to the limitations of neoclassical models that determine the rate of economic growth only based on exogenous variables. Starting with the 60s and especially with the 80s of the last century, several specialist works appeared in which economic growth is explained taking into account endogenous economic variables: Kenneth Arrow (1962), Robert Lucas (1988), Paul Romer (1990), Gene Grossman (1991), Elhanan Helpman (1991), Philippe Aghion (1992), Peter Howitt (1992), etc.

For example, Kenneth J. Arrow proposed in 1962 the "learning by doing" model, which considers that the development of human resources is carried out continuously, through learning, the accumulation of knowledge contributing to continuous economic growth. Robert Lucas also talks about the role of human resources in economic growth, who believes that the greater the time devoted to learning outside the program hours, the greater will be the productivity of work, and therefore the economic growth.

As stated by Jones, C.I. (2019), perhaps the most well-known model that is part of the category of modern/new theories of economic growth is the one proposed by P. Romer in 1990. An important premise from which P. Romer started in designing his model was the one that companies use ideas and different categories of goods in practice. Unlike goods which are rivals, ideas are non-rivals. These ideas can be the basis of economic growth. For P. Romer, the role of human resources is decisive in the research-development sector, a sector that must contribute to the production of new capital goods. Thus, Romer provides a theory of endogenous technological change that highlights the important role of researchers and entrepreneurs.

In 1991, Gene Grossman and Elhanan Helpman proposed a growth model based on the process of innovation and imitation. Innovation is related to the activity of creating new products, while through imitation the new knowledge follows a process of diffusion, from the more technologically developed regions to the less developed ones (Grossman, G.M and E. Helpman, 1994). Innovation and imitation are, in the opinion of the two economists, the engine of technological progress. Unlike P. Romer who considered that the introduction of new capital goods constitutes the basis of economic development, G. Grossman and E. Helpman believe that development can be achieved by diversifying consumer goods.

Discussion and conclusions

The current paper aims to make a retrospective of the most representative theories of economic growth developed over time. We have to make a remark from the beginning: there is no best theoretical model of economic growth. Each individual theory tries to explain an economic reality according to the period in which they were proposed. If the mercantile and,

partially, the classic models tried to express an economic reality in which agriculture had a major role, with the industrial revolution and the development of the industrial sector, the economic picture changed and, implicitly, new determinants of economic growth were identified. In the following table, we tried to present the main determinants of economic growth identified by the most representative authors of economic growth theories:

Table 1. The main determinants of economic growth

Author/autthors	**The main determinants of economic growth**
Adam Smith	- capital increase; - division of labor (specialization); - technical progress;
Thomas Malthus	- the population growth rate.
David Ricardo	- capital accumulation; - reinvestment of profits;
Roy Harrod and Evsey Domar	- the saving rate in the economy; - the productivity level of the capital;
Trevor Swan and Robert Solow	- technical progress (the rate of exogenous technical change).
Franck P. Ramsey, David Cass and Tjalling C. Koopmans	- the rate of exogenous technical change;
P. Romer	- innovation and R&D activities; - the introduction of new capital goods;
Gene Grossman şi Elhanan Helpman	- innovation and imitation; - diversification of consumer goods;

A major difference between economic growth theories refers to the way in which they try to explain the phenomenon of economic growth: by means of exogenous or endogenous variables. Models proposed by Roy Harrod, Evsey Domar, Trevor Swan, Robert Solow are considered to be exogenous models, in which the growth rate is calculated based on some exogenous variables. The more recent endogenous growth models, proposed, among others, by Kenneth Arrow, Robert Lucas, Paul Romer, Gene Grossman, Elhanan Helpman, etc., try to explain the phenomenon of economic growth based on the internal conditions existing at the company level.

Unlike the classical and neoclassical models, the modern models of economic growth consider as many aspects of the contemporary economic reality as possible: imperfect competition, national and international economic interdependencies, etc. which gives them a greater dose of reliability. The transition from purely theoretical models, based on simplifying assumptions in which, for example, competition was considered perfect, to modern models that are better reflecting the real economy was not achieved overnight, but required the work of many well-known economists who took over and developed the work of their predecessors in the field of economic growth theory.

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TECHNICAL INTEROPERABILITY AND CHANGE MANAGEMENT BY INTEGRATING SERVICES OF LOCAL AND REGIONAL INTEREST

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Abstract

Purpose *– In order to establish a public service, public authorities must establish clear organizational relationships.*

Methodology/approach *- Change management is a critical process that ensures the accuracy of data and the continuity and reliability of services provided to other public authorities or institutions, citizens, or businesses, as the provision of a public service is the outcome of the collective effort of parties producing or using components of the service.*

Findings *– In order to maintain the uninterrupted delivery of public services, it is imperative for authorities involved in providing these services to reach a consensus on change management procedures.*

Research limitations/implications *– The subject organization is accountable for the road infrastructure that is controlled by the Sibiu County Council. If the service extends to a regional level and intersects with national level organizations, extending the study findings may necessitate a modified approach to the input data.*

Practical implications *– Technical interoperability connects information systems technically. Interface standards, connectivity services, application integration, data integration, data presentation and sharing, etc. Technical interoperability is not distinctive to public administration institutions, but political, legal, administrative, and partially semantic aspects are. Thus, formalized specifications, such as Directive 98/34/EC standards or ICT industry fora and consortia specifications, should be used to assure technical compatibility.*

Originality/value *– Organizational interoperability include the integration of systems, optimization of business processes, and the sharing of relevant data. Organizational interoperability seeks to fulfill the needs of the user community by providing readily available, easily recognizable, accessible, and user-focused services.*

Key words: *interoperability**,** change management, public services.*

Introduction

The degree of creative involvement in the development of new solutions, new tools for evaluation, decision, design and strategic execution determines the constraints in today's knowledge-based society rather than the technological level. Knowledge also requires action, and competitive and sustainable action requires forward thinking and a social-entrepreneurial vision on the part of public administration to achieve a sustainable leap in well-being. The

purpose of this study is to highlight the importance of innovation in public administration in achieving social transformation. Analyzing the relationship between the two main ideas of the paper - innovation and sustainable social change - as well as their application in administrative sciences and encouraging creative projects to improve the quality of life of citizens are the objectives of the study.

Adapting public administration to meet the demands and needs of citizens is at the heart of improving public services. The Europe 2020 plan highlights the need for innovation in a smart, sustainable and inclusive society, which calls on national governments and public administrations to address complex social and societal issues. The paper draws on literature research, applications of these ideas in other nations, and the application and evaluation of the data collected. A case study examining how the City of Brasov maintains public services and responds to complex problems underpins the final section of the article. The social and economic effects of the activities carried out by this local public administration in Brasov county on people's lives and the changes brought about within the city are the results of the study. The report highlights the importance of involving researchers and practitioners in bringing about social change and the need for public institutions to adopt a strong and continuous innovative approach. This study exposes excellent practices in local public administration and advances knowledge on the topics.

Change management is a methodical way of approaching change or modification of an organization's objectives, procedures and technology. The primary objective of change management is to execute tactics that facilitate and regulate change while helping individuals adapt to change.

The creation of a new public service for local and regional interest is the result of proactive measures that can be taken by the public administration, requiring the formation of new agreements with other cities or counties or regions or areas of activity.

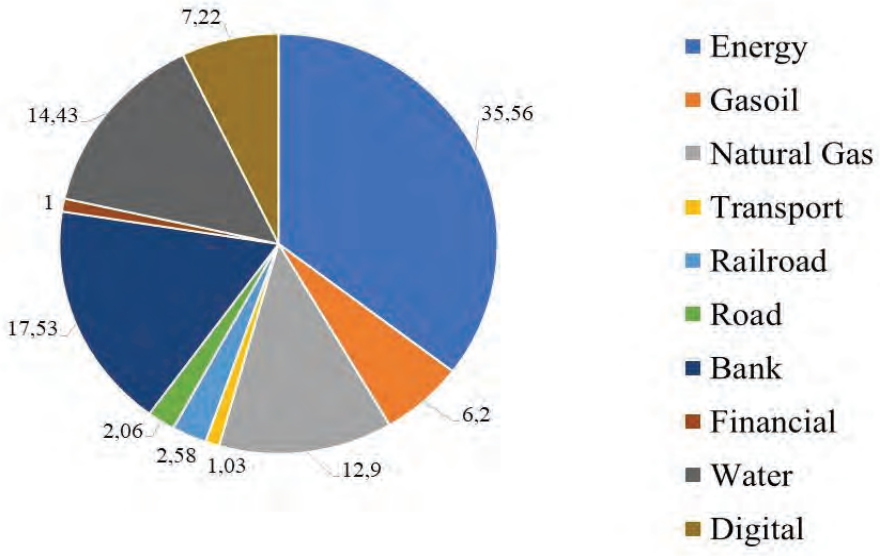

Fig. 1. Types of services of general interest in Romania, year 2023, [1]

Where new EU legislation leads to the creation of a new service, national legislation must specify the scope, priorities and resources required for the establishment and operation of the service. In order to achieve effective collaboration, it is essential that all parties involved have a common understanding, reach consensus on the necessary steps and synchronize their objectives. The successful implementation of cross-sectoral measures relies on the administration allocating resources and setting priorities in order to achieve pre-established common objectives.

Basic details on procedures in public infrastructure services

Each public authority and organization contributing to the provision of a public service operates in accordance with the laws and regulations of that country. In order to ensure the integrity of Community public services, it is essential to preserve the validity of information and data protection when information is exchanged between two organizations. This applies to both the state providing the information and the state receiving it. This component of interoperability refers to the collaboration of organizations, such as authorities and public administration institutions, from different sectors to achieve mutually agreed objectives. Organizational interoperability includes merging systems, streamlining business processes and sharing relevant data.Organizational interoperability aims to meet the needs of the user community by providing services that are readily available, clearly recognisable, quickly accessible and user-oriented.

To ensure efficient and effective collaboration between different public bodies and organizations and to deliver public services at European level, it is necessary for them to synchronize their existing business processes or even create and implement new ones.

When business processes are aligned, they are documented in a standardised way. This is done to ensure that all relevant authorities and public administration institutions that are involved in the provision of public services are able to understand the overall business processes and their respective responsibilities.

The fundamental tasks of management. Own assessments

In order to deliver a public service effectively, public affairs management needs to document its business procedures and reach agreement on how these procedures should interact with each other.

There needs to be a clearly defined framework for the relationship between service providers and service customers to meet the requirements of service orientation, which serves as the basis for the conceptual model for public services.

To do this, it is necessary to identify tools that can be used to formally establish collaborative efforts, to provide mutual support and to link operational procedures that are linked to service provision. Memoranda of Understanding on collaborative activities and collaboration are examples of such documents. Service level agreements that are approved by the public administration bodies involved are other examples of such instruments.

It is necessary for the public administration to build distinct organizational links to establish an effective public service framework.

In order to maintain the accuracy of data and to guarantee the continuity and reliability of the services provided to public authorities, institutions, individuals and businesses, change management is an essential activity to be carried out. This is because the provision of a public

service requires the concerted efforts of a number of different parties who are involved in the production or use of the components of that service.

Authorities involved in the provision of public services need to reach consensus on change management processes to ensure that these services continue to be provided without disruption.

Organizations are able to interpret and manage information from different sources due to semantic interoperability. Consequently, this ensures that the precise significance of the information is understood and maintained throughout the interactions that take place between individual parties.Services that are of significant interest are defined by the EU White Paper and include both economic and non-economic services that are advantageous to everybody. Integrated services are one component of services required for the general welfare of the people; they meet the needs of both local and zonal (areal) populations.

The municipal and zonal (areal) authorities has the responsibility of offering user-specific, efficient, and effective services. Having the money at their disposal, they have to answer to the voters and the general public for the quality of these services.

To this end, district and municipal governments must assess and evaluate a cost analyzis as a foundation for assessing the effectiveness and caliber of services provided in their jurisdiction. Mechanisms for this assessment must involve benchmarking against certain criteria.

