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Ph.D. Candidate Eng. Dipl. Laura-Florentina MIȘCĂ (BOANȚĂ)

PhD THESIS ABSTRACT

Contribuții la creșterea inovării prin proiecte de cercetare-dezvoltare-inovare utilizând metode hibride de management

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Contributions to enhancing innovation through research-development-innovation projects using hybrid management methods

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Content

Legend

No.crt.	**Abrev.**	**Semnificație / Significance**
1	AO	Agilitate Organizațională / Organizational Agility
2	APM	Agile Project Management / Agile Project Management
3	CE	Ingineria multimilor / Crowd Engineering
4	CECAN	Centrul pentru Evaluarea Complexității / Center for Complexity Assessment
5	CO	Cultura Organizațională / Organizational Culture
6	CO_2	Dioxid de Carbon / Carbon Dioxide
7	CRI	Indicele de Pregătire Comercială / Commercial Readiness Index
8	CSN	Navigator pentru sustenabilitatea corporativă / Corporate Sustainability Navigator
9	DIQ	Coeficient de inovare digitală / Digital Innovation Quotient
10	IMM	Întreprinderi Mici și Mijlocii / Small and Medium Enterprises
11	KPI	Indicator Cheie de Performanță / Key Performance Indicator
12	MCDM	Decizie pe baza mai multor criterii / Multiple-Criteria Decision-Making
13	MIA	Analiza Multi-Index / Multi-Index Analysis
14	MRL	Nivelul de Pregătire a Pieței / Market Readiness Level
15	ORL	Nivelul de Pregătire Organizațională / Organizational Readiness Level
16	OUG	Ordonanța de Urgență Guvernamentală / Government Emergency Ordinance
17	PET	Tereftalatul de Polietilenă / Polyethylene Terephthalate
18	RESTART_4Danube	Boosting Creative Industries in Urban Regeneration for a Stronger Danube Region / Boosting Creative Industries in Urban Regeneration for a Stronger Danube Region
19	RRL	Nivelul de Pregătire Reglementară / Regulatory Readiness Level
20	RL	Nivel de maturitate / Readiness Level
21	SCRUM	Metodologie de management și dezvoltare a proiectelor / SCRUM
22	TRL	Nivelul de Pregătire Tehnologică / Technology Readiness Level

Chapter 1. Analysis of agile innovation in industrial systems: Current context

1.1. The concept and characteristics of the "Agile Enterprise"

Organizational agility refers to a company's ability to adapt quickly and efficiently to unforeseen changes in the competitive environment, involving adjustments to technology, employees, and products. Initially developed in manufacturing, it has expanded to the entire organization, becoming crucial for innovation and maintaining competitiveness. According to S. Trzcieliński, agility should be viewed as a new paradigm based on organizational intelligence and resource flexibility, which are essential for meeting market demands [1-6].

In conclusion, organizational agility involves a combination of adaptability and innovation, allowing businesses to respond rapidly to unpredictable changes. It entails reconfiguring resources and effective cooperation to manage changes both in the short and long term, ensuring success in a dynamic business environment [1-11]. Innovation plays a central role in this process, being closely linked to agility and thus contributing to the long-term differentiation and competitiveness of organizations [3].

Table 1.1. Synthesis of research on the impact of agility on innovation within an organization

Researchers	Research Results
V. Sambamurthy, A. Bharadwaj și V. Grover	- indicate a significant impact of investments in IT innovation on company success and obtaining competitive advantages, supported by agility attributes
R. Raschke	- indicates a positive correlation between IT infrastructure flexibility and business process agility - indicates a positive correlation between business process agility and performance effectiveness/quality within an enterprise
A. Shahin, M. Nikjoot și A. Nilipour	- indicate a close relationship between internal and external factors and product innovation - indicate that the introduction of innovative products and services in the past five years and the high success rate in their implementation, relative to competitors, is a specific attribute of innovation - indicate the existence of a link between internal factors (strategy, organizational structure, information system, employee personality), external factors (business partner network, level of utilization of scientific and technological advancements, communication and information transfer network), and the innovation process
C. Wang și P. Ahmed	- setting key indicators for product and process innovations - identifying key innovation indicators, such as: increased number of innovations compared to competitors; promoting the company as an organization active in introducing innovative products or services; high success rate in introducing new products and services relative to competitors

Adapted from Sajdak, M (2013) [12]

Implementing agile approaches in organizations promotes innovation and increases competitiveness, allowing for rapid adaptation to market changes. Agile methods, such as SCRUM and Kanban, have transformed how companies operate by emphasizing flexibility, collaboration, and the customization of offerings. This adaptability is crucial in a dynamic business environment, but applying these principles in scientific research remains an open challenge.

Enterprise agility is critical for survival and prosperity in an unpredictable business environment, supported by the ability to quickly reconfigure resources and processes. Agile organizations leverage strategic networks to access external resources and gain a competitive advantage, thus reflecting a complex approach that integrates internal flexibility with external adaptability.

1.2. Impact of organizational culture value system on enterprise agility

Organizational agility (AO) is essential for firms' competitiveness in volatile environments, enabling the rapid identification and exploitation of opportunities. Although technology is central to AO, organizational culture (CO) plays a crucial yet often underestimated role. Recent research emphasizes that the technological intensity of an industry influences how cultural values support AO [13].

Diverse organizational cultures, such as group, market, or adhocratic culture, influence agility differently. Unexpectedly, hierarchical culture can support AO in certain contexts through structure and formality. Sambamurthy and colleagues note that AO manifests through customer, partnership, and operational agility, each being essential for adapting to changes [14,15].

1.3. Dimensions of Organizational Agility

In a context of rapid changes and intense competition, organizational agility (AO) is crucial for the success of firms, relying on the detection and prompt response to changes through dynamic capabilities, strategic flexibility, and market orientation. AO helps organizations adapt effectively to turbulent environments by managing market risks and opportunities. Examples such as Wal-Mart and Xerox demonstrate the role of detection and response in OA, while Agile principles and open innovation enhance adaptability and competitiveness [10, 16, 17-32].

The development of new products is essential in a competitive market, requiring efficient supply chains for rapid launch and withdrawal of outdated products. Innovative methodologies such as lean development and agile project management (APM) are increasingly used by SMEs and startups, impacting organizational structure and external relationships. Hybrid solutions, combining traditional project management (TPM) with agile methods, offer flexibility and improve team performance, though the application of APM outside the software industry is still under evaluation. Agile approaches accelerate innovation through iterative prototyping, and makerspaces (see Figure 1.1.) support this process by creating a collaborative environment that fosters the development and testing of ideas [33-38].

Fig. 1.1. Characteristics of a Makerspace Viewed as an Open Innovation Ecosystem – adaptation [39]

In conclusion, agile approaches such as the "SCRUM" method are extremely effective for product development in contexts of uncertainty and frequent change. They facilitate customer integration and the use of prototypes for continuous feedback, supporting iterative development based on team competencies and early risk management. However, physical prototyping can be costly and time-consuming. The "SCRUM" method has expanded beyond software, proving useful in other organizations and fields, including research, although its implementation can be challenging in more rigid or academic contexts [39,40].

Agile methodologies, which were initially developed for managing software projects, have been successfully adapted to other fields, including research and prototype development. Agile principles, such as an emphasis on team collaboration, iterative development, and the use of planning visualizations, contribute to improved performance and collaboration in complex projects. However, applying these methods in research and other sectors can face challenges, such as coordination between different disciplines and managing uncertainty, highlighting the need for a balance between flexibility and rigorous management to ensure innovation and success in collaborative projects.

The study "Management of a Multidisciplinary Research Project: A Case Study on Adopting Agile Methods" highlights the positive effects of agile methodologies on transparency, trust, and engagement within research teams (see Figure 1.2.). The adaptation of agile methods has been associated with an improved collaborative atmosphere and more efficient knowledge transfer. Frequent communication, including "stand-up" meetings, has significantly increased, contributing to better coordination of activities and addressing various topics beyond current tasks [41,42].

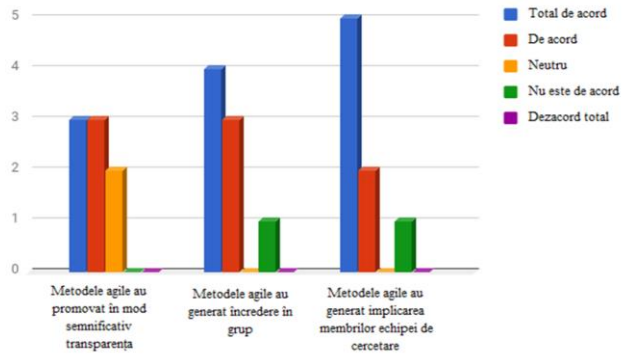

Fig. 1.2. Perceptions of the impact of agile methodologies on improving transparency, trust, and research team engagement – adapted [41]

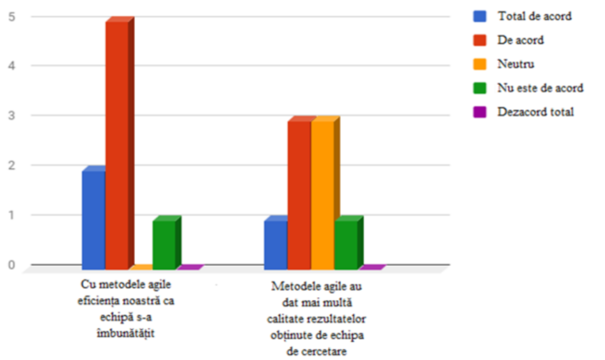

Fig. 1.3. Perceptions of the contribution of agile methods to increasing the efficiency and quality of results achieved by a research team – adapted [41]

The perceptions of the contribution of agile methods to the efficiency and quality of research are mixed (see Figure 1.3.). Although agile methods are recognized for improving team efficiency, their impact on the quality of work is less convincing. Agile approaches, which focus on incremental results and modules, do not always align with traditional research practices, which can affect the quality of documentation and dissemination of results [41,42].

Collaboration in teams plays a crucial role in research, considering that most knowledge is now generated by interdisciplinary teams. Studies show that collaboration in research brings multiple benefits, including increased citations and resource efficiency. However, collaboration can be complex and challenging, especially in geographically dispersed teams. Main challenges include engagement, transparency, and effective communication. Collaborative research requires careful coordination and advanced management techniques to handle complexity and ensure project success.

The "SCRUM" methodology was developed to support project management in software by breaking work into small tasks, completed in cycles called "sprints," and through regular meetings to track progress and adjust activities. Key features of "SCRUM" include built-in instability, self-organizing teams, overlapping development phases, continuous learning, subtle control, and organizational knowledge transfer. This methodology promotes transparency and collaboration within teams, being essential for improving teamwork and member motivation. The use of "sprints" and Kanban boards for visualizing progress are fundamental practices that contribute to optimizing resource allocation and facilitating effective task coordination. Although initially intended for software development, "SCRUM" proves valuable in other domains and organizations, demonstrating flexibility and efficiency in project management [43-55].

In the paper "Management of a Multidisciplinary Research Project: A Case Study on Adopting Agile Methods," the adoption of the "SCRUM" methodology was evaluated as an effective solution for managing research projects. Observations suggest that "SCRUM" provides flexibility, autonomy, and self-organization, essential for adapting to the complexity and frequent changes encountered in research projects. In the context of CECAN, the "SCRUM" method has proven useful for managing activities in an environment with numerous stakeholders and diverse rules, demonstrating its ability to respond to unforeseen events and regularly adjust activities. This adaptability is crucial in an organization with researchers from different institutions and with diverse responsibilities, where maintaining a systematic and cohesive framework can be challenging [42].

The literature emphasizes the importance of interactions and self-organization in research teams, highlighting the success of the "SCRUM" method within CECAN. It facilitated regular feedback and collaboration, adapting to project complexity and providing flexibility for ongoing adjustments. However, challenges related to self-organization and task distribution have been observed, indicating difficulties in strictly applying "SCRUM" in some contexts. The use of digital Kanban boards, such as Trello, has improved coordination and visibility of project progress, and agile methods have brought benefits to scientific research, although they require specific adaptations for each organization.

Chapter 2. Strategies and processes for developing innovative products

2.1. Digital innovation

In the era of digitization and technological innovation, companies must adapt their strategies to fully leverage the opportunities offered by new technologies. Digital innovation transforms not only products and processes but also business models, providing organizations with the ability to respond quickly to changes and to exploit the flexibility and generativity of digital technologies [56, 57]. This includes the convergence of functionalities and the reuse of resources to create innovative solutions within a collaborative ecosystem. Organizations are required to move from traditional approaches to innovative practices that promote collaboration and the combination of resources, thus offering adaptable solutions to the ever-changing market needs.

Implementing digital innovations requires a balance between optimizing existing processes and exploring new technologies, such as blockchain, which presents significant challenges and opportunities. In this context, exploring emerging technologies and evaluating their economic viability become essential for the effective integration of innovations into organizational activities and maintaining competitiveness in a constantly changing landscape [58].

2.2. Agile Project Management

Digitalization has amplified opportunities in innovation and entrepreneurship, facilitating access to resources and collaboration but also generating challenges, such as tensions between data protection and commercial interests. Future approaches must integrate multiple perspectives and develop balanced policies to support both innovation and the protection of rights in a sustainable manner [59].

Digital technologies transform resource exploitation and overcoming constraints, offering an integrated view of innovation. Agile management, originating from the software industry, is essential in dynamic environments, emphasizing flexibility and collaboration. Its success depends on the team's competencies and the integration of agile techniques with traditional methods, ensuring effective project management across various domains.

Agility theory highlights the importance of adaptability and flexibility in project management, especially in the context of rapid changes. Organizations must move beyond traditional approaches and adopt agile practices that promote close collaboration. Flexibility becomes essential, manifested through an organizational culture that supports innovation and continuous adaptation for the success of research and development projects.

The study on types of innovation and products highlighted significant diversity among participating professionals, coming from a wide range of sectors and functions. This diversity allowed for a comprehensive perspective on project and program management, reflecting the varied realities of different industries. The extensive experience of the participants, most of whom have over seven years of activity in the field, contributed to the depth of the analyses and conclusions. This multitude of viewpoints emphasizes the relevance of a diverse and well-grounded approach in understanding and applying innovation across different sectors [60].

Project analysis shows that one-third of these projects led to the development of new products, while the rest focused on software, technological solutions, or services. Innovation had a significant impact, either through new elements for the company or at the market level. Projects varied in pace, from "typical" to accelerated, and employed both traditional approaches and agile and hybrid methodologies, highlighting the need for adaptability and efficiency (see Figure 2.1.).

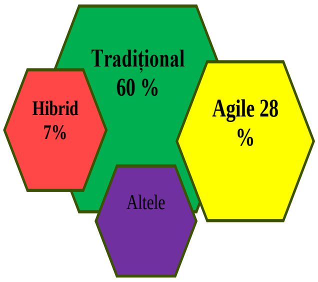

Fig. 2.1. Management method used for project management – adaptation [60]

This approach provides organizations with the flexibility needed to address the complex challenges of the current business environment. However, the effective implementation of these methods remains a challenge, especially outside of software development. However, the effective implementation of these methods remains a challenge, particularly outside the realm of software development.

Companies need to develop adaptable management strategies capable of responding to uncertainties and complexities efficiently. Expanding the use of agile methods and integrating them into a hybrid framework is an increasing trend, aimed at supporting innovation and improving project performance.
Industrial sector

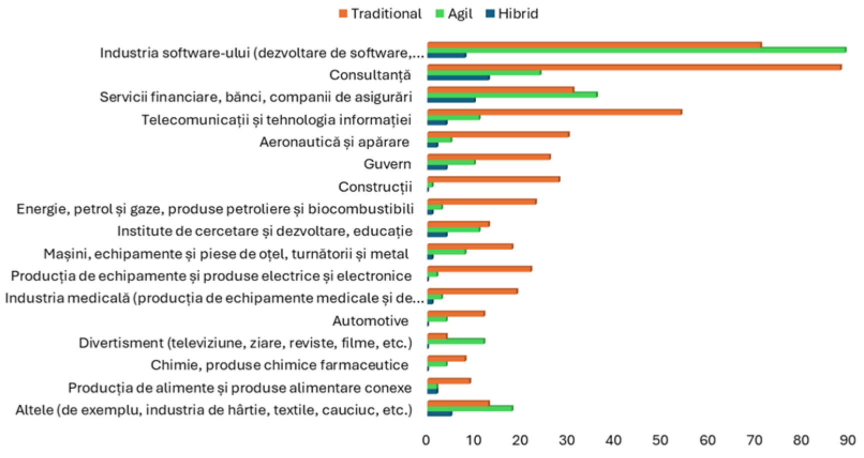

Fig. 2.2. Self-reported use of a management method (traditional; agile; hybrid) versus industrial sector – adapted [60]

The conclusions highlight the need for integrating hybrid approaches in project management, combining agile and traditional elements to ensure flexibility and rapid response to changes, especially in the industrial sector (see Figure 2.2.). Simplifying processes and using visual tools are essential for team clarity and accountability. Agility is a critical competence for innovative projects, requiring proactivity and constant collaboration. In a dynamic environment, organizations must develop hybrid management frameworks tailored to each project to maximize performance and results.

Chapter 3. Agile and open innovation: organizational agility, management methods, and case studies

3.1. Case study on the application of the "SCRUM" management method

The implementation of agile methods, especially "SCRUM," has proven essential in managing collaborative research projects, facilitating more efficient interaction among team members and better adaptability to changes. The RESTART_4Danube project illustrates the importance of these methods in urban revitalization, promoting transnational collaboration and strengthening ties between the public and private sectors. The integration of agile and hybrid approaches in project management thus becomes essential for success in complex and dynamic environments.

The adoption of the "SCRUM" method for the RESTART_4Danube project is justified by its complexity, involving 25 organizations from 12 countries, which requires a flexible structure for effective management. "SCRUM" facilitates collaboration and regular feedback, essential for coordinating complex activities, and allows adaptation to the specific needs of the project, avoiding excessive rigidity. Thus, "SCRUM" is suitable for coordination and adaptation in this complex international project.

The adoption of "SCRUM" in RESTART_4Danube focuses on managing the project's complexity through short sprints and self-organization, without additional formal training. The project manager, in the role of "SCRUM Master," coordinates the team and facilitates collaboration. Tools such as Excel and Trello are used to track progress and deliverables, with the Trello board organized into columns such as "To Do," "In Progress," and "Done" for transparency and efficiency.

In the RESTART_4Danube project, the "SCRUM" method was implemented gradually, adapting to the specific requirements of the project. Although it was not applied strictly according to software standards, it was used to organize and control activities through "sprints," with monthly meetings for progress monitoring. The concept of incremental development, initially intended for software applications, was modified to fit a complex collaborative project, using "minimum viable results" to evaluate and validate essential deliverables. This process allowed for the achievement of concrete and qualitative results in line with the established objectives.

In conclusion, the application of the "SCRUM" method in the RESTART_4Danube project demonstrated how agile principles can be adapted to the complex requirements of an interdisciplinary project. The method was implemented gradually, adjusted to fit the project's specifics, without external specialized training. Transforming the concept of "minimum viable product" into "minimum viable result" allowed for effective evaluation and validation of deliverables, thus ensuring the project's progress and success.

3.2. Case Study: "Crowd Engineering" and "Crowdsourcing" in Product Innovation

Engineering design of industrial systems using "crowdsourcing" is becoming increasingly popular for generating ideas and solving complex problems. It is important to balance maximizing resources with improving the quality of results and controlling costs. Although there is no integrated methodology for managing "crowd-based" initiatives, their integration brings challenges such as complex decisions and employees' reluctance to disclose knowledge. An organizational framework for using "crowdsourcing" includes selecting appropriate initiatives, making structural decisions, and designing suitable incentives (see Figure 3.1.).

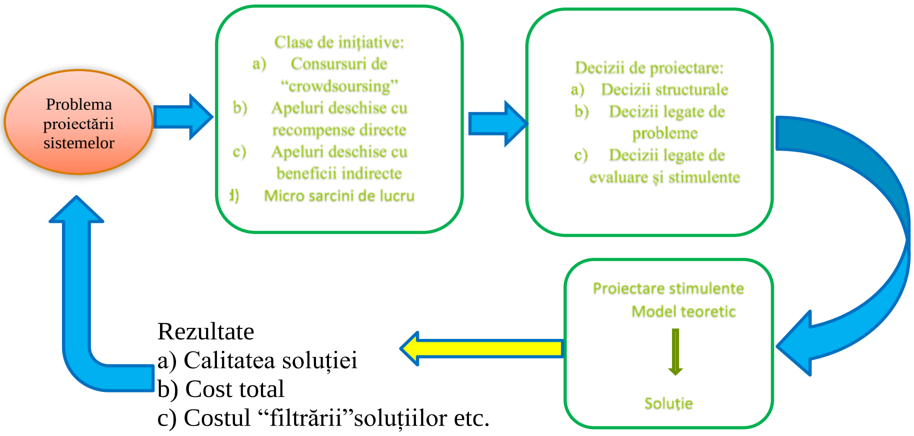

Fig. 3.1. Framework for using "Crowdsourcing" in engineering system design

In engineering design with "crowdsourcing," the process is divided into three stages: selecting the type of initiative, establishing the structure of the contest (phases, duration, constraints), and defining evaluation and reward methods. It is essential to clearly establish the distribution of prizes among team members and to include appropriate incentives to maximize results and reduce costs, with hackathons contributing to innovation and collaboration.