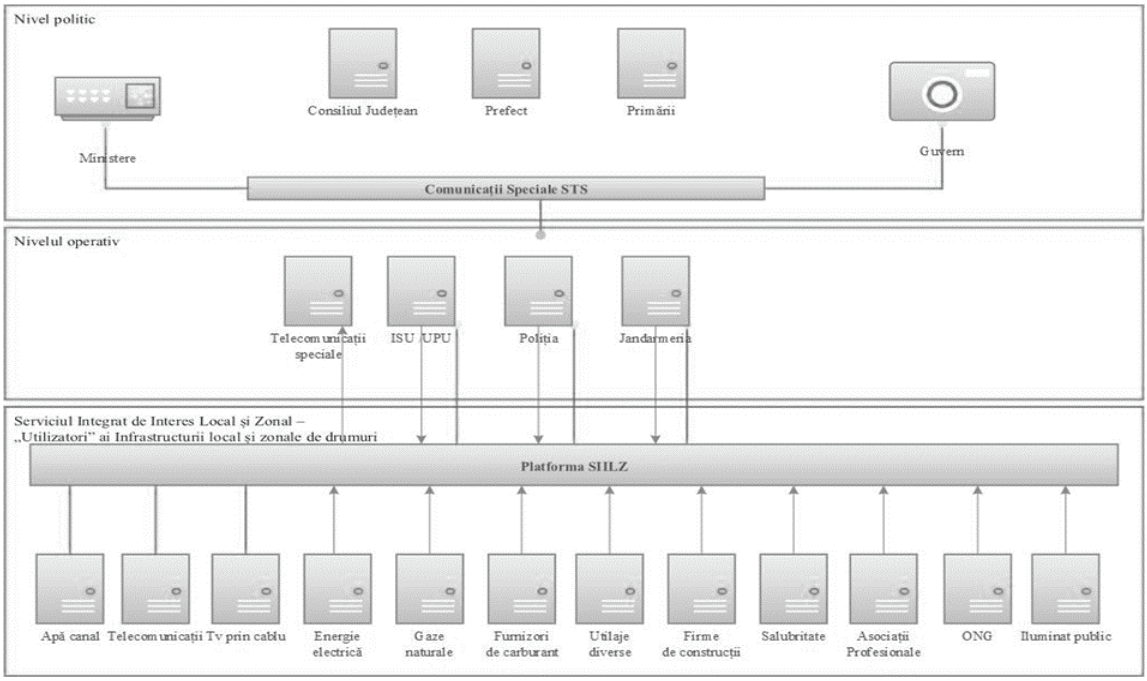

Fig. 2 The fundamental tasks of management. Own assessments

The term "Integrated Service of Local and Zonal (area) Interest" (SIILZ) describes services offered by qualified suppliers who have demonstrated their material and intellectual capacities through contracts and other documentation. Delivery of these services is done in the public interest. According to the legal rules of the service, the SIILZ can be built at the level depicted in Figure 2, which arranges five procedures:

Procedures A is for disaster readiness;

Procedures B is for managing relevant information;

Procedures C is for carrying out unforeseen emergency works;

Procedures D is for managing activities required by specific regulations; and

Procedures E is for environmental monitoring.

Part of the study, representatives of public interest service providers and the general public were polled and informed about the EU White Charter on Services of General Interest. As stressed in the White Paper, services of general interest—a pillar of the European social model—must be made readily available and of excellent quality to all EU citizens and businesses. The White Paper emphasizes the need of guaranteeing that everyone has access to services of common interest in order to maintain the social and territorial coherence and economic competitiveness of Europe.

Building sector-specific data structures that act as building blocks is the first step in the semantic interoperability process. Following their construction, it is very necessary that the organizations that are directly involved reach a consensus on the interpretation of the information that is communicated. Significant challenges are posed by the fact that the linguistic, cultural, legal and administrative environments of Member States are very different from each other.

The following components are included in the semantic interoperability framework that builds on the EIF: In the context of data structures and the relationships between them, semantic interoperability refers to the relevance of data structures. This includes improving the vocabulary used for data transfers and ensuring that all communicating entities have a common knowledge of the data structures.

Defining the structure, layout and patterns of the information to be shared is what is meant by the term 'syntactic interoperability'.

To achieve semantic interoperability at the European level requires, at the very least, compliance with a set of standards and rules.

There is a consensus among groups that are both sectoral and cross-sectoral on the use of semantic interoperability resources at EU level - Established processes and methods for creating semantic interoperability resources.

The technical components involved in the process of integrating information systems are those that are referred to as technical interoperability. There are a number of components that are included in this, including interface standards, connection services, application integration services, data integration services, data presentation and sharing, and so on.

Politically, legally, administratively and to some extent semantically, public administration institutions have various characteristics that differentiate them from each other. On the other hand, technical interoperability is not specific to them. The use of codified specifications is recommended to ensure technological compatibility. Examples of such specifications are the standards defined in Directive 98/34/EC or the specifications developed by ICT industry fora and consortia.

Change management for public service re-engineering

While administrative simplicity of public services and work process re-engineering are the main goals, the report also includes some doable suggestions for modernizing public services from the standpoint of beneficiaries.

Work process re-engineering is the process of completely reevaluating and restructuring work processes inside an organization in order to significantly alter important performance measures like cost, quality, and service delivery speed. Reengineering seeks to bring about significant rather than gradual change and concentrates on ongoing enhancements in participatory service delivery that will benefit all socioeconomic groups equally.

Reducing legal requirements and the need to show eligibility criteria—such as information to be submitted by the applicant and supporting documentation—is known as administrative simplification.

An inventive approach to reconsidering the provision of public services is beneficiary-centeredness, which puts the user experience, creativity, and co-creation ahead of quantitative data and linear models.

The methods of tariff computation are not analyzed in this approach; this work will be done in a different exercise. According to the Society for Human Resource Management (SHRM), change management is defined as the act of accessing and deliberately using information, techniques, and resources to adapt to change. In addition, it encompasses the establishment and implementation of strategies, structures, processes and technologies to have the ability to adapt to changes in external conditions and the environment in which the organization operates.

Assuring the effective execution of new company strategies, products, and processes is the main goal of change management. Reducing the degree of any unanticipated consequences that implementation may have is essential to reaching this objective.

Several difficulties arise in managing organizational change. Several principles must be given priority in order to manage change inside an organization with the greatest potential outcomes. We shall now go into three of these tactics in the paragraphs that follow in order to make the change management process easier for leaders.

Integrity and public candor

Employers who want to guarantee the effective execution of change must be transparent and honest with all information that affects their staff. Because so many workers find change uncomfortable, openness in managing change helps establish trust and rapport with them.

Work to keep communication regular.

To what extent employees are prepared to participate in conversation before, during, and after significant changes inside the company depends significantly on the connections that are built with them. Even in the absence of inquiries, leaders might start conversations with staff members to learn about their viewpoints on the events in their immediate surroundings. Every stakeholder has the chance to voice their opinions, so any misunderstandings may be immediately and easily settled.

Needful information easily accessible

If staff workers cannot easily access entire information and records, then just ownership of them is insufficient. Using a centralized system that houses all necessary paperwork and data streamlines the change management procedure.

Methodologies that are effective in transition management

In business, change is an inevitable reality. The rapid advancement of technology, the ever-changing marketplace and the growing needs of customers require businesses to be able to adapt and discover successful strategies to survive and thrive.

However, even the most well-intentioned efforts to bring about change within an organization can be met with opposition from staff.

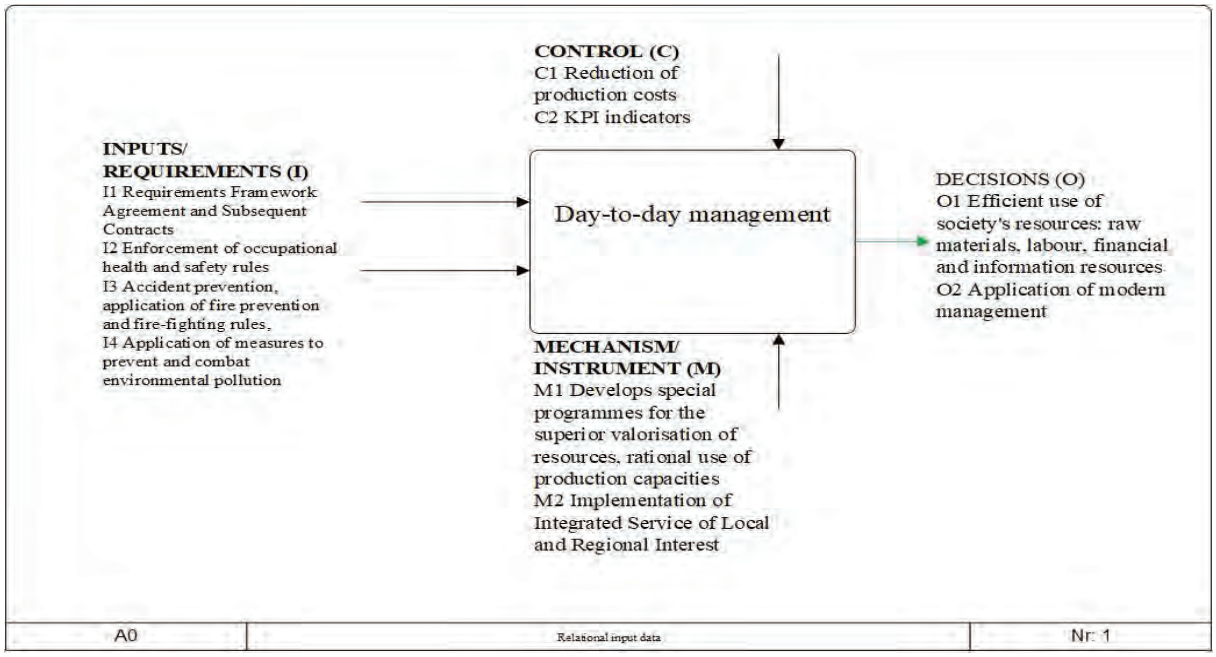

Fig. 3 The fundamental scope of management. Own assessments

Managing change in a company is a process that is both strategic and continuous, aiming to successfully implement change within the organization.

Change is something that needs to be carefully thought through and implemented, whether it is implementing new technology, reorganizing an organization or changing its culture.

Successfully managing change and overcoming resistance from employees are therefore two of the most important procedures for a company's success.

Resistance to change: underlying reasons and symptoms of resistance

When employees are faced with change, they frequently show resistance. Employee resistance to change can be attributed to a number of different factors. Fear of the unknown can manifest itself, for example, when someone is faced with the task of responding to new demands and duties.

At other times, resistance to change may be fuelled by concern about losing a job, outdated skills or techniques, lack of trust in leaders or even comfort with the status quo. All of these factors can contribute to resistance to change.

Regardless of the underlying reasons, this resistance can slow down or even halt the implementation of change altogether and have a negative effect on both employee morale and productivity.

Resistance to change can manifest itself in a variety of ways, from outright antagonism or sabotage to lack of collaboration and indifference to change.

Because this is the case, it is essential that leaders and managers have an understanding of these causes and confront opposition in a way that is both successful and sensitive. It is extremely important for leaders to pay attention to these expressions and respond to opposition in a way that is both constructive and productive.

Overcoming resistance to change: coping strategies that work

When trying to overcome resistance to change, it is essential to use a comprehensive strategy that takes into account both the technical and human components of the situation.. Transparent and compassionate communication is the first step.

Business executives must from the outset clearly and openly convey the benefits and reasons for change. This is required to make sure that employees understand the plan and justification for the change as well as the stages and procedures of the process:

a. Value and include the employees in your work

Participating in the planning and decision-making process with employees can help to increase their degree of acceptance and commitment to change. Creating an environment where staff members feel appreciated and involved can help to lower resistance to change and encourage a feeling of ownership over it.

b. Additionally included are training and continuing education.