The "Crowd Engineering" method accelerates product development by integrating various external and internal perspectives, optimizing costs and time, and improving quality. Recent research analyzes the balance between traditional and agile methods in innovation, and the application of "Media Richness" theory has been tested in a practical case for developing an innovative product.

Table 3.1. Prototypes built by the daily sourcing & research team for polyol synthesis using unconventional energy and waste recycling

#	**Prototype description**	**Category**	**Prototype type**	**Prototype form**	**Purpose**	**Evaluator**
1	Analysis of the use of unconventional energy in energy-intensive industries, combined with recycling waste used as raw materials	Utility	Paper prototype[1]	Design prototype	Exploring technical solutions and opportunities	Development team and potential user
2	Design of the microwave heating reactor prototype	Utility	Paper prototype[2]	Design prototype	Exploring technical solutions	Interdisciplinary team
3	Manufacturing and testing of the microwave heating reactor prototype	Utility and technical feasibility	Laboratory prototype	Functional prototype	Manufacturing and testing microwave heating prototype	Interdisciplinary team
4	Testing the microwave heating reactor prototype for PET waste as raw material	Utility and technical feasibility	Laboratory prototype	Functional prototype	Testing microwave heating prototype with waste recycling	Interdisciplinary team

[1] "https://uxplanet.org/the-magic-of-paper-prototyping-51693eac6bc3"
[2] "https://uxplanet.org/the-magic-of-paper-prototyping-51693eac6bc3"

5	Trials with the microwave heating reactor prototype + alternative materials as raw material	Technical feasibility	Testing prototype and modifying reactor parameters in the laboratory	Functional Prototype	Testing prototype with alternative materials as raw material	Development team and potential user
6	Final testing of the reactor prototype	Technical feasibility	Testing prototype, modifying reactor parameters and additives used in polymerization	Functional Prototype	Final testing of the prototype	Development team and potential user
7	Final version of the reactor	Utility and technical feasibility	Final Prototype	Functional Prototype	Final inspection/acceptance	Potential user and development team

The development process of the microwave heating reactor involved several stages (see Table 3.1.), from the initial analysis of industrial applications and prototype design to manufacturing, testing, and optimizing it for PET waste and alternative materials recycling. The interdisciplinary team conducted successive tests to refine the prototype and achieve the final product with improved features, which was validated and accepted by the investor.

The "Crowd Engineering" (CE) method combined with iterative prototyping and "Media Richness" theory provides an effective solution for developing innovative products. The case study of Daily Sourcing & Research demonstrated the success of this method in creating an innovative product for unconventional energy recycling, highlighting the effectiveness of digital and collaborative approaches in the innovation process.

Chapter 4. Methods for assessing and improving the innovative and agile abilities of the research organization

4.1. IMP³rove innovation audit evaluation for a research organization in Romania

Launched in 2006 by the European Commission, IMP³rove supports SMEs in innovation management, enhancing competitiveness through assessments, consulting, and benchmarking, with a database covering a broad thematic spectrum (see Figure 4.1.). The project has demonstrated a positive long-term impact by optimizing business strategies, reducing costs, and facilitating access to international markets. IMP³rove also provides training and resources for consultants and intermediaries and assists financial actors through benchmarking reports that reduce investment risks and support the continuous improvement of performance.

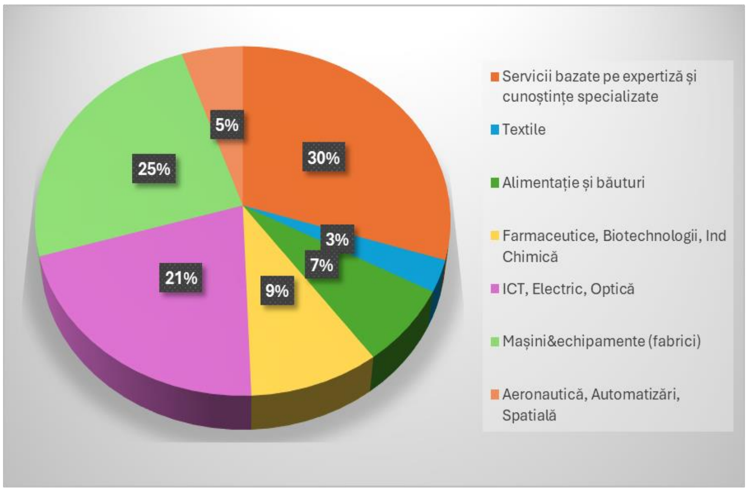

Fig. 4.1. Thematic distribution of the IMP³rove database; status as of November 3, 2009 – adapted [62]

For policy decision-makers, IMP³rove is a useful tool in the development and evaluation of support policies for innovation, providing valuable insights into the challenges and barriers faced by SMEs in innovation management.

IMP³rove is a sophisticated framework for assessing and improving innovation management within an organization. Through its three main stages—assessment, consulting, and follow-up—SMEs benefit from a detailed analysis of their innovation practices, identifying opportunities for improvement.

The results are documented in reports that serve as a basis for action plans and subsequent evaluations, thus contributing to sustainable impact and the continuous improvement of innovation management. The IMP³rove audit analyzes innovation management performance, including strategy, organizational culture, and innovative processes. The report details the organization's performance, providing scores and recommendations for improvement. The Spider Diagram illustrates areas of success and those requiring attention. The assessment is based on A.T. Kearney's "Innovation House" model, offering a detailed analysis for profitable growth [63].
IMP³rove helps organizations assess and improve innovation management, supporting sustainable and profitable development. The IMP³rove audit evaluates five dimensions of innovation management: Strategy, Organization and Culture, Processes, Facilitation Factors, and Results. It uses data from questionnaires and interviews, and the consultant aids in the correct interpretation of these.
The research organization in Romania received an overall score of 48% in innovation management effectiveness. The report compares performance with industry leaders and provides recommendations for improvement. The IMP³rove audit report for the transportation research organization in Romania cannot be included in the thesis appendices due to confidentiality and its

extensive volume. However, the analysis indicates that performance in innovation strategy is estimated at approximately 50% of the ideal value, and the characteristics of innovation strategies are at half the industry average (see Figure 4.2.). These observations suggest the need for significant improvements in the approach and implementation of innovation strategies.

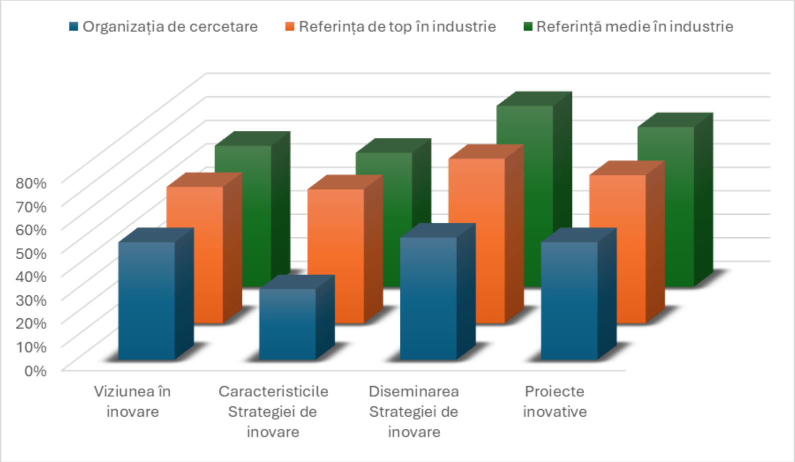

Fig.4.2. Evaluation of performance in terms of innovation strategy – excerpt from IMP³rove audit report

The IMP³rove report shows that the research organization in Romania has low performance in organizing and culture of innovation, with the exception of innovation partnerships, which are overstated. The innovation life cycle reveals low feedback and a minimal focus on radical innovation, with clear discrepancies between idea generation and implementation. Poor performance in continuous improvement suggests a more "technology push" approach. It is recommended to improve feedback, expand partnerships, and allocate more resources for long-term innovations, including developing radical ideas and increasing investment in research and development.

4.2. Evaluation of the Digital Innovation Quotient (DIQ) for a Research Organization in Romania

Digital Innovation Quotient (DIQ) assesses the maturity and performance of organizations in digital innovation by analyzing strategy, culture, processes, competencies, and results. It provides a clear picture of strengths and areas for improvement, with strategic recommendations for optimizing digital performance and making informed decisions, thus supporting long-term success. The DIQ audit for the research organization in Romania shows that it has an above-average score in digital innovation, reflecting solid performance compared to other international firms. The assessment, based on five essential dimensions (digital strategy, digital business model, digital processes, digital ecosystem, and support factors), suggests a favorable starting point for continuous improvement in digital innovation processes. The organization benefits from a strong foundation and a well-prepared team of specialists, providing significant opportunities for development.

The DIQ assessment for the research organization in Romania confirms its strong performance across most dimensions, including "Digital Innovation Strategy," "Digital Business Model," "Digital Processes," and "Digital Ecosystem and Culture," with above-average results. However, the dimension "Facilitation for Digital Innovation" shows a below-average score, indicating the need for improvements in resource management, cybersecurity, and KPIs. Overall, the organization has a solid foundation for digital innovation but needs to focus on optimizing deficient areas to maximize its competitive advantage.

4.3. Evaluation of the Corporate Sustainability Navigator (CSN) audit for a research organization in Romania

The Corporate Sustainability Navigator (CSN) assesses performance in corporate sustainability through four key dimensions: economic, social, environmental, and sustainable development management. CSN helps organizations identify gaps, align with industry standards, improve competitiveness, and ensure regulatory compliance. It is an essential tool for integrating sustainability into business strategies, thereby enhancing efficiency, reputation, and financial performance. The Corporate Sustainability Navigator (CSN) audit for the research organization in Romania indicates solid performance in corporate sustainability. The organization is above average compared to global benchmarks and sustainability leaders, demonstrating strengths in all four evaluated dimensions: economic, social, environmental, and sustainable development management. This evaluation highlights the competitive pressure to maintain and improve sustainability performance, providing a solid foundation for future strategies. The research organization has a below-average score in sustainability standards, indicating the need for additional efforts to improve performance. The dimensions "Profit," "People," "Planet," and "Sustainable Development Management" show that the organization needs to adopt more effective strategies to become more sustainable and competitive. Previous recommendations will be essential for addressing deficiencies and aligning with industry standards.

4.4. Self-assessment questionnaire on the agile approach of the research organization in Romania

The self-assessment questionnaire developed for this thesis provides a clear view of the organization's readiness for an iterative, user/beneficiary-focused agile approach. It allows for the evaluation of organizational culture, past experience, flexibility, and other key aspects, helping teams establish improvement objectives and monitor progress. The results will guide the expert in formulating conclusions and solutions, being essential for developing and piloting the hybrid method within the doctoral study. The questionnaire can be consulted in the doctoral thesis, with the summarized results presented in Figure 4.3. and analyzed in the following sections.

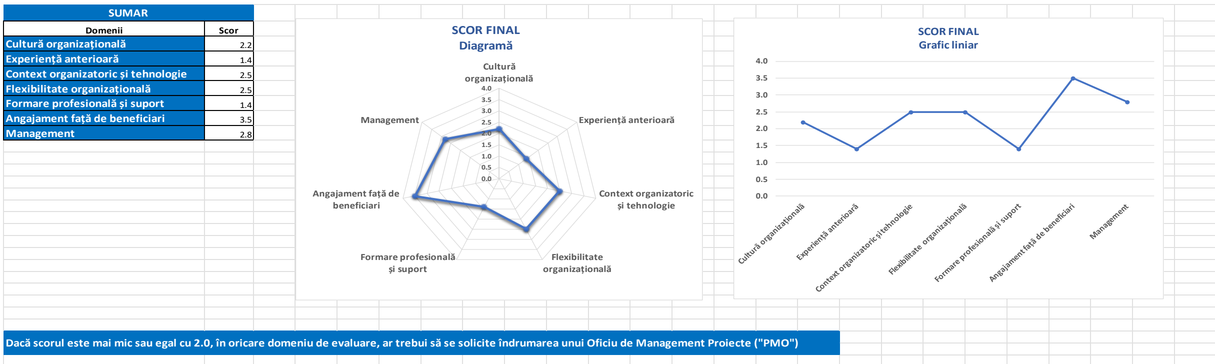

Fig. 4.3. Diagram and line chart resulting from the application of the self-assessment questionnaire

The organizational culture of the research organization shows strengths in interdisciplinary collaboration, team autonomy, and risk-taking but reveals significant gaps in leadership support and understanding of the challenges and costs of agile methods. Although there is a solid foundation for an agile and innovative environment, barriers related to insufficient leadership support and lack of awareness of difficulties could hinder an effective transition. It is essential for the organization to increase education and support to ensure a successful implementation of agile practices.

The research organization has limited experience with agile methodologies, scoring a total of 1 out of 4 points. While it has a good capacity for segmenting activities and well-documented processes, the lack of specialized resources and difficulties in resource management are significant obstacles. To successfully adopt agile methodologies, investment in staff training and improvements in project planning and execution are essential.

The research organization has a favorable context for implementing agile methodologies, with autonomous teams and adequate tools. However, it requires improvements, including the allocation of specialized resources to validate iterative cycles and greater management involvement in the selection of technical solutions. Addressing these areas will maximize the efficiency and success of the agile approach.

The research organization shows a moderate degree of organizational flexibility, with strengths in adjusting priorities and maintaining a balance between requirements and outcomes. However, it faces challenges in phased delivery and managing resistance to change. In addition, professional development and support for human resources are insufficient, with a low level of expertise and awareness among staff and leadership. To improve efficiency in implementing agile methodologies, the organization must address these challenges, develop internal competencies, and better support adaptability and efficient implementation.

The research organization has a strong commitment to its beneficiaries and a good management structure but needs to improve budget efficiency, integration of conclusions, and competencies in agile methods. By addressing these aspects, the organization will be able to maximize project success and beneficiary satisfaction.

The research organization has a solid foundation for agile methodologies but requires improvements in training, managerial support, and resource management. It is recommended to intensify training, actively engage management, and optimize resources to improve project implementation.

Chapter 5. Methods for evaluating innovative products and technologies

The development of "Methods for Evaluating Innovative Products and Technologies," which also includes published elements by the author [61, 64], is as follows.

5.1. Introduction

Evaluating innovative products is essential for their success, involving technical testing, market analysis, and economic assessment. The main goal is to ensure that the product meets quality standards and aligns with market needs. The evaluation of technological readiness measures how well a technology can be integrated into an existing system, including both the maturity of the product and its implementation capability. A rigorous and systematic analysis is necessary to minimize risks and maximize long-term success.

Technology Readiness Level (TRL) evaluates the progress of a technology from research to full implementation, ranging from basic research (TRL 1) to fully operational technology (TRL 9). Complementarily, the Market Readiness Level (MRL) measures the readiness of a product for commercialization, from market identification (MRL 1) to market success (MRL 9). By integrating TRL and MRL, organizations can comprehensively assess both the technological viability and the commercial success of innovative products.

The Regulatory Readiness Level (RRL) measures a product's compliance with legal regulations, from identifying requirements (RRL 1) to final approvals (RRL 9), while the Acceptance Readiness Level (ARL) evaluates the social acceptance of the technology, from negative perception (ARL 1) to full acceptance (ARL 9), ensuring a complete and efficient integration into the market and society.

Organizational Readiness Level (ORL) evaluates an organization's readiness to integrate a new technology, from initial resistance to change (ORL 1) to full and functional integration (ORL 9), while the Commercial Readiness Index (CRI) analyzes the commercial maturity of emerging technologies, including regulatory, acceptance, technical, and financial performance aspects, to ensure market success.

A multidimensional evaluation of innovative products and technologies is essential to obtain a complete picture of their development and implementation stages. This approach addresses aspects such as technological progress, market readiness, legal compliance, social acceptance, and integration challenges, using six key dimensions: TRL, MRL, RRL, ARL, ORL, and CRI. A detailed and balanced assessment helps identify barriers and areas that require attention, facilitating informed decisions and efficient implementation of innovative technologies.

The "Aggregated Readiness Level" (AgRL) method combines various readiness/maturity metrics to provide a holistic evaluation of an innovative product. This approach allows a detailed assessment of the product's technological and commercial stages, emphasizing the importance of global optimization rather than the individual improvement of each sub-metric. AgRL facilitates informed decision-making and helps maximize overall readiness/maturity, thereby increasing the chances of success in the target market.

5.2. Case Study – Innovative Product Littar® – Asphalt Mixture for Road Applications

To illustrate the application of the readiness/maturity level evaluation methodology, we aim to analyze a specific case study: an innovative product, specifically an asphalt mixture intended for road construction. This material stands out by integrating granular-shaped particles derived from glass and plastic waste, alongside conventional mineral aggregates (such as rock aggregates and fillers).

The Littar® case study illustrates the application of the readiness/maturity level evaluation methodology in an innovative context. Littar® is an advanced asphalt mixture that integrates glass and plastic particles into traditional mineral aggregates. The manufacturing process, which includes mixing the glass with aggregates and filler at controlled temperatures and adding bitumen and plastic, produces a material with superior performance compared to conventional asphalt.

This technology addresses environmental issues by transforming plastic and glass waste into a valuable material for road construction, contributing to the reduction of ecological impact and improving recycling efficiency. Littar® not only optimizes the characteristics of asphalt but also offers a sustainable solution for waste management and infrastructure development [66].

Fig. 5.1. (a): Cylindrical Littar® test sample – (b): Littar® in an optimal road structure – adapted from [66]

Littar® is an innovative asphalt mixture that utilizes plastic and glass waste, with lower density and weight compared to traditional asphalt (see Figure 5.1.). This reduces transport costs and carbon emissions, requiring 18% fewer trucks for a 1-kilometer road and decreasing CO2 emissions by 1046 tons. The manufacturing process integrates easily into existing plants and has a reduced environmental impact [66].

The evaluation using the "Aggregated Readiness Level" (AgRL) method showed an overall Multi-Index Analysis (MIA) score of 5, indicating performance limited by technological maturity (TRL) and highlighting the importance of a balanced assessment in product development [64, 65].

Littar® is at an intermediate stage of development. With a TRL of 5, the product has been tested but not fully validated in real-world environments; an MRL of 4 indicates market readiness but requires additional strategies; RRL and ARL, both at 3, suggest the product needs to meet regulations and undergo large-scale testing; ORL of 3 shows that the organization needs to improve its readiness. These scores emphasize the need for further efforts in all areas to achieve full maturity and commercial success. The AgRL / MIA methodology helps identify and correct imbalances in product development, facilitating a more efficient market launch [64, 65].

Littar® received a CRI score of 1, indicating early commercial readiness and the need for significant improvements in marketing and distribution strategies. Additionally, the MIA score of 5 reflects limited technological maturity, affecting commercial readiness.

To progress, Littar® must develop more effective market strategies, ensure compliance with legal regulations, and continue technological testing and optimization. These measures are essential to improving commercial readiness and maximizing market potential.

Chapter 6. Development of hybrid management models for R&D projects. Morphological Analysis Matrix for improving maturity indicators and transition from CRI1 to CRI2 in the case of Littar®

The development of "Hybrid Management Models for R&D Projects. Morphological Analysis Matrix for Improving Maturity Indicators and Transition from CRI1 to CRI2 in the case of Littar®," which includes published elements by the author [61,64,67], is outlined as follows.

6.1. Project PROPOSAL FOR IMPROVING THE Commercial Readiness Index (CRI) for Littar® - Case study

Littar® is currently at an early stage of commercial readiness (CRI 1), requiring significant investments in marketing, distribution, and technological validation. To advance to a higher level of commercial maturity (CRI 2), attracting investments and optimizing regulatory frameworks are crucial.

The maturity analysis of Littar® indicates that it is at the initial stage of CRI 1, with all key dimensions—TRL, MRL, RRL, ARL, and ORL—at a basic level. To progress to CRI 2 and prepare the product for subsequent stages, significant investments and additional efforts are needed, particularly in the areas of regulation and organizational readiness. In conclusion, future progress depends on continued investments and improvements to increase the technological and commercial maturity of Littar®.

Currently, Littar® is at a commercial readiness level (CRI 1), indicating that it is still in the preliminary testing phase, without proven market value. The project proposal aims to advance to CRI 2, focusing on technological development and strengthening regulatory and organizational aspects. This progress will facilitate the integration of Littar® into road infrastructure projects, leveraging its environmental potential and contributing to CO_2 emissions reduction by using recycled materials in road construction.

Littar® will reach CRI 2, the "Commercial Trial" phase, indicating that the technology is fully developed and validated but requires further testing and validation under real commercial conditions. To achieve full maturity, the product must attract private investment and continue to comply with national and international regulations. Managing technological, legal, and marketing risks is essential for commercial success, and an effective communication strategy is crucial for reducing socio-economic resistance and facilitating the product's widespread adoption.