Giving staff members ongoing chances and resources for training and development can increase their confidence and degree of comfort in handling change. These can help staff members acquire the competencies needed in the setting of the new demands of change.

c. Rewarding and praising others

Acknowledging the efforts and achievements of employees might help to inspire and promote good behavior among them during the transformation process. Offering material incentives or public recognition might help to build support for change.

d. Patterning the desired behavior

Leaders should show by their own deeds and behaviors that they are adaptable and willing to change. Employee perceptions and behavior may be positively impacted by exhibiting a positive attitude and confidence in the process of change.

e. Emotional management and resiliency building

Overcoming opposition requires first controlling employee emotions and attending to their issues. Leaders must to be understanding of the emotions and worries of their employees and should also provide support and resources to deal with these problems.

Finally, in a world that is continually changing, the success of a business depends on the intricate procedures of managing change and overcoming employee resistance. Company leaders' reluctance to change may be as much as possible minimized by using a thorough and

all-encompassing approach that emphasizes open communication and engaged employees. Enough resources and support, the example of the desired behavior and culture, and the recognition of accomplishments are all elements that help teams navigate change successfully and can eventually result in innovation and long-term success.

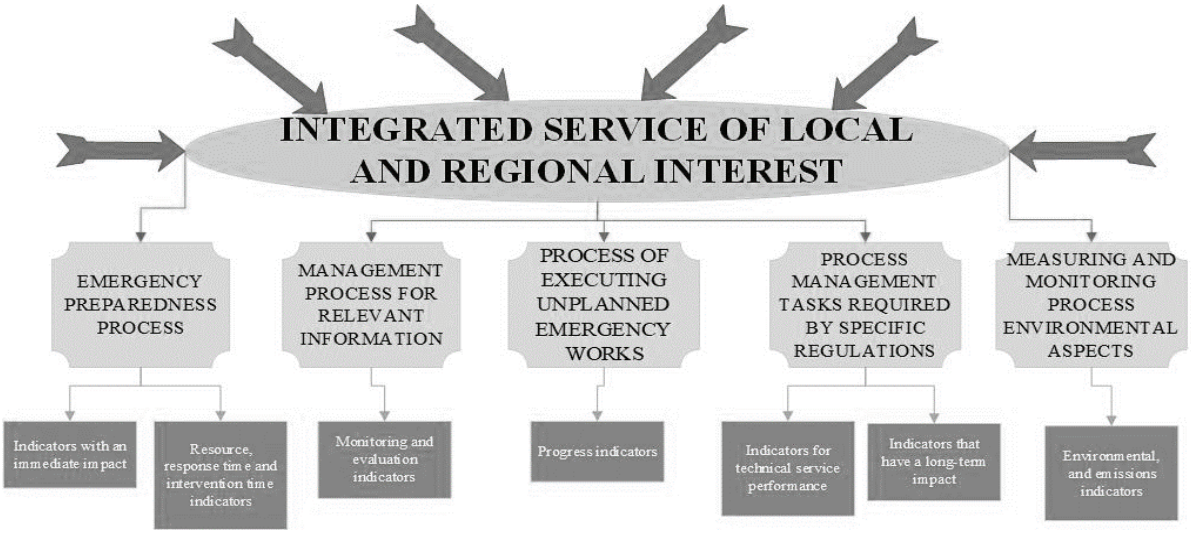

Fig. 4 The interoperability functions in processes. Own assessments

Conclusions

Why do inside our company we oppose change?

I searched the specialist bibliographies to find solutions to this question, and I can give you an overview of the viewpoints that I thought were important.

Although everyone of us has a natural inclination to feel autonomous, everyone is aware that individuals are by nature dependent on one another.

We act to create an environment where we may freely express ourselves because we want to separate ourselves, at some time in our lives, from our families, our schools, or any other form of institution that we believe limits our freedom.

For instance, the desire to ascend to the top of the organizational hierarchy together with the independence to take initiative and make decisions results in the development of the human being into a functioning adult. This grownup is the one that adds the knowledge of their own worth to a set of goals, hobbies, aspirations, or projects.

Therefore, the ability of organizations to respond to basic psychological needs of humans as well as to contain and realize the individual goals of its members (in a more comprehensive, efficient, and expedient way) may explain the reason for their formation and existence.

Change management is therefore one of the biggest challenges of our day and is starting to worry businesses and other organizations constantly.

One specific component of this issue in Romania transcends the conventional approaches of addressing opposition to change. This is owing to the mindset of our people. It's called overconfidence or overestimating one's own skills in relation to those of others ("I am more capable / more prepared, more..., than others").

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PORT ORGANIZATION. A UNITARY CONCEPT IN VARIOUS CONTEXTS

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Abstract

Purpose *– proposing a unitary concept for the third component of the port system, analyzing all types of organizations that fall into this category.*

Methodology/approach *– the categories of existing port organizations were analyzed and how they are found in the specialized literature with the aim of finding a common concept valid for all types.*

Findings *– there are many types and typologies of organizations that carry out activities in the port field that often have different names or concepts and attributes depending on the area where they are discussed.*

Research limitations/implications *– given the particularities of each port and region on the globe, it is possible that certain types of organization have not been taken into account by omission.*

Practical implications *– the use of a unitary concept of port organization could facilitate collaborations between institutions, governing bodies and ports at a global level.*

Originality/value *– a concept proposal for port organizations that provide port services or carry out activities related to water transport.*

Key words: *port organization, port management*

Introduction

Seaports represent complex systems within global logistics chains with a significant positions in the economic growth of a country open to the sea. Port systems consist of three major components: infrastructure, superstructure and port organizations that operate these structures. This paper proposes a unitary concept for the third component of the port system, analyzing all types of organizations that fall into this category. Proposing a definition for this term is not intended to change or replace certain terms already existing in the literature, but rather to facilitate the use of a unitary and universal concept valid in various contexts. This term refers to a category of organizations, not to the way the port is organized or managed.

The lack of a concrete definition for port organizations is due to a deficiency in the national legislation that appears since the regulation of the terms administration, port operator, authority, port service provider. Because there can be organizations of the type: administration, operator or service provider (safety, pilotage, towing, tying, untying), more precisely, many types and typologies of organizations in the port field, making it difficult to compose a term

whose definition to include all types of existing port organizations. Although certain terms are defined and present in Romanian legislation, there are certain inconsistencies.

The structure of the port system

The global integration of production and consumption, the development of an international transportation network, shifts in relationships between ports, along with dynamics in port hinterlands and logistics, have heightened competition among ports. Carriers, providers and shipping companies no longer simply opt for a particular port; instead, they choose a chain where a port represents a single node. To meet the demands of international trade and supply chains, ports must efficiently handle an increased volume of larger vessels and hinterland modes of transport. These evolving trends, together with the increasing influence of private companies in port operations, are forcing ports to adopt a strategy more market-oriented, innovative and adaptive in order to meet the diverse requirements of all stakeholders engaged in trade passing through ports. (Notteboom, Pallis, and Rodrigue, 2022).

A port is a specialized facility or location where ships and other craft can dock to load and unload cargo, passengers or to carry out various maritime activities. These points has an important position in the context of global trade and transport, acting as nodal points in shipping and transport of persons between land and water transport networks. The size and complexity of ports can vary considerably, from small fishing ports to large international container ports handling millions of containers annually. They are essential components of the global supply chain, facilitating the structured movement of goods and supporting economic growth (European Commission, 2014).

As defined by the law, a port encompasses a designated land and water area, equipped with the necessary infrastructure and facilities for the arrival of ships, the loading and unloading of cargo, storage of goods, as well as the boarding and disembarking of passengers and crew, along with any additional infrastructure required by transport operators within the port. (Ministry of Transport, 2019).

Moreover, the specific structure and organization of a port system can vary greatly relying on factors as size, location and the types of cargo it handles. Some ports may be small and specialized, while others are large and multifaceted, with extensive infrastructure and services (Notteboom, Pallis, and Rodrigue, 2022).

In a more simplistic way, the port considered as a system (Figure 1) has the following components:

- Port infrastructure – according to the law, port infrastructure is defined as the facilities and structures necessary for offering port services in relation to transportation. This includes items such as docking areas for ships, pier walls, quays, pontoons in tidal zones, inland basins, embankments, and land reclaimed from water. Additionally, it involves infrastructure for alternative fuels and systems for the waste collection from the operation of ships and cargo residues. (Ministry of Transport, 2019);

- Port superstructure – structures related to transportation that are supported by various facilities, including storage areas, fixed structures like warehouses and terminal buildings, as well as mobile equipment such as cranes. (Ministry of Transport, 2019);

- Port organizations – these represent organizations that operate in the port field and their object of activity is according to the activities performed within the port or activities related to water transport that impact the development and global performance of the port.

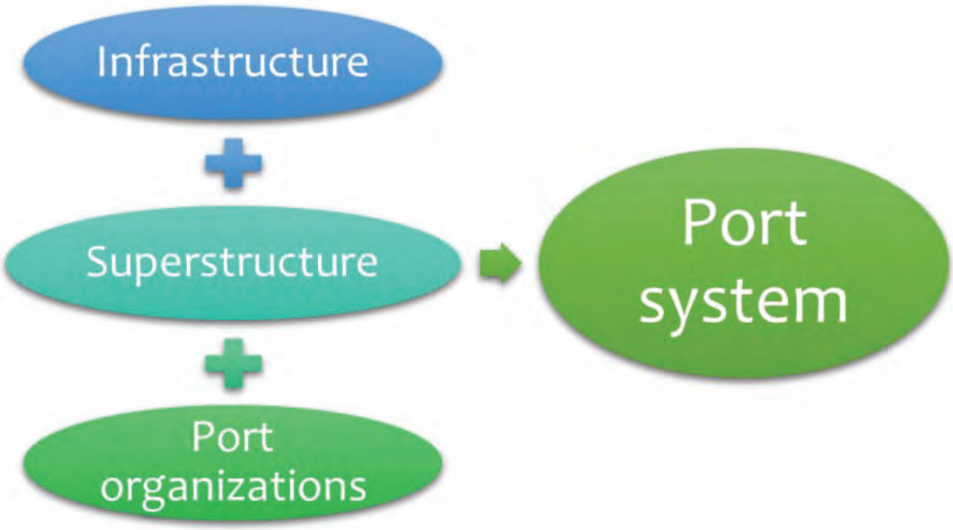

Figure 1. The structure of the port system

A port's infrastructure and superstructure, together with the diverse range of organizations involved, create a complex ecosystem that facilitates the movement of goods and supports traffic and trade. The collaboration and coordination of these elements is crucial for the efficient and effective operation of a port.

Regarding the management model adopted by the ports, it is impacted by a number of elements that determine the optimal management to meet the identified needs. These factors can be: Past developments of the port system, the socio-economic structure of the country, types of goods handled and the port location.