The case study highlighted the challenges and opportunities related to applying the CRI (Commercial Readiness Index) methodology to evaluate the commercial maturity of Littar®. Currently, Littar® is at CRI 1, and the company aims to progress to CRI 2 to ensure an efficient market launch. The CRI framework allowed for identifying key performance indicators and major barriers, facilitating the development of a clear action plan to improve product maturity and overcome technological and commercial challenges.

6.2. Hybrid project management. Models

In project management, the "waterfall" and "agile" methods represent two essential approaches, each with distinct advantages. The waterfall method offers a linear and predictable structure, ideal for projects with stable requirements, while the agile method is characterized by flexibility and adaptability, favoring iterative delivery and quick adjustments to changes. In practice, many organizations opt for hybrid models that combine aspects of both methods to more effectively address the complexity and variability of modern projects. Adapting these models to the specific context of a project is crucial for success.

In the current context, traditional management approaches prove to be limited when faced with a dynamic and unpredictable socio-economic environment. Within this framework, the development and testing of a new method for generating customized hybrid models is proposed, using a morphological analysis matrix. This method will be tested through a case study and will offer professionals a guide for identifying and implementing the most suitable practices. Although hybrid models provide a flexible solution for various projects, they require customization to strike a balance between flexibility and control. The proposed method aims to facilitate this customization by offering tailored solutions to meet the specific needs of projects and organizations.

The development of the method includes the validation of management tools by an expert, ensuring that they are relevant, functional, and adaptable. Feasibility is assessed through a case study in a research organization, analyzing readiness for agile approaches. In conclusion, hybrid methods, which combine agile and traditional aspects, are essential for project success in dynamic environments.

The creation of hybrid models requires the evaluation of organizational, team, product, and project characteristics to tailor management solutions. The morphological matrix aids in selecting and customizing management practices, offering a flexible framework that can be adjusted based on the specific needs of each project and organization [68, 69].

The development of hybrid management models occurs in four steps: customizing the morphological matrix to reflect the specifics of the organization and project, selecting and analyzing the project or group of projects, using a questionnaire to assess project characteristics, and finally, selecting and organizing the appropriate management practices based on the collected data. This process allows for the development of management solutions tailored to the specific needs of each project.

6.3. Customizing the Morphological Matrix for a case study in hybrid project management

In the process of developing hybrid models, the research organization analyzed is shown to be capable of using both classic planning and agile methods for project structuring. In terms of project objectives, the organization can adjust plans to meet new requirements, but most projects follow a classic "waterfall" model. These aspects are reflected in the morphological matrix, highlighting the applicability of a hybrid model adapted to the organization's specifics.

The research organization is able to adjust project priorities and activities based on updated information, but predominantly relies on traditional and partially hybrid methods for managing deliverables and innovation processes. Project monitoring and control are performed efficiently, with clear managerial principles and a balance between project requirements and the results achieved. However, resources for agile implementation are limited, and client involvement is positively evaluated in the context of agile processes. Overall, the organization primarily adopts traditional management models, with some hybrid and agile elements, as reflected in the assessments from the IMP³rove audit (see Table 6.1.).

Table 6.1. The Morphological Matrix of project management practices, for the Case Study – adapted [70]

+Adaptability, predictability, and standardization

+Adaptability, predictability, and responsiveness

Practici/ grupuri de acțiuni		A		B		C		D
Structura planului proiectului	Tipuri de plan	1.Planificare (Gantt)	Tipuri de plan	1.Planificare (Gantt) 2.”Backlog ul” produsului 3. ”Sprint backlog”	Tipuri de plan	1.Viziune 2.Produsul”Backlog ului” 3. ”Sprint backlog”	Tipuri de plan	1. Kanban
Descrierea scopului proiectului	Format	Scopul proiectului	Format	Obiective și viziunea proiectului	Format	Business Model Canvas al proiectului	Format	Viziunea proiectului
	Conținut	- Toate informațiile proiectului în detaliu -Posibile reguli contractuale	Conținut	- Informații de proiect pe care echipa le consideră importante - Viziunea proiectului	Conținut	- Componente logice și vizuale ale poriectului - Organizare vizuală și logică a proiectului în blocuri de întrebări	Conținut	-Descriere metaforică și ambiguă folosind instrumente și tehnici vizuale
Defalcarea activităților proiectului	Format	Structura proiectului defalcată pe activități	Format	Sarcini/activități	Format	Descrierea activităților	Format	Obiectivele proiectului
	Conținut	-Activitatile au coduri și sunt clasificate în pachete de lucru, livrabile și produse	Conținut	- De fiecare pachet de lucru se ocupă o personě desemnată, chiar dacă este ajutată de echipă	Conținut	-Explicații scurte pentru a specifica ceea ce trebuie realizat pentru ca produsul fie calitativ și ceea ce dorește utilizatorului	Conținut	-O descriere detaliată și clară a cerințelor clientului, care are o valoare semnificativă pentru proiect
Monitorizarea și controlul proiectului	Indicatori	Cost, timp si progres exprimat in %	Indicatori	Cost, timp și livrabile parțiale	Indicatori	% de completare a activităților	Indicatori	Livrabile parțiale, prototipuri, demostrații, schițe/desene
	Rapoarte	Rapoarte cu indicatori de performanță, documente scrise, audituri și analize ale fazelor de tranzație	Rapoarte	Rapoarte cu indicatori de performanță, documente scrise, și instrumente vizuale (postere, fotografii, notițe – post-it-uri, etc.)	Rapoarte	Tablouri vizuale care indică progresul proiectului	Rapoarte	Nu folosește rapoarte, ci doar artefacte (instrumente) vizuale care indică progresul proiectului.
	Întâlniri de proiect	-Formale -Întâlniri rare	Întâlniri de proiect	-Formal și informal -Întâlniri frecvente	Întâlniri de proiect	-Informal -Întâlniri regulate SCRUM (sprinturi)	Întâlniri de proiect	-Informal -Întâlniri regulate SCRUM (sprinturi)
	Frecvență	La semnarea contractului și la finalizarea acestuia	Frecvență	La semnarea contractului, la etape și la livrarea finală	Frecvență	Săptămânal	Frecvență	Zilnic

Implicarea clientului	Interacțiune	-Minimum - Managerul de proiect completează sau modifică activitățile proiectului pentru a se conforma scopului acestuia	Interacțiune	- Minimum - Clienții evaluează progresul proiectului la fiecare etapă	Interacțiune	-Ridicat - Echipa evaluează propunerile clienților și modificările activităților asigurându-se de calitatea proiectului și de satisfacția clientului	Interacțiune	-Foarte ridicat -Clientul evaluează, prioritizează, aduce îmbunătățiri sau modifică produsul -Echipa schimbă/modifică activitățile pentru a obține rezultatele așteptate de client
Resursele și durata estimată	Formal	Plata activităților și orele de muncă/persoană	N/A		N/A		Formal	Suma necesară pentru a angaja un anumit număr de persoane, astfel încât să se atingă viteza de lucru necesară pentru finalizarea proiectului
	Tehnic	Estimarea parametrică, analogică pentru trei etape					Tehnic	Opinie specializată

The conclusion of the audits highlights that there are no one-size-fits-all solutions for the effective implementation of management practices, whether traditional, agile, or hybrid. Instead, the final decision is based on a complex assessment of the specific factors, uncertainties, and risks of each organization and project. This underscores the importance of an adaptable and informed approach in choosing work methodologies. In the next chapter of the thesis, the connections between the use of hybrid management models in applied research and decision support algorithms for optimal decisions will be explored.

Chapter 7. Decision-making algorithm for analyzing the development process of a new asphalt mix

The design of a decision-making algorithm for analyzing the development process of a new asphalt mix, specifically Littar®, which includes elements published by the author [71], is as follows.

7.1. Context and optimization models

In the analysis of innovative product development, multicriteria methods and mathematical decision-making algorithms are essential for evaluating and optimizing the process, thus ensuring a systematic and objective approach that enhances success in a competitive market. The construction industry adopts innovative solutions for reducing emissions, such as recycling asphalt pavement and plastic and glass waste, contributing to resource conservation and CO2 emission reduction. This doctoral thesis proposes a decision algorithm for evaluating the impact of these measures, supporting informed decision-making under conditions of uncertainty.

Implementing group decision-making under uncertainty involves several stages: defining the problem, identifying and evaluating alternatives, establishing possible states of the environment, selecting experts and determining their weights, evaluating alternatives according to experts' opinions, and using optimization criteria such as Laplace and Hurwicz. The Laplace and Hurwicz algorithms aid in decision optimization through different approaches: Laplace treats all scenarios with equal importance, while Hurwicz combines the best and worst outcomes, adjusting according to the coefficient of optimism. Performance analysis, including cost and emission reductions, supports informed decision-making and reduces uncertainty, thus facilitating the selection of the most suitable alternative.

7.2. Modified Laplace and Hurwicz algorithms in decision optimization for developing Littar® in the context of "scenarios" and "alternatives" selection and data analysis

In decision-making, options are evaluated using utility functions and specific algorithms such as modified Laplace and Hurwicz, employing "sums" in calculation formulas to reflect the idea of "accumulation," e.g., of "performance indicators" from the proposed "scenarios." The Laplace model considers scenarios as having equal probabilities and selects the option with the highest average value, while the Hurwicz model adjusts the evaluation using an optimism coefficient. The study analyzes three alternatives and scenarios, using performance indicators and analytical methods to determine the optimal option. The modified algorithms allow for a more comprehensive evaluation of options.

In this doctoral thesis, we evaluate options for optimizing new asphalt mixes, focusing on reducing production, transportation costs, and CO2 emissions. We analyze these options using performance scenarios and specific indicators. Scenarios are evaluated for cost and emission reduction objectives, and data are structured according to different levels of technological and market maturity.

We apply decision algorithms such as Laplace and Hurwicz to determine the most effective options. The Laplace algorithm suggests ideal scenarios for different contribution weights, such as technological or marketing management (see Tables 7.1. and 7.2.). Ideal scenarios vary based on decision-makers' experience and the product's maturity level. The conclusions also highlight the importance of adapting management strategies (waterfall, agile, hybrid) according to the specific context of product development and established performance objectives.

Table 7.1.Results of application of modified Laplace algorithm in Cases I.1 and I.2

		Performanță ("reduceri") Ri,j (%)			Formula Ri,j ^ (ie) (%)				Formula Ri,j ^ (ie) (%)				
RL Eie preconizat (ie=1÷3)	Alternative pentru „reduceri" Ai (i=1÷3)	Scenarii pentru evoluția performanței Sj (j=1÷3)			S1	S2	S3	Cazul I.1	S1	S2	S3	Cazul I.2	
		S1 - Creștere	S2 - Reducere	S3 - medie (S1,S2)	Ri,1 ^ (1)	Ri,2 ^ (2)	Ri,3 ^ (3)	Cel mai bun EV din formulă (Ai)	Ri,1 ^ (1)	Ri,2 ^ (2)	Ri,3 ^ (3)	Cel mai bun EV din formulă (Ai)	Alternative pentru „reduceri"
E1	A1	6.00	4.00	5.00	2.25	5.25	7.50	7.50	3.00	9.00	3.00	9.00	A1
	A2	19.00	17.00	18.00	8.10	18.90	27.00	27.00	10.80	32.40	10.80	32.40	A2
	A3	84.00	82.00	83.00	37.35	87.15	124.50	124.50	49.80	149.40	49.80	149.40	A3
E2	A1	7.00	3.00	5.00	2.25	5.25	7.50		3.00	9.00	3.00		
	A2	20.00	16.00	18.00	8.10	18.90	27.00		10.80	32.40	10.80		
	A3	85.00	81.00	83.00	37.35	87.15	124.50		49.80	149.40	49.80		
E3	A1	8.00	2.00	5.00	2.25	5.25	7.50		3.00	9.00	3.00		
	A2	21.00	15.00	18.00	8.10	18.90	27.00		10.80	32.40	10.80		
	A3	86.00	80.00	83.00	37.35	87.15	124.50		49.80	149.40	49.80		

Table 7.2. Results of application of modified Laplace algorithm in Cases II.1 and II.2

		Performanță ("reduceri") Ri,j (%)			Formula Ri,j ^ (ie) (%)				Formula Ri,j ^ (ie) (%)				
RL Eie preconizat (ie=1÷3)	Alternative pentru „reduceri" Ai (i=1÷3)	Scenarii pentru evoluția performanței Sj (j=1÷3)			S1	S2	S3	Cazul II.1	S1	S2	S3	Cazul II.2	
		S1 - Creștere	S2 - Reducere	S3 - medie (S1,S2)	Ri,1 ^ (1)	Ri,2 ^ (2)	Ri,3 ^ (3)	Cel mai bun EV din formulă (Ai)	Ri,1 ^ (1)	Ri,2 ^ (2)	Ri,3 ^ (3)	Cel mai bun EV din formulă (Ai)	Alternative pentru „reduceri"
E1	A1	6.00	4.00	5.00	2.25	5.25	7.50	7.50	9.00	3.00	3.00	9.00	A1
	A2	19.00	17.00	18.00	8.10	18.90	27.00	27.00	32.40	10.80	10.80	32.40	A2
	A3	84.00	82.00	83.00	37.35	87.15	124.50	124.50	149.40	49.80	49.80	149.40	A3
E2	A1	7.00	3.00	5.00	2.25	5.25	7.50		9.00	3.00	3.00		
	A2	20.00	16.00	18.00	8.10	18.90	27.00		32.40	10.80	10.80		
	A3	85.00	81.00	83.00	37.35	87.15	124.50		149.40	49.80	49.80		
E3	A1	8.00	2.00	5.00	2.25	5.25	7.50		9.00	3.00	3.00		
	A2	21.00	15.00	18.00	8.10	18.90	27.00		32.40	10.80	10.80		
	A3	86.00	80.00	83.00	37.35	87.15	124.50		149.40	49.80	49.80		

The modified Hurwicz algorithm is applied based on the values obtained with the Laplace algorithm, focusing on combinations of contribution degrees with the highest weights. Three distinct cases are analyzed (III.1, III.2, and III.3), each with different optimism and pessimism coefficients.

Case III.1: The maximum optimism coefficient is 0.7 (corresponding to MRL), and the optimal scenario is S2, which suggests a reduction in the assumed targets for cost and CO2 emission reduction. The recommended management type is “waterfall” for TRL and ORL, “agile” for MRL and ARL, and “hybrid” for CRI (see Table 7.3).

Case III.2: The maximum optimism coefficient is 0.7 (corresponding to TRL), and the optimal scenario is S1, which aims to increase the assumed targets. The recommended management type is “waterfall” for TRL, RRL, and ORL, “agile” for ARL, and “hybrid” for CRI (see Table 7.4).

Case III.3: The maximum optimism coefficient is 0.7 (corresponding to RRL, ARL, ORL, and CRI), and the optimal scenario is S3, which maintains the assumed targets without requiring expertise in marketing or technological development. The recommended management type is “waterfall” for RRL and ORL, “agile” for ARL, and “hybrid” for CRI (see Table 7.5).

In conclusion, the application of the modified Hurwicz algorithm helps identify the optimal scenario and choose the appropriate management approach based on the predominant contribution of the decision-makers and the optimism coefficient.

Table 7.3. Results of applying the modified Hurwicz algorithm for case III.1

		Performanță ("reduceri") Ri,j (%)			Formula Ri,j ^ (ie) (%)			Cazul III.1		
RL Eie preconizat (ie=1÷3)	Alternative pentru „reduceri" Ai (i=1÷3)	Scenarii pentru evoluția performanței Sj (j=1÷3)			S1	S2	S3	S1-Mărire	S2-Reducere	S3-Medie (S1, S2)
		S1-Mărire	S2-Reducere	S3-Medie (S1, S2)	Ri,1 ^ (1)	Ri,2 ^ (2)	Ri,3 ^ (3)	α = 0,4, Formula Hi,j ^ (ie) (%)	α = 0,7, Formula Hi,j ^ (ie) (%)	α = 0,15, Formula Hi,j ^ (ie) (%)
E1	A1	6.00	4.00	5.00	2.25	5.25	7.50	4.35	5.93	3.04
	A2	19.00	17.00	18.00	8.10	18.90	27.00	15.66	21.33	10.94
	A3	84.00	82.00	83.00	37.35	87.15	124.50	72.21	98.36	50.42
E2	A1	7.00	3.00	5.00	2.25	5.25	7.50	4.35	5.93	3.04
	A2	20.00	16.00	18.00	8.10	18.90	27.00	15.66	21.33	10.94
	A3	85.00	81.00	83.00	37.35	87.15	124.50	72.21	98.36	50.42
E3	A1	8.00	2.00	5.00	2.25	5.25	7.50	4.35	5.93	3.04
	A2	21.00	15.00	18.00	8.10	18.90	27.00	15.66	21.33	10.94
	A3	86.00	80.00	83.00	37.35	87.15	124.50	72.21	98.36	50.42

Table 7.4. Results of applying the modified Hurwicz algorithm for case III.2

		Performanță ("reduceri") Ri,j (%)			Formula Ri,j ^ (ie) (%)			Cazul III.2		
RL Eie preconizat (ie=1÷3)	Alternative pentru „reduceri" Ai (i=1÷3)	Scenarii pentru evoluția performanței Sj (j=1÷3)			S1	S2	S3	S1-Mărire	S2-Reducere	S3-Medie(S1,S2)
		S1-Mărire	S2-Reducere	S3-Medie(S1,S2)	Ri,1 ^ (1)	Ri,2 ^ (2)	Ri,3 ^ (3)	α = 0.7, Formula Hi,j ^ (ie) (%)	α = 0.4, Formula Hi,j ^ (ie) (%)	α = 0.15, Formula Hi,j ^ (ie) (%)
E1	A1	6.00	4.00	5.00	2.25	5.25	7.50	5.93	4.35	3.04
	A2	19.00	17.00	18.00	8.10	18.90	27.00	21.33	15.66	10.94
	A3	84.00	82.00	83.00	37.35	87.15	124.50	98.36	72.21	50.42
E2	A1	7.00	3.00	5.00	2.25	5.25	7.50	5.93	4.35	3.04
	A2	20.00	16.00	18.00	8.10	18.90	27.00	21.33	15.66	10.94
	A3	85.00	81.00	83.00	37.35	87.15	124.50	98.36	72.21	50.42
E3	A1	8.00	2.00	5.00	2.25	5.25	7.50	5.93	4.35	3.04
	A2	21.00	15.00	18.00	8.10	18.90	27.00	21.33	15.66	10.94
	A3	86.00	80.00	83.00	37.35	87.15	124.50	98.36	72.21	50.42

Table 7.5. Results of applying the modified Hurwicz algorithm for case III.3

		Performanță ("reduceri") Ri,j (%)			Formula Ri,j ^ (ie) (%)			Cazul III.3		
RL Eie preconizat (ie=1÷3)	Alternative pentru „reduceri" Ai (i=1÷3)	Scenarii pentru evoluția performanței Sj (j=1÷3)			S1	S2	S3	S1-Mărire	S2-Reducere	S3-Medie (S1,S2)
		S1-Mărire	S2-Reducere	S3-Medie (S1,S2)	Ri,1 ^ (1)	Ri,2 ^ (2)	Ri,3 ^ (3)	α = 0.7, Formula Hi,j ^ (ie) (%)	α = 0.4, Formula Hi,j ^ (ie) (%)	α = 0.15, Formula Hi,j ^ (ie) (%)
E1	A1	6.00	4.00	5.00	2.25	5.25	7.50	3.04	4.35	5.93
	A2	19.00	17.00	18.00	8.10	18.90	27.00	10.94	15.66	21.33
	A3	84.00	82.00	83.00	37.35	87.15	124.50	50.42	72.21	98.36
E2	A1	7.00	3.00	5.00	2.25	5.25	7.50	3.04	4.35	5.93
	A2	20.00	16.00	18.00	8.10	18.90	27.00	10.94	15.66	21.33
	A3	85.00	81.00	83.00	37.35	87.15	124.50	50.42	72.21	98.36
E3	A1	8.00	2.00	5.00	2.25	5.25	7.50	3.04	4.35	5.93
	A2	21.00	15.00	18.00	8.10	18.90	27.00	10.94	15.66	21.33
	A3	86.00	80.00	83.00	37.35	87.15	124.50	50.42	72.21	98.36

7.3. Classic Laplace and Hurwicz algorithms (classic and modified) in optimizing decisions for the development of Littar®, using "alternatives" logic for fulfilling "scenarios" of work and analysis of calculated data

The classic Laplace algorithm is used to optimize decisions based on two sets of "contribution degree" weights (see Table 7.6 – Cases 1 and 2). In the first case, the weights are TRL (0.15), MRL (0.35), and RRL/ARL/ORL/CRI (0.50), while in the second case, they are TRL (0.50), MRL (0.30), and RRL/ARL/ORL/CRI (0.20). Performance indicators are normalized, and the algorithm is applied to determine the optimal values. Results show that, in the first case, the optimal alternative is A3 (reduction of CO_2 emissions) with a value of 99.76, whereas, in the second case, the optimal alternative is A7 (reduction of production costs) with a value of 112.00. Interpretation of the results suggests that in the first case, CO_2 emission reduction is recommended due to technological experience, while in the second case, reduction of production costs is recommended due to managerial skills. The classic Laplace algorithm is also available in WinQSB, with results consistent with those obtained manually. The recommended management varies between "waterfall" for technological development and "agile" for managerial aspects.