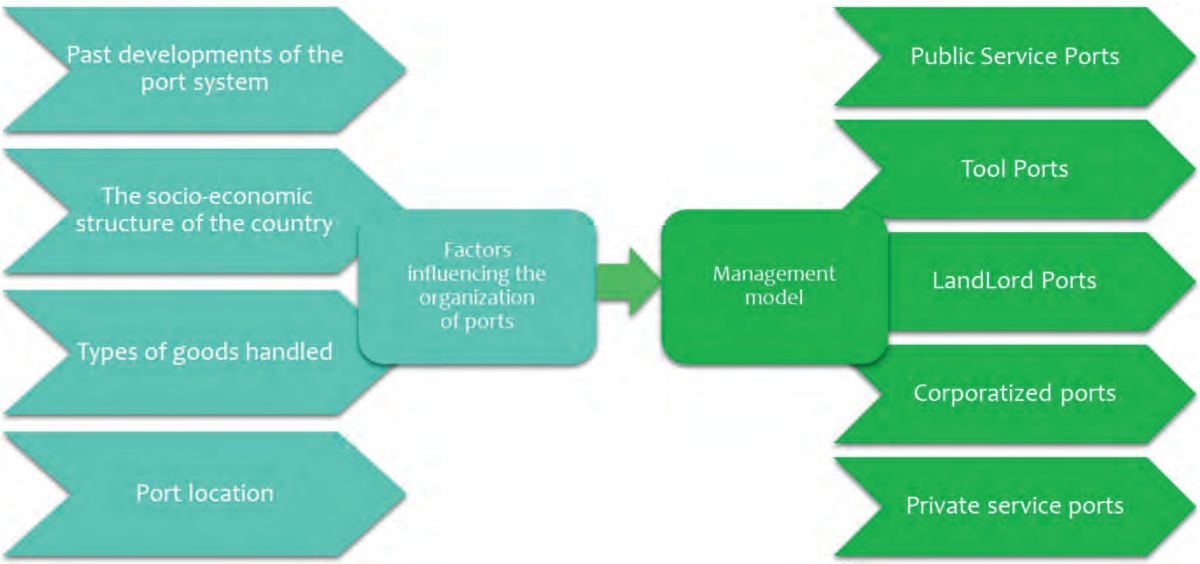

Figure 2 Categories of ports according to the influencing factors on the way of organization

The management approach embraced by the port dictates the management style of the port entities—be it public or private—nestled within its confines. Consequently, private port entities

like port operators function as independent enterprises with unique management and organizational frameworks, while public port entities typically operate under the direction of the port authority, which falls under the jurisdiction and supervision of the Ministry of Transport, and where the workforce comprises civil servants employed by the port authority (Parola et al., 2015).

The intricate nature of port configurations is a significant subject that impacts maritime efficiency through a range of elements such as the extent of relevant operations, the expansion of intermodal transportation, and adverse consequences (Quintano, Mazzocchi, and Rocca, 2020).

Analysis of specific terms and determinants: the concept of port organization

The IMO lists on its official website the port organizations (Maritime Knowledge Centre, n.d.) as agencies, associations, committees or institutions specialized in the port field that practically represent port authorities or administrations, port companies, shipowners as well as decision-makers.

As a port system is composed of infrastructure, superstructure and port organizations, it follows that port organizations must refer to all organizations operating in the port with activities related to water transport or related activities. Thus, to define the term port organization, it is demanded to analyze the determining factors that contribute to its conception. The port organization can refer to a wide range of port actors. The port organization can be represented by a port administration/authority, a port operator or a port service provider (Figure 2).

In quality management, an organization is defined as an individual or a group of individuals that possesses specific functions, responsibilities, authorities, and relationships to achieve its goals. (Anttila, J., & Jussila, K, 2017). Thus, in port field, it can be used the port organization for any entity that respect this definition and also the characteristics of port related activities.

In Regulation (EU) 2017/352, adopted by the European Parliament and the Council on February 15, 2017, which sets forth a framework for port service provision and outlines common financial transparency standards for ports (European Commission, 2017), the European Commission provides definitions for the following terms:

- The term "competent authority" refers to any public or private entity empowered to perform activities associated to the organization and management of port operations, on behalf of an authority at the local, regional, or national level, as defined by domestic laws or national instruments. This includes the port administration or its designated representatives.

- The term "port management authority" refers to any governmental or private entity that, according to national laws or regulations, is designated or authorized to oversee and manage port facilities at the local level. This includes performing various functions, whether independently or in conjunction with other activities, such as coordinating and managing port traffic, as well as overseeing the operations of various stakeholders within the port.

- A "port service provider" is defined as any individual or legal entity that offers or intends to offer one or more types of port services for a fee.

- The term "terminal operator" is not defined by Romanian legislation, but in the framework of the United Nations Convention, it is described as the natural or legal person responsible for taking custody of goods involved in international transport, having the role of guaranteeing the performance of related services relating to goods.

However, we find in the State Aid Scheme of 26.10.2023 the definition: "private port operators" - micro, small, medium or large enterprises settled corresponding to the specific legislation of the member state of which they hold nationality, which carry out unloading and loading activities, transshipment, receipt and dispatch of goods from the ship, to the ship to and from other means of transport (Ministry of Transport and Infrastructure, 2023). (Insert figure 3 about here)

A category of organizations that contribute to the operation and existence of the port is represented by the interested parties. Stakeholders are persons or groups of persons (organizations) that influence the performance of port activities or are influenced by them. They cannot be fully classified as port organizations considering that apart from the economic actors carrying out port/logistics activities what can be port organizations (other loading/unloading organizations, carriers, inspection services, shipping lines, organizations pilotage/towage, other operators, etc.), there are other stakeholders such as: public policy makers, internal stakeholders (directors, employees, members of the Board of Directors, shareholders, etc.) and community groups: local residents, consumers/taxpayers, environmental groups, the media, and others (Notteboom, Pallis, and Rodrigue, 2022).

Thus, we can define the port organization = individual or legal person, public or private entity that:

- Is empowered to perform activities associated to the organization and management of port operations, on behalf of an authority at the local, regional, or national level, as defined by domestic laws or national instruments, or
- is designated or authorized to oversee and manage port facilities at the local level. This includes performing the coordination and management of port traffic, as well as overseeing the operations of various stakeholders within the port, or
- offers or intends to offer one or more types of port services for a fee, or
- according to the specific legislation of the member state whose nationality it holds, carries out activities of unloading, loading, transshipment, receiving and dispatching goods from the ship, to the ship to and from other means of transport.

Conclusion

Given that the types of existing port organizations are extremely different, combining the definitions provided by official sources is almost impossible. Thus, in order to provide a definition of this term, the existing definitions can be cumulated, using the most relevant variant depending on the case. Proposing a definition for this term is not intended to change or replace certain terms already existing in the literature, but rather to facilitate the use of a unitary and universal acceptable concept valid in various contexts. The term would be: port organization, not to be confused with the same expression in English that translates verbatim: "port organization" which refers to the way of organizing the port in question (or port management).

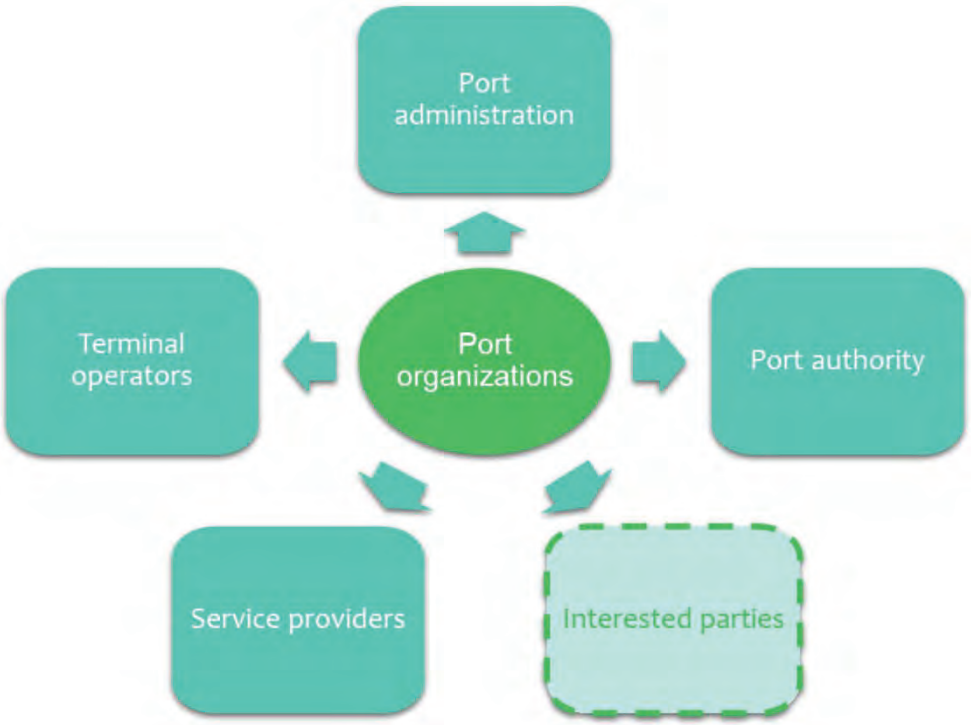

Figure 3 Types of port organizations

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TOTAL QUALITY MANAGEMENT PRINCIPLES APPLIED WITHIN THE FIELD OF ROAD FREIGHT TRANSPORT: A SPECIFIC APPROACH

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Abstract

Purpose *– Applying the principles of total quality management within organizations that operate in the road freight transport industry, additionally showcasing the potential effects of this strategic approach on an organization.*

Methodology/approach *– A medium sized road freight transport company operating in Romania was studied.*

Findings *– Total quality management fundamental principles can be applied within the specified field, with favorable consequences in terms of overall organizational performance.*

Research limitations/implications *– The research has been carried out upon studying the practices of a medium organization operating in the field of study. Thus, it is not possible to extrapolate the results unless further research is conducted.*

Practical implications *– Provide a clear understanding of how the fundamental principles of total quality management apply within the specific field and serve as a starting point for organizations in implementing a management system based on total quality.*

Originality/value *– This article presents itself as a starting point in studying total quality transportation applications within small and medium organisations operating in the road freight transport field. In addition, the study addresses the lack of research regarding the Romanian road transport industry.*

Key words: *road freight transport, total quality principles, competitive advantage.*

Introduction

In the rapidly changing environment of the present era, the transportation sector plays an essential function in facilitating globalization. Road transport of goods and other commodities is the most utilized type of transport globally, given its inherent advantages (Bektaș, 2017). Transportation is essential in the supply chain and global economy since it facilitates the transfer of commodities from their origin to their destination. Thus, this activity enhances the value of the products and provides flexibility in their distribution (Lietuvnikė et al., 2017). Due to extended infrastructure, vehicles are able to reach destinations that cannot be served by any other method of transportation.

In today's economy, small and medium enterprises are crucial (Woźniak et al., 2019), being the key element that links microeconomics and macroeconomics (Distanont and Khongmalai, 2018). Therefore, understanding how these organizations function and proposing methods of improvement is of upmost importance in supporting overall economic development. It has been acknowledged that total quality management is a central pillar for enhancing company performance (Oakland, 1989; Žeželj, 2013; Yu et al., 2020).

This paper analyzes the adaptation of total quality management principles within an organization operating in the sector of road carriage of wholesale goods or other commodities. To accomplish its scope, a medium sized organization is the focus of the research. To support the importance of implementing this strategy, this piece of work will highlight the benefits of implementing total quality management in such organizations.

Literature review

Road freight transport

Road freight transport represents an essential activity in supporting the development and growth of the global economy (Garcia et al., 2008; Nowakowska-Grunt and Strzelczyk, 2019; Collaço et al., 2022). Without road freight, most of the activities carried out on a daily basis would come to a standstill and the supply chain would be destroyed. Thus, the road transport of goods is much more than a convoy of high-tonnage vehicles on the roads. Many academics and practitioners argue that rhe most used form of transport at a global scale is represented by road freight transport (Carboni et al., 2024; Nkesah, 2023; Stenico de Campos et al., 2019). Engström (2016) descirbes this mode of transport as "the blood " of modern society. This aspect is due to the advantageous characteristics of road freight transport, such as flexibility, adaptability and low costs.

The transport industry stands at the core of the functionality for modern human settlements and is crucial to connecting different markets globally. For any industry to function efficiently, road transport services are required. Thus, it is obvious that road freight transport organizations have a particularly important role in the global economy (McKinnon, 2019).Due to the significant and rapid growth of this industry, the competition is increasingly fierce. Thus, to mantain their market share and generate positive financial outcomes, organizations must also adapt operations to effectively compete with rivals, while simultaneously finding ways to cover the ongoing rise in expenses (Poliak et al., 2021).

On the other hand, road freight transport also gives rise to negative consequences, such as increasing the final cost of goods, polluting air and water, using scarce resources and favoring the occurrence of traffic accidents (Demir et al., 2014; Litman and Burwell, 2009; Nkesah, 2023). From this point of view, the activity of road transport of goods, although essential to contemporary society, can be identified as a very significant factor that partake in increased environmental degradation and, subsequently, worsen living conditions.

Competitive advantage

Competitive advantage represents an organization's capacity to outperform its competitors in terms of performance, through using techniques that differentiate the enterprise form its competitors such as lower pricing, superior quality of the services and increased customer satisfaction (Porter, 1998). In addition, this not only enables the business to enhance its profitability, but it also creates value for both the organization and its stakeholders (Kuncoro and Suriani, 2018). Furthermore, competitive advantage can be defined as a crucial element that sets an

organization's products or services apart from all other options available to customers from rival companies.

Competitive advantage can be established using diverse strategies (Christensen, 2001). It can emerge from executing certain aspects of the supply chain more effectively than rival companies (Li et al., 2006). Additionally, it can originate from distinctive resources and capabilities that are exclusive to the company (Bel, 2018). Moreover, assets, traits, and abilities that are difficult to duplicate or surpass by competitors establish a sustained competitive advantage, resulting in a stronger long-term market position. Furthermore, the benefit remains enduring only if competitors are unable to swiftly duplicate the exceptional product or service attributes. Therefore, the organization must possess a particular capacity that sets it apart from its competitors to create meaningful competitive advantage (Coyne, 1986). Ghemawat (1986) proposes that there are three primary categories of durable advantage: dominance in market share, superior access to resources or customers, and limitations on the competitor's alternatives. Moreover, Ghemawat (1986) asserts that none of these categories are mutually exclusive and that the greater their interaction, the more beneficial it is for the organization.

Porter's (1985) generic tactics claim that competitive advantage can stem from either differentiation or cost. Although his perspective may be accurate, his approach can only result in a temporary competitive edge. To attain enduring competitive advantage, a company should choose the Resource-Based View, supporting a framework in which both advantages can harmoniously coexist. Combining this technique with the stakeholder theory has proven to be a great strategy in obtaining competitive advantage (Freeman et. Al, 2021). Hence, positioning tactics offer only a transient advantage, while capability strategies offer a more enduring benefit (Huang et al., 2015).

Total Quality Management

According to theorists Chase and Aquilano (1992), total quality management may be defined as an extensive management method aimed at achieving excellence in all aspects of an organization's products and services, which are considered significant by the customer. This definition is limiting, as it focuses on quality perceived by the customer, and does not consider quality from the point of view of processes.

Oakland (1989) advocates total quality management as a strategic methodology that aims to enhance overall business efficiency and adaptability. The need for organizational alignment is noted in terms of systematic structuring and involvement of all components of an organization, including departments, activities and individuals at all hierarchical levels. However, Oakland's (1989) definition emphasizes quality from an organizational point of view, specifically process efficiency and finished product quality, but completely ignores quality from an external point of view.

Yu et al. (2020) define total quality management as the utilization of both qualitative techniques and human resources to enhance all organizational operations and surpass the present and future requirements of clients. Total quality management is described as a continuous organizational process in which executives take the necessary measures to provide an opportunity for everyone in the organization to set and achieve standards that are not only in alignment with the internal and external customers’ needs and expectaions, but they also overcome them (Miller, 1996).

Dihardjo and Ellitan (2021) argue that the implementatiom a total quality management system must be basen on solid principles. The three fundamental principles of total quality management represent: (1) focusing on the customer, (2) constant process enhancement and

(3) total involvement. Even if there are more principles of total quality management debated in literature and practice, this paper will focus solely on the fundamental ones.

Methodology

To accomplish the purpose of this study, a Romanian medium-sized company that operates in the selected industry has been chosen as the object of this study. Thus, it's operations and daily activities were analyzed. First and foremost, the theoretical framework has been created to showcase concepts complementary to the field of road freight transport and total quality management. In addition, the three fundamental principles of this strategic approach were highlighted.

The company and its operations were observed over a period of 6 months. The next step of the research is to analyze all the activities carried out in a freight transport organization and identify areas of improvement. Moving on, the fundamental principles of total quality management have been applied and discussed, in order to showcase the benefits of this strategy.

Results

Customer focus

According to the findings of Tenner and Detoro (1992), the concept of customer focus involves understanding that the concept of quality is predicated on the premise that every individual in an organization has a customer and it is imperative to consistently meet their requirements, needs and expectations so that the organization as a whole can effectively respond to the external (final) customer's requirements. In a transport organization, it is of upmost importance that all departments work together in order to achieve quality. The information must flow accurately from one level to another, so that the final customer is satisfied withh all the operations, which include the proper transport of the goods, timely information regarding any issues that may cause delays, precise delivery time and correct invoicing

A framework consisting of 3 main activities is defined through which organizations can more easily understand who their consumers are, what their needs are and how they can be met (Tenner and Detoro, 1992). First of all, it is necessary to identify the consumer, his needs and how they can be satisfied. Secondly, so that the requirements of clients are met and exceeded, identifying the product/service characteristics that the customer requests, the standard of performance of the product so that it can satisfy the needs, as well as the importance of the characteristics of the good or service and the alignment between consumer satisfaction and product performance represent aspects of utmost importance. Thirdly, the voice of the consumer needs to be heard, and this can be achieved from both the supplier and consumer perspectives. Within a road freight organization, the application of this principle is fundamental, as customer requests are specific and the service must be customized in relation to them. Figure 1 showcases the application of this principle in a transport organization and how it is strongly linked to the second principle of total quality management.

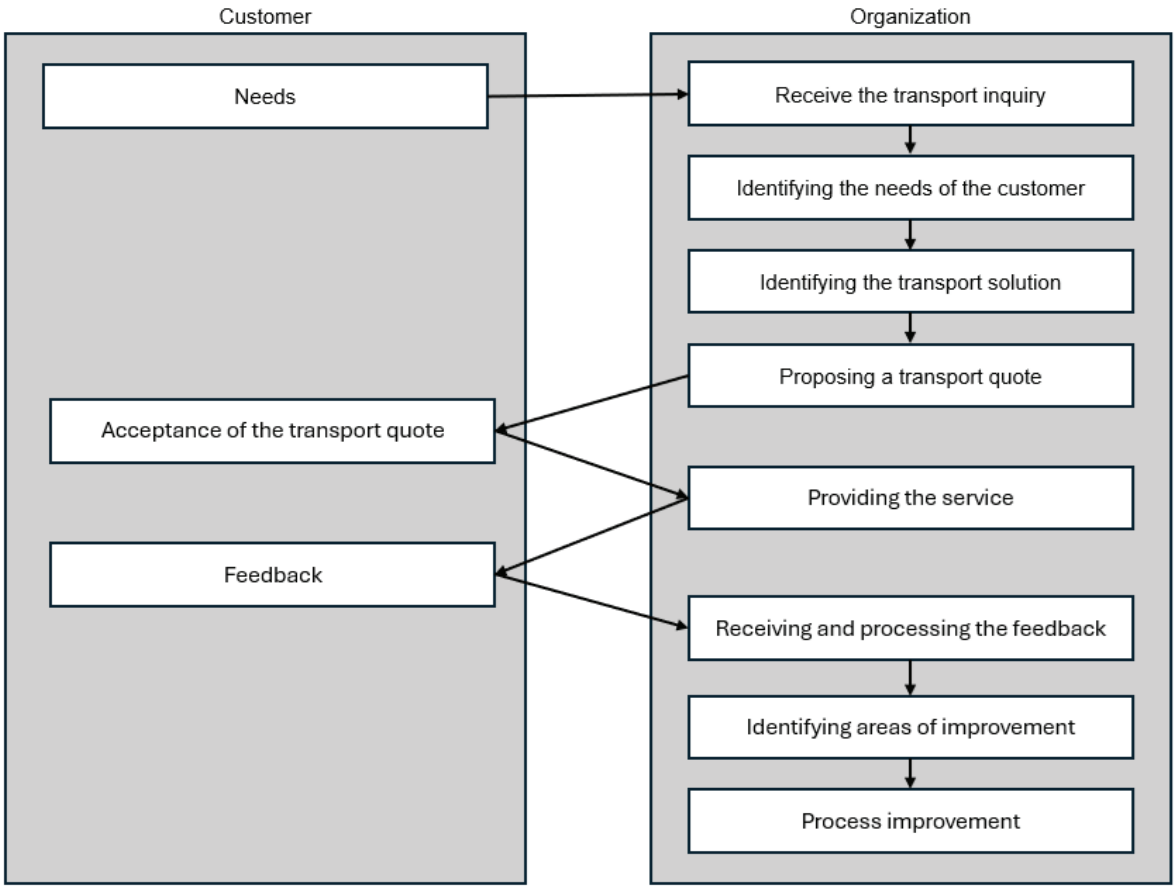

Figure 1. Customer focused approach in road freight transport

Constant process improvement

The second quality principle refers to continuous process improvement, which aims to use precise methodologies and metrics to systematically collect and evaluate data in order to improve processes considered vital to the organization's mission (Jurow and Barnard, 1993). The continuous improvement of processes, especially through the use of a PDCA-type strategy, is an essential activity within a transport organization, as it allows the early identification of possible problems and facilitates their solution, without causing other repercussions. Overall customer satisfaction can also be increased through this process. The use of evidence-based information and feedback channels is also essential for continuous process improvement. Data analysis, performance indicators and customer feedback can help freight companies identify weaknesses or consumer dissatisfaction.

Every freight transport company aspiring to increase efficiency, lower costs and enhance servicingactivities uses continuous process improvement. This approach encourages continuous review, modification and improvement in all operations so that the service provided can meet and even exceed customer expectations and needs (Shortell et al., 1998). Thus, customer satisfaction can be directly linked to process improvement, as shown in Figure 2. Continuous process improvement involves systematically examining workflows, methods and systems to pinpoint areas that need enhancement. In a road freight company, this may involve reviewing loading protocols, optimizing routes and scheduling deliveries. More precisely, transport planning should be done as soon as possible after receiving a transport order, and the expected delivery time should be as accurate as possible. By regularly reviewing these

operational factors, organizations can identify inefficiencies, blockages and opportunities for optimization.

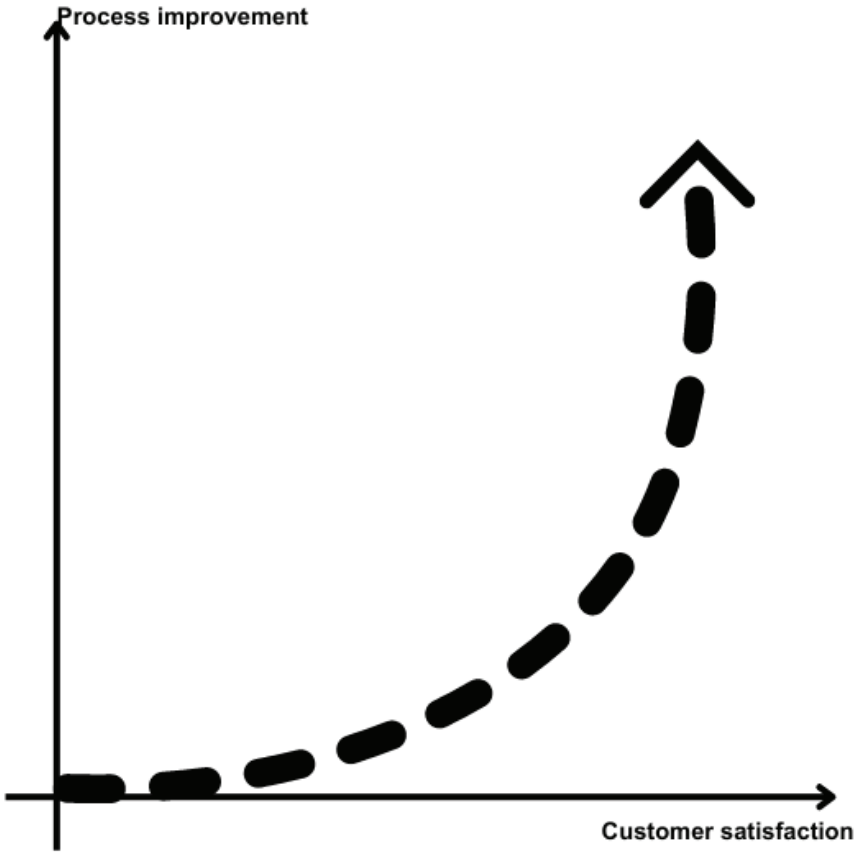

Figure 2. The relationship between process improvement and customer satisfaction

A culture of continuous process improvement requires company-wide participation and cooperation (Tan and Wisner, 2001). Employees should be empowered to make proposals, present new ideas and actively solve problems. Suggestion programs, cross-functional teams, and frequent performance reviews can help firms encourage ownership and responsibility for change. Also, in order to be able to ensure the effectiveness of strategies for constant quality improvement, it is necessary for people in management to adopt this attitude and support change initiatives.