Table 7.6. Results of applying the classic Laplace algorithm, in cases 1 and 2

		Performanță ("reduceri") Ri,j (%)			Formula Ri,j ^ (ie) (%)				Formula Ri,j ^ (ie) (%)				
RL Eie preconizat (ie=1÷3)	Alternative pentru „reduceri" Ai (i=1÷9)	Scenarii pentru evoluția performanței Sj (j=1÷3)			S1	S2	S3	Cazul 1	S1	S2	S3	Cazul 2	
		S1 - Creștere	S2 - Reducere	S3 - medie (S1,S2)	Ri,1 ^ (1)	Ri,2 ^ (2)	Ri,3 ^ (3)	Cel mai bun EV din formulă (Ai)	Ri,1 ^ (1)	Ri,2 ^ (2)	Ri,3 ^ (3)	Cel mai bun EV din formulă (Ai)	Alternative pentru „reduceri"
E1	A1	120.00	80.00	100.00	18.00	28.00	50.00	96.00	60.00	24.00	20.00	104.00	A1
	A2	105.56	94.44	100.00	15.83	33.06	50.00	98.89	52.78	28.33	20.00	101.11	A2
	A3	101.20	98.80	100.00	15.18	34.58	50.00	99.76	50.60	29.64	20.00	100.24	A3
E2	A4	140.00	60.00	100.00	21.00	21.00	50.00	92.00	70.00	18.00	20.00	108.00	A4
	A5	111.11	88.89	100.00	16.67	31.11	50.00	97.78	55.56	26.67	20.00	102.22	A5
	A6	102.41	97.59	100.00	15.36	34.16	50.00	99.52	51.20	29.28	20.00	100.48	A6
E3	A7	160.00	40.00	100.00	24.00	14.00	50.00	88.00	80.00	12.00	20.00	112.00	A7
	A8	116.67	83.33	100.00	17.50	29.17	50.00	96.67	58.33	25.00	20.00	103.33	A8
	A9	103.61	96.39	100.00	15.54	33.73	50.00	99.28	51.81	28.92	20.00	100.72	A9

The application of the modified Hurwicz algorithm leads to the following results, presented in Tables 7.7 (Set 1 Coefficients λ + Set 1 Coefficients α) and 7.8 (Set 2 Coefficients λ + Set 2 Coefficients α).

Table 7.7. Results of applying the modified Hurwicz Algorithm, for Set 1 coefficients λ + Set 1 coefficients α

		Performanță ("reduceri") Ri,j (%)			Formula Ri,j ^ (ie) (%)			Setul 1 coeficienți λ + Setul 1 coeficienți α		
RL Eie preconizat (ie=1÷3)	Alternative pentru „reduceri" Ai (i=1÷9)	Scenarii pentru evoluția performanței Sj (j=1÷3)			S1	S2	S3	S1-Mărire	S2-Reducere	S3-Medie (S1, S2)
		S1-Mărire	S2-Reducere	S3-Medie (S1, S2)	Ri,1 ^ (1)	Ri,2 ^ (2)	Ri,3 ^ (3)	α = 0,4, Formula Hi,j ^ (ie) (%)	α = 0,7, Formula Hi,j ^ (ie) (%)	α = 0,4, Formula Hi,j ^ (ie) (%)
E1	A1	120.00	80.00	100.00	49.01	40.99	45.00	44.20	46.61	44.20
	A2	105.56	94.44	100.00	114.37	95.63	105.00	103.13	108.75	103.13
	A3	101.20	98.80	100.00	163.38	136.62	150.00	147.32	155.35	147.32
E2	A4	140.00	60.00	100.00	53.03	36.97	45.00	43.39	48.21	43.39
	A5	111.11	88.89	100.00	123.73	86.27	105.00	101.25	112.49	101.25
	A6	102.41	97.59	100.00	176.76	123.24	150.00	144.65	160.70	144.65
E3	A7	160.00	40.00	100.00	57.04	32.96	45.00	42.59	49.82	42.59
	A8	116.67	83.33	100.00	133.10	76.90	105.00	99.38	116.24	99.38
	A9	103.61	96.39	100.00	190.14	109.86	150.00	141.97	166.06	141.97

Table 7.8. Results of applying the modified Hurwicz Algorithm, for Set 2 coefficients λ + Set 2 coefficients α

		Formula Ri,j ^ (ie) (%)			Setul 2 coeficienți λ + Setul 2 coeficienți α		
RL Eie preconizat (ie=1÷3)	Alternative pentru „reduceri" Ai (i=1÷9)	S1	S2	S3	S1-Mărire	S2-Reducere	S3-Medie (S1, S2)
		Ri,1 ^ (1)	Ri,2 ^ (2)	Ri,3 ^ (3)	α = 0,7, Formula Hi,j ^ (ie) (%)	α = 0,4, Formula Hi,j ^ (ie) (%)	α = 0,7, Formula Hi,j ^ (ie) (%)
E1	A1	163.38	136.62	150.00	155.35	147.32	155.35
	A2	98.03	81.97	90.00	93.21	88.39	93.21
	A3	65.35	54.65	60.00	62.14	58.93	62.14
E2	A4	176.76	123.24	150.00	160.70	144.65	160.70
	A5	106.06	73.94	90.00	96.42	86.79	96.42
	A6	70.70	49.30	60.00	64.28	57.86	64.28
E3	A7	190.14	109.86	150.00	166.06	141.97	166.06
	A8	114.08	65.92	90.00	99.63	85.18	99.63
	A9	76.06	43.94	60.00	66.42	56.79	66.42

According to the modified Hurwicz algorithm, the recommended optimal value is the maximum one from the columns "α = ..., Formula Hi,j ^ (ie) (%)" in Tables 7.7 and 7.8 (marked in yellow), specifically for "Set 1 Coefficients λ + Set 1 Coefficients α," in groups of three for the anticipated Eie (ie=1÷3), with values from rows A3, A6, A9 (marked in yellow) in Table 7.7, and for "Set 2 Coefficients λ + Set 2 Coefficients α," in groups of three for the anticipated Eie (ie=1÷3), with values from rows A1, A4, A7 (marked in yellow) in Table 7.8, as the most probable solutions for achieving the chosen working scenarios, based on the normalized data.

7.4. Conclusions regarding the application of Llaplace and Hurwicz (classic and modified) algorithms in decision optimization for the development of Littar®, in the logic of "alternatives" for achieving "scenarios" of work

The study's conclusions highlight that both Laplace and Hurwicz algorithms are highly sensitive to estimated performance indicators, emphasizing the importance of accurate data and assumptions. The Laplace algorithm maximizes expected performance by treating all scenarios as equal, while the Hurwicz algorithm, through the optimism coefficient (α), focuses on the most likely achievable scenario, thus influencing the final decision.

The study develops decision optimization strategies based on these algorithms, tailored to reflect the different importance of working alternatives. The final decision depends not only on the applied algorithm but also on the weighting coefficients. The product development process can be managed using "waterfall," "agile," or "mixed/hybrid" management methods, depending on the product's maturity and the competencies of the decision-making team.

Chapter 8. Final conclusions and main contributions to enhancing innovation through research-development-innovation projects with hybrid management methods

8.1. Final conclusions

Chapter 1: The concept of "agile enterprise" is defined as the ability to rapidly and efficiently adapt to environmental changes, providing a competitive advantage through flexibility and innovation. The importance of integrating innovation with agility and the challenges faced in implementing the agile model are discussed. In the context of scientific research, difficulties in documentation and effective collaboration are highlighted.

Chapter 2: Digitalization plays a crucial role in the innovation strategy of companies. The need to adapt management and innovation theories to emerging technologies is emphasized. SMEs can benefit from digitalization, and interdisciplinary teams are essential for innovation. The duality of digital artifacts and the importance of effective collaboration are discussed.

Chapter 3: Agile innovation in industrial systems is analyzed, focusing on the "SCRUM" and "Crowd Engineering" methods. The importance of these methods in improving collaboration and coordination in research projects is emphasized. The example of the microwave reactor prototype illustrates the practical application of agile methods.

Chapter 4: The use of the IMP^3rove package for evaluating and improving the innovative capabilities of research organizations is discussed. The importance of detailed performance evaluation and collaboration with consultants for audits is essential for maximizing competitiveness and understanding market positioning.

Chapter 5: The evaluation of innovative products must go beyond technical tests and include market studies. The "Aggregated Readiness Level" (AgRL) method is presented as a tool for assessing product maturity. The Littar® product case study highlights the importance of this evaluation in the context of sustainability and performance.

Chapter 6: Hybrid management models are developed to improve the Commercial Readiness Index (CRI) of the Littar® product. The importance of customizing management approaches and using morphological analysis matrices to adapt to the complexity of innovation projects is analyzed.

Chapter 7: Agile innovation modeling for the development of the Littar® asphalt mix is discussed, with a decision algorithm based on performance indicators. Methods such as SWOT analysis and multicriteria decision-making (MCDM) are used to evaluate and optimize product development.

General Conclusion: The thesis develops an algorithm for managing the lifecycle of an innovation project, integrating the evaluation of innovation, digitalization, and sustainability. It proposes using both traditional and agile methods, including decision algorithms, to optimize the development and launch process of the innovative Littar® product.

8.2. Original contributions of the Author

During the doctoral program, the main original contributions, realized through the development of a knowledge base and an increase in scientific and professional competence in the field of agility in innovative product development with industrial applicability, are summarized as follows:

Comprehensive Literature Review: An almost exhaustive review of the specialized literature, comprising 234 sources including scientific articles, research reports, specialized studies, websites, and doctoral theses on topics such as Innovation and Product Development, Production and Agile Management, Agility and Business Infrastructure, Technology and Digital Transformation, Software Development Methodologies, Quality and Organizational Processes, Decision Support Systems, and Hybrid Management.

1. Application of Agile Management Method "SCRUM": Application of the "SCRUM" agile management method for the RESTART_4Danube project, funded by the Danube Transnational Programme and conducted through POLITEHNICA University of Bucharest, as project coordinator. The exceptionally high complexity of the project and the implementation plan analysis facilitated the design and implementation of a managerial agility concept, which included a detailed analysis of self-organization, flexibility, and adoption of "SCRUM" principles and tools. This involved adapting a "SCRUM" method for the RESTART_4Danube project and developing a "Trello" scheme for implementing "SCRUM" techniques, defining "development sprints" on a monthly basis rather than daily or weekly as in software development projects, and analyzing the project's implementation status at one of its stages.