Total involvement

The last fundamental principle to be discusssed is the total involvement of all departments and hierarchical levels within an organization. Thus, all employees, regardless of their hierarchical position, are given the power to collaboratively improve their work environment (Dihardjo and Ellitan, 2021). This is achieved through a flexible organizational framework that enables them to collectively address issues, improve operational procedures and effectively meet customer expectations. Within a road freight organization, this process can only be accomplished

through increased communication within the organization and effective centralization of information. Given the interdependence of processes and operations within a transportation organization, it is necessary for administrative staff to be alert not only to issues flagged by data analysis, but also to those noted by personnel performing transportation operations.

In relevant literature, total quality management in transport is called total quality transport. The use of the term total quality transportation (TQT) is used as an alternative to total quality management to redirect the focus away from the preconceived assumptions associated with total quality management and to emphasize the commitment to providing high quality transportation services, encouraging developing existing skills, learning and promoting a sense of pride among employees in their efforts to provide exceptional service (Metri, 2006). Total quality transportation users adhere to a transportation service philosophy centered on customer orientation and continuous improvement. This philosophy encompasses several key elements, including a commitment to meet or exceed customer requirements, active involvement of a significant number of stakeholders, use of statistical tools for analysis, continuous evaluation of processes, demonstration of strong quality leadership, delivery of training and retraining, improving safety measures, analyzing current performance, implementing a green transport system and complying with local needs and regulations.

For an organization to achieve optimal efficiency, it is imperative that all components within the organization function cohesively, recognizing the interconnectedness of individuals and activities. In addition, total quality management is a systematic approach aimed at eliminating individual inefficiencies by including all stakeholders in improvement processes. Its main objective is to increase work efficiency to achieve the desired results in short time intervals.

Discussion and conclusions

Given the fact that this market allows for slight to no service differentiation, companies should focus on other resources that can be used in order to create, sustain and enhance competitive dvantage. Thus, total quality management should be one of the key organizational processes, as it enables the establisment of a durable competitive advantage and differentiation from the competition. Total quality management is applied in all departments within a road freight transport organization, such as, but not limited to: logistics, accounting, human resources or operational departments. The principles and strategies related to total quality management are to be applied at the level of the entire organization, including all its functions.

Constant process improvement is cyclical, focusin on increasing quality from an organizational point of view, and on increasing the quality perceived by the customer. Total quality management within a road freight organization is concerned with cost efficiency, by optimizing transport routes and fuel consumption rationing, shortening working times in terms of internal processes (e.g. introduction, operation and data analysis, as well as their transmission, can be made more efficient by using specialized software).

The implications of this paper are limited due to the specific research method. Taking into account that only one company has been studied, the results cannot be used as a benchmark for generalisation. Thus, further exploration on the topic is needed in order to extrapolate. However, the outcomes of this study may serve as a treshold in understanding how the principles of total quality management apply within an organisation that provides road freight transport services.

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EVALUATION OF DIGITAL READINESS INDEX (DRI) IN TOURISM SECTOR AS A STEP TOWARD DIGITALIZATION

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Abstract

Purpose *– The implementation of digital technologies in tourism sector helps the organizations to obtain competitive advantages. An increased availability and accessibility in the market, a greater visibility and a better usage of human force are among benefits of the companies which deal with digital instruments. This study aims to afford a scientific approach in evaluating the level of digitalization for small and medium enterprises from tourism sector using digital readiness index.*

Methodology/approach *– The digital readiness index was evaluated for small and medium hotels located in Chania. They have a minor to average level of digitalization. There are registered 126 hotels in Chania. The reference dimension was utilized as a non-statistical procedure in order to establish the number of respondents. There were selected twenty hotels but were considered only the most important from the center and beach area. The number was enough because they come from a homogenous segment and is sufficient to determine 90-95% of all viable requirements. Digital readiness assessment was done as a multi question valuation of the present situation of digital readiness along two dimensions: technology usage and capacity of the organization. The free toolbox provided by Tourbit was used.*

Findings *– The results show the need of a higher investment in informatics and digitalization, creation of a digital workspace, using of cloud computing and the implementation of IoT.*

Research limitations/implications *– The limitation of this study is given by the number of hotels included in the assessment. A greater number will provide better results.*

Practical implications *– The results allow one to obtain recommendations for raising digital readiness. The SMEs can benefit from consultancy and dedicated trainings.*

Originality/value *– The study is a starting point for companies from tourism sector which intend to raise their level of digitalization. The policy makers can use it in order to design strategies. The study can be extended to other players from tourism.*

Key words: *digitalization, digital readiness index, tourism.*

Introduction

The tourism sector counted as 7% in global trade before pandemic (UNWTO, 2020). Covid-19 had a strong negative impact on it. Travel restrictions forced all players in the sector to think of new solutions. The need for safe holidays and contactless services increased the demand for digital transformations. The use of the internet plays an important role. Virtual tourism was an alternative to traditional tourism despite the fact was not like a real visit. (Akhtar, et all, 2021) Travelers' behaviour and the purchasing habits were changed. They wanted to benefit from new technologies. Tourism organizations as well as travelers needed to improve their digital skills. Much effort was made to increase digital expertise at organization level. Digitalization

provides a higher level of added value. It is considered that the capability of digitalization is not entirely investigated and exploited (Munar and Doering, 2022).

The intensity of digitalization of tourism commodities is different from country to country and from organization to organization. The most common digital tools are digital content, social media, travel blogging, digital storytelling, augmented reality, virtual reality, blockchain. All the players from the tourism sector have to invest in digitalization in order to be agile and obtain a higher degree of customer retention. Digitalization is a must for smart tourism development. Innovation and design of new digital solutions increase the level of competitiveness.

Digitalization in tourism

Digitalization has a great impact in transforming tourism. Nowadays the traditional way of tourism is changed because of digitalization. It supports the destinations and helps to increase sustainability and minimize the negative impact of mass tourism. The pandemic accelerated the demand for digital businesses. Customer requirement for digital services in tourism continuously increased. More than 90% of travelers research online their vacations. (Dredge, 2018). Design of digital solution raises tourism competitiveness. Digital transformation is customer oriented. (Popsa, 2023)

Digital technologies afford knowledge about destinations previously go to see that place. Conventional marketing methods and instruments are transformed by incorporating digital tools. Cost decrease is a positive effect of digitalization. Websites are common digital tools and are considered credible. Social media became a communication channel for different generations of travelers. It is more important for younger generations and decreases with age (Hysa et all, 2021). Social media allows us to establish virtual groups and to impact decision making by revealing travel experiences (Perakakis et all, 2016). Another new element is the implementation of chatbots. Chatbots were established to induce humanlike communication. (Leung and Wen,2020) They are a kind of e-agents which helps customers and provide information in real time. (Tussyadiah, 2020) Blockchain offers secure operations, transparency and traceable payments. (Vidal, 2020). Augmented reality (AR) enhances tourists' experience. It seems to be a direct relation between the visitors' disposition to pay and implementation of AR. Additional revenue is generated by using AR (Chung et all, 2015).

A key factor for getting digitalization is the readiness of stakeholders. Different ways of assessing it are presented in the literature review. The digital readiness index (DRI) is one of them.

Methodology

The digital readiness index (DRI) was evaluated for small and medium hotels with low to average degree of digitalization. The free toolbox provided by Tourbit was used. The calculus of digital readiness index is based on the methodology of multi- attribute decision making. The estimation of the situation is done with the characteristics of the company. Multi- attribute approach is appropriate in solving real life decisions because it is transparent and allows the evaluation and analysis of the company. (Ilijas, 2015)

The digital readiness index (DRI) was assessed for five hotels located in Chania, Greece. This place was selected because it is a very famous one and with over tourism. The tourism sector as well as the population try to find better solutions to assure the sustainable development of the area. The number of arrivals on the airport doubled in the interval 2013-2019. The pandemic affected tourism but less than in other regions. The year 2023 registered the same number of tourists as before Covid. It is expected a higher number of tourists in 2024.

Implementation of innovations and digital technologies can be solutions for overcoming the negative effects of mass tourism.

The reference dimension was utilized as a non-statistical procedure in order to establish the number of respondents. There were selected twenty hotels out of 126 registered in the town but were considered only the most important from the center and beach area. The number was enough because they come from a homogenous segment and is sufficient to determine 90-95% of all viable requirements.

Digital readiness assessment (DRI) was done as a multi question valuation of the present situation along two dimensions: technology usage and capacity of the organization. Technology usage considers three elements: the internal operation and management, customer management and product or service enhancement. The capacity of the organization is analyzed from the point of view of informatics policy, organizational culture and general strategy. Results are graphically represented in two axes. The x axe illustrates technology usage, and the y axe shows the capacity of the organization. Each axe has four levels. The levels of technology usage are beginner, intermediate, proficient and expert. The levels of capacity of organizations are not ready yet, promising, in the process and front-runner.

There are four dials in the graph. The state of the organization is analyzed according with the situation in previous year and the expected situation for this year. The state of the year is illustrated with a circle. An arrow near the circle presents the advancement movements in the close future. This development trend is constructed on the company's expectations. The color of the circle provides a visual illustration of the situation. A red circle shows a company which is a beginner in digitalization. An orange circle is used for a company which is in the developing stage of digitalization. An advanced performance in digitalization is illustrated with a yellow circle. A high level of digitalization is represented with a green circle.

Analysis of technology usage

Technology usage is evaluated by mixing the results concerning the existence of digital tools and their implementation in internal operation and management, product or service development and customer management.

1. Internal operation and management

The company uses software solutions for inside management. The software solutions are not integrated, and they are implemented only for some specific topics. The hotel intends to introduce and integrate additional complete solutions which must be integrated for all inside management. It is recommended to gain more knowledge in the implementation of software solutions. Modern software solutions facilitate more efficient business. The optimization of the business can be done by computer data processing, reliable up-to-date data and an improved communication in the firm.

Digital technologies are used only for communication and collaboration by email and social networks to enable digital connectivity and remote collaboration. It is recommended to create a digital workspace which offers the base of a modern company in a digital environment. The workspace becomes independent by the work location of employees. The remove of communication barriers determines a higher productivity and innovation level.

Cloud computing is used in a very low degree. Cloud computing offers three groups of services: infrastructure, platform and software as a service. The software as a service is an online tool for customers by a booking portal. There is also a very limited extent for a project with the suppliers. It is suggested to be used gradually in some specific areas. Other dedicated web applications for tourism can be implemented.

The hotel feels that blockchain is not important for its activity. A better understanding of it will permit the implementation and to earn benefits. Blockchain can help for more secure, traceable and transparent operations. Business rating or a reward system for loyal customers can be done by using blockchain.

2. Product and service development

The answers provided demonstrate that the hotel does not use digital technologies for value proposition. It is strongly recommended to use them in order to increase the value added for the products and services. Customer relationship management tools can be implemented.

Communication with business partners and suppliers is done mainly through email or by phone. This approach can generate miscommunication and a slow reaction to unexpected fluctuations. Higher level of digitalization of cooperation gives a higher competence.

The hotel did not achieve measurable effects in terms of revenue and costs due digitalization. The identification of areas where can be decreased the cost by implementing digitalization is a first step. A second step can be to set up a dedicated budget for digitalization.

The usage of augmented reality AR and virtual reality VR is not considered important. AR applications can simulate some places from the area and VR can show difficult or inaccessible places of great interest.

3. Customer management

Social media is used as an extra to marketing activities but can be a strategic communication channel. Employees must be educated to use social media as a platform for brand building. To hire a person dedicated only to social media communication is in discussion.

Technologies for relations with customers are not used. They have to be implemented in order to monitor and collect data on customers and sales.

Mobile business is not used. Their practice will permit the customers to access booking information, visits or other trips.

The website is the only digital web channel. Digital web sales channels can be employed. They reduce the sales costs but and increase efficiency. Overreliance in indirect sales channels is an important issue.

Analysis of capacity of the organization

1. Informatics policy

Informatics policy considers digitalization strategy, data management and share of investment. The hotel does not have a digital strategy but is aware of its necessity. The connection with support institutions can help in the design of a proper strategy. Data management includes collection, storage, organization, storage and protection of data. The company has arranged data which can be used for daily activities but is suggested to begin to do it in an integrated way in order to reach the business intelligence. The hotel has already invested in informatics and in information structure but is advised to assign a higher share for these investments. Nowadays the share of investment is less than 1%.

2. Organizational culture

The company does not have a person who takes care exclusively of digitalization and IT. It is recommended to hire one and in medium time create a small IT department. The manager

considers the workers correctly proceed their tasks but without individual commitment. Their dedication can be stimulated by some special financial and nonfinancial rewards. They are ready to work with the new technology and agree to do it. It is necessary to involve the personnel in process of change and digitalization. Nowadays the employees are somewhat autonomous, but the general manager has to increase their opportunity to work independently. Open communication is encouraged between different departments. The employees' cooperation is supported. The innovation of individuals is encouraged but the errors are not accepted. It is suggested the acceptance of mistakes.

3. General strategy

The employees are sent on trainings only in the mandatory framework imposed by legislation. Continuous professional development is a key advantage. It is advised to recognize the key personnel. A management strategy for them must be created. The workforce has the basic knowledge and skills in the digital instruments, but the acquisition of advance skills is mandatory. The company is agile because it can easily adapt at internal and external changes and continuously follows the market trends. The head of the company is responsible for the management. The inclusion of the head of departments is desirable because of their specific knowledge. The decision making is based on the knowledge and data from business reports. Time to time, the opportunities are exploited depending on the estimated level of risk.

Discussion and conclusions

The digitalization readiness index (DRI) analysis was done in terms of technology usage and capacity of the organization. The situation of the hotel was analyzed for the year 2023 and was expected for 2024. Due to confidentiality reasons the company name will be "A". The diagram shows the digital readiness of the company basedon two areas. The position and the colour of the circle illustrate the state of the organization. The graph was generated with the Turbit free toolbox.

As can be observed for the year 2023, the company is a beginner from the point of view of technology usage and is promising from the point of view the capacity of the organization. The circle is red in the graph and is located in the left down dial. An arrow goes from this circle to the left-up dial. The circle associated with the year 2024 is orange and shows an intermediate level of technology usage. An improvement is noticed also in the capacity of the organization. It is in the transition from a promising situation to an in the process situation.

The implementation of the above proposed recommendation will help the hotel to increase the digitalization readiness index. The personnel must be trained in different areas of expertise in digitalization, key personnel have to receive better knowledge and skills. A special person must be nominated for social media and in medium run an IT department must be created. A higher percentage of revenue must be invested in informatics and digitalization. Implementation of innovative technologies at product/ service level as well as at managerial level will help the company to gain competitive advantage and to increase the market share.

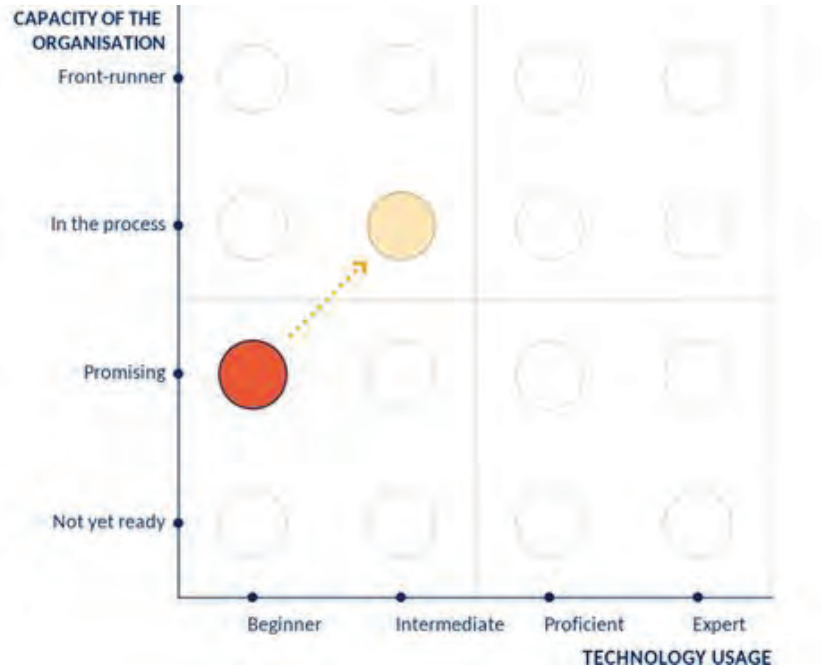

Figure 1: Digitalization readiness index for company A

Most of the selected organizations were positioned as beginners or intermediate from a technology usage point of view last year. Just one company was proficient. The situation was better in accordance with the capacity of the organization, more organizations being in the left upper dial.

The results indicate a great need of investment in the digitalization, creation of a digital workspace and using cloud computing in specific areas. Last but not least, the internet of things IoT is known and implemented to a low degree. It can offer the tourists the capacity to control accommodation parameters. More organizations must be included in the study. They can be grouped according to the needs and special programs can be tailored.

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What we can expect from blockchain technology in tourism, Digital Customer Experience

CREDITING - AN ESSENTIAL ADAPTIVE ELEMENT IN THE DEVELOPMENT OF THE ROMANIAN ECONOMY OVER TIME

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Abstract

Purpose – *The primary objective of this paper is to foster a deeper comprehension of the historical events and legal frameworks that have shaped the evolution of the credit system in this country. Additionally, beyond providing a thought-provoking theme, this study aims to offer a valuable resource for understanding the past and making informed business decisions today. By examining the credit market's history, contemporary strategists and decision-makers can better navigate the complexities of the ever-changing business landscape. This research endeavors to shed light on the credit market's significance in Romania's economic development, highlighting intrinsically the challenges and opportunities that await it in the future.*

Methodology / Approach *– By examining the context, economic conditions, and legal regulations, this study aims to provide a comprehensive understanding of the credit market's evolution and its impact on Romania's overall economic development. The analysis traces the credit market's trajectory from the early 19th century to the end of the Second World War, enlightening the key milestones, challenges, and opportunities that have shaped its course. Moreover, the paper delves into the legal and regulatory frameworks that have governed the credit market over time. By analyzing the evolution of credit laws, regulations, and institutions, the study clarifies some of the factors that have shaped the credit market's structure, functioning, and accessibility.*

Findings *– Through the study of the past and applying its insights, organizations can enhance their ability to navigate uncertainty, adapt to change, and position themselves for long-term growth and prosperity.*

Research Limitations / Implications *– Although, the findings in this paper can have practical and theoretical implications for the organizations which try to improve continuously their adaptability and navigate the challenges of today's dynamic business scene, the focus of this survey is centered upon a specific aspect of the financial area, respectively the credit evolution, while in the business environment, challenges can appear from many, different directions.*

Originality / Value *– By combining historical analysis, economic theory, legal frameworks, and demographic data, consulting the works of renowned scholars in the fields of economics, history, and law, we endeavored to provide a deeper understanding of the complex interplay between historical events, economic conditions, and legal regulations in shaping the development of the credit system in this country.*

Key words*: Credit market, credit evolution, financial legislation*

Introduction

Romania's credit market has evolved through a complicated interplay of history, economics, and law. By understanding the historical context, identifying key trends, and applying the lessons learned from the credit market, present-day organizations can enhance their resilience, improve their ability to navigate uncertainty, and position themselves for long-term success.

The Credit Market in the Main Romanian Provinces: Wallachia, Moldavia, and Transylvania until the Great Union of 1918

In the mid-19th century, the three provinces were once again separate and under the domination of foreign powers. Since Wallachia and Moldavia were under Ottoman rule, while Transylvania was part of the Habsburg Empire, this subject will be approached collectively for the first two provinces and separately for Transylvania, up until 1918, the year of the Great Union.

The Credit Market in the Romanian Provinces of Wallachia and Moldavia until the Unification of 1859

Before the Unification of 1859 under the leadership of Alexandru Ioan Cuza, the two Romanian provinces, Wallachia and Moldavia, which were under Ottoman domination, were economically underdeveloped compared to Western countries. Among the causes of this situation were foreign domination, the semi-isolation of the Southeast European space from Western economic flows, frequent wars fought on their territory, the existence of a Balkan mentality that supported corruption, weak institutional structuring, and long periods of instability.

In this context, the ongoing corruption within the administration, excessive, discretionary, and chaotic taxation, and the venality of the ruling class and officials severely affected the spirit of accumulation and saving, as well as trust in honest work, institutions in general, and the political elite in particular. Thus, against the backdrop of maintaining Ottoman domination, medieval forms of economy persisted, delaying political division and the formation of a national economic market. Additionally, the monetary situation was chaotic, with money regarded as a commodity like all other goods. There was no national currency, and a multitude of foreign currency signs circulated, with over 80 varieties in use (BNR, 2005). This monetary system was exposed to significant external and internal speculation and fluctuations, varying from day to day and from one locality to another, which undermined the function of value measurement. To this, one could add the intentional deterioration of coins to extract precious metal, as well as the practice of hoarding.

As shown in Table 1, during this period, a usury credit system operated, consisting of "large" and "small" loans. The former were intended for the wealthy clientele, nobility, large merchants, and the state, and were practiced by loan sharks, money changers, and large merchants. The debts of these beneficiaries became perpetual, with debtors being constantly indebted. Nevertheless, the risks were relatively low due to solid guarantees, usually real estate such as estates and buildings. It is noted that this type of credit was unproductive, as it was intended for covering luxury expenses, such as travel and stays abroad (Axenciuc, 1997).

In parallel, "small" loans were available to peasants, craftsmen, small merchants, and various employees, practiced by landowners, tenants, innkeepers, and specialized small loan sharks. Interest rates for these loans reached up to 200 percent, a level reflecting not only the pressure of demand but also higher risks due to the lack of guarantees. This type of credit was unproductive, as interest rates were generally higher than average profit rates, reducing the beneficiaries' chances of achieving a better standard of living. During that time, Romanian

society was marked by the urgency of modernizing internal institutions and strengthening national construction.

Table 1: The Usury Lending System in Wallachia and Moldavia in the Mid-19th Century

Type of Credit	Beneficiaries	Providers	Characteristics	Risks	Guarantees
Large	Wealthy clientele, nobility, large merchants, state	Loan sharks, money changers, large merchants	Non-productive; intended for luxury expenses (travel, stays abroad)	Low	Real estate - estates, houses, land
Small	Farmers, craftsmen, small merchants, employees	Landowners, tenants, innkeepers, small specialized loan sharks	Unproductive: interest rates are generally higher than average profit rates	High	No guarantees

The Credit Market in the United Principalities from the Unification of 1859 to the Great Union of 1918

With the establishment of the modern Romanian national state in 1859, accomplished under the leadership of Alexandru Ioan Cuza, alongside political changes, there was also a transition from the pre-modern feudal system to a modern market economy. During this period, there was a pressing need for low-interest loans; large landowners, the bourgeoisie, and individuals with more modest resources felt the absence of a banking system, particularly an issuing bank, which would have allowed them to move away from ruinous usurious loans. The increased accessibility of credit was crucial for the success of their enterprises.

The situation was addressed through the adoption of important laws and the creation, over the course of a decade, of several institutions responsible for lending, such as the House of Deposits and Consignments (December 1, 1864), Rural Land Credit (June 1, 1873), and Urban Land Credit (Bucharest Urban Credit Society) (1875) (Giurescu, 2007). The emergence of these institutions was a reflection of a new business spirit based on credit and cultivated public confidence in domestic financial power.

An important innovation during this period, which prepared significant changes in the credit market, was the introduction of a national monetary system based on the Law of April 22 / May 4, 1867.

As a result of the adoption of the new monetary system, the first real national currency with intrinsic value, the Leu, was created, expressed in precious metal, despite Ottoman resistance and Austro-Hungarian protests. One leu was equivalent to 0.3226 grams of gold with a fineness of 900 per thousand or five grams of silver with a fineness of 835 per thousand. The leu was defined according to the decimal and bimetallic system of the Latin Monetary Union, which included France, Belgium, Switzerland, Italy, and Luxembourg (BNR, 2005).

The monetary stability characteristic of the gold standard system during the period 1880-1914 resulted in remarkable price stability, which was unprecedented for the next 110 years. Thus, Romania entered the international trade and currency exchange market with a stable and efficient monetary organization (Kirițescu & Dobrescu, 1998).

Table 2: Leu Exchange Rates – Common Currencies in the Period 1880 – 1914

Exchange Rates	1 real (Spain)	1$ (USA)	1 £ (GB)	1 RM Reichsmark (Germany)
Lei	5.039	5.18	25.25	1.24

At the same time, in the United Principalities, which were named Romania after 1877, the year of independence from Ottoman domination, following the adoption of the Law for the issuance of mortgage bonds in the amount of 30 million lei (June 12, 1877), backed and guaranteed by state lands, paper money began to circulate for the first time. This marked a significant step forward in the evolution of the national monetary system.

The establishment of a national banking system was marked by the founding of the National Bank of Romania through the Law for the establishment of a discount and circulation bank dated April 17/29, 1880, published in the Official Gazette no. 90, in the form of a joint-stock company, with a share capital of 30,000,000 lei, one-third subscribed by the Romanian state and two-thirds by private investors.

As a result of these changes, a modern credit system for large investments was implemented, characterized by an abundance relative to demand, interest rates lower than the average profit rate, and a specialization in the main branches of the economy such as trade, industry, and agriculture. It had a predominantly productive nature, being intended for investments and economic transactions. Additionally, the system was based on reasonable guarantees, making it stimulative for deposits.

Among the economic progress recorded as a result of the new system, the number of enterprises increased to 175 by 1877, the expansion of the petroleum and salt extraction industries, the development and modernization of transportation routes, the increase in the number of imported agricultural machines, and the use of wage labor in agriculture were notable. The number of traders also increased, and foreign trade doubled between 1864 and 1880. Of the total exports, 85 percent was represented by wheat, which earned Romania the title of the "granary of Europe" (BNR, 2005).

Tables 3, 4, and 5 present the types of specialized loans from this period, several important banking institutions, and the sources of capital. It is primarily noted that credit supports activities in agriculture, the main concern of the population. Regarding capital, there is a good representation of both banks with domestic capital and those with Austrian, German, French, and English capital, many of which were supported by representatives of the Jewish minority (Boelcke, 1987).

Table 3: Types of Loans Offered by Specialized Banks

Year	Types of Credit	Banking Institution
1880	Issuing bank and main credit institution	National Bank of Romania
1873	Agricultural Credit	First Land Credit Society
1874	Land Credit	Bucharest Urban Land Credit Society
1881	Land Credit	Iași Urban Land Credit Society
1903	Credit for Small Farmers	Popular Banks
1906	Credit for Vine Growers	Wine Credit House
1906	Credit for Urban Areas	Urbanization Credit House
1908	Credit for Rural Areas	Rural Credit House

Table 4: Banks with Foreign Capital

Source of Capital	Year of Establishment	Banking Institution
German capital	1895	Romanian General Bank
Austrian capital	1904	Romanian Credit Bank
Jewish bank with Hungarian, German, and French capital	1905	Marmorosch – Blank Bank
English, Austrian, French, and Belgian capital	1906	Romanian Commercial Bank

Table 5: Banks with Romanian Capital

Banking Institution	Year of Establishment
House of Deposits and Consignments	1864
House of Savings and Postal Checks	1880
Agricultural Bank	1894
Discount Bank of Bucharest	1898
Commerce Bank of Craiova	1898
Romanian Bank (PNL)	1910

This period manages to bring modernization and essential changes to the credit market, the main evolution being the transition from the suffocating usury credit system to a sustainable lending system practiced by the new banking institutions.

The Credit Market in Transylvania between the Mid-19th Century and the Great Union of 1918

Between the mid-19th century and the Great Union of 1918, Transylvania was under Habsburg domination. In this province, alongside the majority Romanian population (61.3 percent), there were also smaller proportions of Hungarian, German, and Jewish minorities (see Table 6) (Cosma, 1880). Paradoxically, the Romanians in Transylvania were the only ones bound to the land, as serfdom was only abolished in 1853. The former serfs, now free peasants, lacked organized credit for agriculture, as lending was based on ethnicity. As shown in Table 8, the first Romanian bank, Albina, was established in Sibiu in 1871, designed to offer loans to the Romanian population, with the aim of ensuring financial resources for the exploitation of local resources. It became the most important Romanian credit institution in Transylvania (Giurescu, 2007). At the same time, the other nationalities, accounting for less than 40 percent, benefited from 16 strong credit institutions, branches of banks from Vienna and Budapest.

Land sales and usurious loans became widespread during this period, driven by "heavy and burdensome debts", (Retegan, 1994) both for survival and for paying taxes to the state, as the treasury was no longer willing to accept arrears (Balog, 2007).

The population of Transylvania in 1850 was 2,061,645 inhabitants, the vast majority being Romanians (see Table 6).

Table 6: Population and Banks in Transylvania

Population by Ethnicity*	Percentage of Total Population*	Number of Credit Institutions	Name of Institutions	Purpose of the Loan	Accepted Guarantees
Romanians	61.3%	1	Albina Bank (1871)	Land, livestock, agricultural machinery and tools, building constructions, payment of debts, trade, promoting crafts, children's education, passions and gambling, for productive and non-productive things	Real estate and agricultural land
Hungarians	19.4%	16	Branches of Banks from Vienna and Budapest in Arad, Sibiu, Brașov, Cluj, Timișoara		
Germans	11.9%				
Jews	3.4%				
Others	4%				

*Source: (Rotariu, Semeniuc, & Mezei, 2004)

During this period, the lack of strong banks serving the Romanian population, both for financing agriculture and industry, reduced their chances of prosperity. Although the Furnica Bank was established in 1883 and the Ardeleana Bank in 1885, usury as a lending method continued to play an important role. The lack of education and poor preparation of the Romanian population led to excessive indebtedness of small landholdings, resulting in an increasing number of properties being sold at auction. The number of small properties sold at auction rose alarmingly by the end of the 19th century, from 9,606 properties in 1875 to 14,921 in 1893, reaching 21,193 in 1903.

Through the information provided, the publications Gazeta Transilvaniei and Revista Economică played a very important role in improving the economic situation in Transylvania, even though, at times, the authors of the articles did not succeed in making accurate predictions regarding solutions for the development of Romanian agriculture and industry (Dobrescu, 1999).

The Credit System from the Great Union to the End of the Second World War 1918-1945

After World War I and the formation of Greater Romania, the banking system experienced a sinusoidal evolution: between 1918 and 1929, the number of banks increased under the influence of inflation and stock market speculation from 1919 to 1926, rising from 215 in 1918 to 1,122 in 1928, in addition to the 4,743 popular banks. This was followed by a process of deterioration and contraction during the economic crisis of 1930-1934 (Căpraru, 2014).

During this period, there was a deepening of credit specialization, with the emergence of industrial loans, craft loans, and loans for public servants. Large banks oriented themselves towards mechanized industry and foreign trade, while small banks targeted domestic trade and small to medium agriculture; most of the loans were directed, especially after the economic crisis, towards large industry, while agriculture had financial resources far below its needs.

In the third decade (1921-1930), the positions held by French, Italian, Swiss, and British banking capital were consolidated by the displacement of German capital, and during the period of 1934-1938, a trend for the revitalization of German capital became evident. At the same time, trends of concentration and centralization of banking capital became apparent, with most assets held by a few large banks centered around the National Bank of Romania (BNR).

In the fourth decade (1931-1940), state intervention became necessary in the form of regulatory and control actions over banking activities, as a result of the disorganization caused by the banking crisis and the collapse of many credit institutions.

The Composition of the Credit System during the Interwar Period

During the interwar period, the credit system included the National Bank of Romania as the sole issuing bank and central discount bank, private commercial banks, specialized credit institutions in the fields of large and small industries, agriculture, employee credit institutions, cooperative credit institutions, public credit institutions, and insurance institutions.

As a consequence of the economic crisis in the fourth decade of the 20th century, Law No. 70 of May 8, 1934, was enacted for the organization and regulation of banking commerce, establishing the High Banking Council, whose leadership was appointed by the National Bank of Romania (BNR). This body had the functions of removing weak banks from the banking network by either closing or merging them; a series of restrictions were introduced to bring order to banking operations; speculative businesses were halted, with the goal of restoring and consolidating the banking system.

Period		Phenomenon	Manifestations
1921	1930	Deepening of credit specialization	Industrial, craft, and public servant credit
			Large banks support large industry and foreign trade
			Small banks support domestic trade and small to medium agriculture
		French, Italian, and Swiss banking capital predominates	
1934	1938	Trends of concentration and centralization of banking capital (revival of German capital)	The majority of assets were held by a few large banks, centered around the National Bank of Romania (BNR)
1930	1940	Banking crisis	Collapse of many credit institutions

Figure 1: Synthesis of Banking Phenomena during the Interwar Period

A special case is represented by the Credit Cooperatives, initially established as Popular Credit Associations. In 1870, the "Economy" Association was founded in Bucharest at the initiative of His Eminence Aurelian, followed by the establishment of credit cooperatives in the counties of Dâmbovița, Buzău, Neamț, Prahova, and Roman. In 1846, the "Sick Benefit, Burial, and Travel Assistance Association of Printers from Brașov" was established in Brașov, the first mutual aid association in Brașov, whose statutes were approved in 1861. A similar association was established in Timișoara in 1851. In 1868, the "Society for Saving and Lending in Rășinari" (Sibiu County) was founded, which was the first Romanian credit institution in Transylvania aimed at harnessing the economic potential of the villages (Giurescu, 2007).

Through the amendments made to the law on June 23, 1938, January 20, 1939, October 18, 1940, and February 22, 1941, the National Institute of Cooperation (INCOOP) was established, which abolished the five previous centers, with the state becoming a partner alongside federations and cooperatives.

Conclusions

From the above, it follows that throughout the history Romania faced a multitude of challenges, but its resilience and adaptation to changing circumstances have paved the way for a more robust and integrated financial sector. As Romania continues its journey toward economic development, the credit market will undoubtedly play a pivotal role in driving growth and prosperity, particularly for those organizations that possess a deeper understanding of the historical context, can identify emerging trends, and apply the lessons of the past, some of them learned from the evolution of the credit system.

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