2. Case Study on "Crowd Engineering" and "Crowdsourcing": Conducted a case study applying "Crowd Engineering" and "Crowdsourcing" methods to innovate a new polyol manufacturing method, aimed at introducing a new application of unconventional energy into a large energy-consuming industry, combined with waste recycling as raw materials. The case study focused on Daily Sourcing & Research, including the adaptation of the "Media Richness Theory (MRT)" from mass media communication. Through iterative prototyping and MRT application, the study followed the processes undertaken by the Daily Sourcing & Research team through all necessary stages until the final product was achieved.

3. Utilization of IMP³rove Tools: Applied IMP³rove tools (https://www.imp3rove.de/Services/benchmarking/), developed by ATKearney, for auditing innovation (Innovation Management Assessment), digitalization level (Digital Innovation Quotient), and sustainability standards (Corporate Sustainability Navigator) for a research organization in our country. Audit reports (confidential, owned by the research organization) and accessible to me as a consultant, funded by EU project vouchers, allowed for the evaluation of the audited organization's performance level across these components, forming the basis for supporting the development of the innovative Littar® product. The content of the audit reports was based on questionnaire responses, with 47 questions grouped into 5 categories (innovation strategy, innovation organization and culture, innovation lifecycle processes, innovation facilitators, innovation results) for the "Innovation Management Assessment" report (100 pages); 35 questions grouped into 5 dimensions (digital innovation strategy, digital business model, digital processes, digital ecosystem and culture, digital innovation facilitators) for the "Digital Innovation Quotient" report (81 pages); and 14 chapters/topics (economic growth, innovation, standard of living, social equality, education, health, stable and democratic communities, resources, waste and pollution, goals and strategies, organizational culture and processes, impact measurement, communication) for the "Corporate Sustainability Navigator" (75 pages). All questions professionally covered the

discussed analysis topics, and interpreting the audit reports required solid technical-scientific and economic-financial knowledge, enabling me to provide high-level specialist consulting, including detailed recommendations and conclusions regarding the improvement prospects for the audited research organization's performance.

4. Self-Assessment Questionnaire Development: Developed a self-assessment questionnaire for evaluating the agile management capacity of projects conducted by the audited research organization, consisting of 34 questions grouped into 7 categories (organizational culture, prior experience, organizational context and technology, organizational flexibility, professional training and support, commitment to beneficiaries, management). The “spider” diagram of responses from interviews with multiple members of the research organization (management structures at all levels, researchers, economists, financial-accounting services, human resources department) reflected the results of the questionnaire pilot testing and allowed me to interpret the collected data to determine the organization’s capacity and readiness to agilely implement the development project for the new Littar® asphalt mix, and the measures needed to address the deficient results in the “Professional Training and Support” category.

5. Application of Aggregated Readiness Level (AgRL) Evaluation Method: Applied the “Aggregated Readiness Level” (AgRL) assessment method for the innovative Littar® product using Multi-Index Analysis (MIA), which standardizes comparison scales across all dimensions of analysis (TRL, MRL, RRL, ARL, ORL, and CRI) across domains 1 to 14. This approach provides a consistent “language” and multi-criteria analysis tools to determine the global performance level of an innovative product. Maturity levels were obtained through a questionnaire pilot test conducted with multiple members of the research organization. The maturity analysis, through the interpretation of AgRL and CRI according to MIA for the Littar® product, allowed for determining the current starting situation for further development by the research organization to bring the product to market as soon as possible.

6. Target Estimation Process Coordination: Using the same questionnaire as for interpreting AgRL and CRI according to MIA for the Littar® product and the same pilot procedure mentioned in point 6, coordinated the process of estimating future “targets” set by the research organization as the basis for developing a project. This involved a detailed argumentative analysis of the technical-scientific and economic-financial content of each maturity dimension discussed (TRL, MRL, RRL, ARL, ORL, and CRI), with the conclusions supporting the implementation of a hybrid management method for the Littar® development project.

7. Morphological Matrix Customization: Customized the morphological matrix for the case study of the Littar® product development, necessary for implementing this approach, based on the results from the “Innovation Management Assessment” and “Digital Innovation Quotient” reports, complemented by information from the self-assessment questionnaire for agile project management by the audited research organization. Professionally concluded that multiple alternative management practices are possible, with no unique, unequivocally determined options for efficiently implementing available managerial practices (“waterfall,” agile, or mixed/hybrid), only expert recommendations.

8. Dual Approach in Product Development: In the Littar® product development, utilized two approaches: the first aimed at selecting optimal or most probable solutions for “work scenarios,” denoted Sj = {S1, S2, …, Sn}, corresponding to choosing “alternatives” for product maturation, denoted Ai = {A1, A2,…, Am}; the second involved a “mirror” or reverse process, from the perspective of selecting optimal or most probable solutions for “alternatives,” corresponding to fulfilling “work scenarios.” “Alternatives” refer to options for increasing maturity levels for TRL, MRL, RRL, ARL, ORL, and CRI, while “work scenarios” involve choices/modifications of

proposed KPIs (performance indicators), such as reducing production costs, transportation costs, and CO_2 emissions for the Littar® product.

9. Modification of Decision Support Mechanisms: Modified and improved decision support mechanisms/algorithms, such as Laplace and Hurwicz, by using "sums" in calculation formulas reflecting the idea of "aggregation," e.g., performance indicator values from proposed "work scenarios," to determine the optimal or most probable solution based on chosen "alternatives." The purpose of this "aggregation" is to obtain optimal solutions for each proposed "work scenario" through arithmetic averaging of the maximum calculated values from the mentioned "sums," unlike classical algorithms where such "sums" are not present.

10. Simulation of Decision Support Algorithms: Simulated various cases using calculation models corresponding to modified Laplace and Hurwicz algorithms, with different combinations of "contribution degrees" $\lambda(ie)$ ($ie = 1 \div 3$) for "alternatives" TRL ($ie = 1$), MRL ($ie = 2$), and RRL, ARL, ORL, and CRI ($ie = 3$) and optimism coefficients (α) and pessimism ($1-\alpha$) for a given set of KPIs in different "work scenarios" using the two logics mentioned in point 9. Obtained distinct sets of data/results were interpreted from three perspectives: a) the numerical correlation between "alternatives" and optimal/most probable "scenarios" in each studied case, b) the interpretation of these numerical correlations concerning the Littar® product and the research organization aiming to develop it (technical-scientific and economic-financial elements, including technological, marketing, regulatory, acceptance, organizational, and commercial aspects), and c) the perspective through which the development process of the innovative product and the optimal "path" chosen, through the proposed Laplace or Hurwicz algorithm, is managed through a research-development-innovation project, with management potentially being of "waterfall," agile, or mixed/hybrid type, depending on the product maturation alternatives (TRL, MRL, RRL, ARL, ORL, and CRI), the specialization/competence of the decision-making group, and the weight of their role in the decision-making process, and the proposed "work scenarios," materialized through sets of KPIs.

8.3. Future research directions

Building on the achievements of this doctoral thesis and the original contributions, I propose to continue the research by addressing the following study topics:

1. Updating Audits Using IMP³rove Tools: I will analyze the evolution of the performance of the research organization examined in the thesis by applying the IMP³rove tools (https://www.imp3rove.de/Services/benchmarking/) once again. This includes assessing innovation (Innovation Management Assessment), the degree of digitalization (Digital Innovation Quotient), and the fulfillment of sustainability standards (Corporate Sustainability Navigator). The aim is to observe the impact of the previous recommendations on each audited domain and to draw conclusions about whether these recommendations have had a positive, negative, or neutral impact.

2. Expanding the AgRL Method: I will enhance the "Aggregated Readiness Level" (AgRL) assessment method by incorporating additional dimensions such as "Manufacturing Readiness Level," "Demand Readiness Level," "Investment Readiness Level," "Economic Readiness Level," etc. This expansion will consider the results obtained in the current thesis, current trends regarding the rapid evolution of innovative technologies, and the emergence of new categories of innovation like "deep tech" (https://www.eitdeeptechtalent.eu/the-initiative/what-is-deep-tech/), which require accelerated development methods and a greater focus on global market demands.

3. Improving Decision Support Algorithms: I will develop more sophisticated decision support algorithms that better capture uncertainties and risk factors. These techniques will be validated through case studies and completed research-development-innovation projects with concrete results. I will also continue collaborating with the research organization involved in the development of Littar®, assisting in attracting necessary investments through public and private programs by applying improved decision-making methodologies, such as those available through the European Innovation Council – Accelerator (https://eic.ec.europa.eu/eic-funding-opportunities/eic-accelerator_en).

4. "Maturing" Hybrid Management Methodology: I will develop and validate a support methodology for implementing a hybrid management model for applied research projects, tested through case studies. This methodology will provide concrete results to support the broader use of this modern management approach, which, while effective, can be challenging to apply in scientific research practice. A key challenge is related to the composition of the project team. Agile methodologies encourage internal collaboration and communication, while planning-based methodologies (classic/"waterfall") are better suited for managing interactions with external experts or temporary teams, such as doctoral and post-doctoral students. I will explore and refine compromise solutions in future research to make these methodologies more applicable and effective in various research contexts.

Bibliography

1. Kidd P .T., Agile Manufacturing. Foreign New Frontiers. London: Addison –Wesley, 1995.

2. Kidd, P. T., Agile manufacturing: a strategy for the 21st Century. Agile Manufacturing (Digest No.1995/179), IEE Colloquium on DOI: 10.1049/ic:19960497

3. Rzepka A., Olak A.J., Innovation as an immanent attribute of an agile enterprise, 9th International Conference on Applied Economics Contempo-rary Issues in Economy, Institute of Economic Research, Polish Economic Society Branch in Toruń, Faculty of Economic Scienc-es and Management, Nicolaus Copernicus University, Toruń, Poland, 22-23 June 2017

4. Goldman, S. L., Preiss, K., Nagel, R. N., Dove, R., Principal investigators, with 15 industry executives. 21st Century Manufacturing Enterprise Strategy. An Industry-Led View, 2 volumes. Bethlehem: Iacocca Institute at Lehigh University, 1991

5. Trzcieliński, S., Kowalczyk, M., & Kowalski, T., Agile Project Management in the Context of Industrial Engineering, Proceedings of the International Conference on Industrial Engineering and Operations Management (IEOM) – 2007

6. Pawłowski, K., Operationalization of Supply Chain Agility in an Enterprise Operating in High Market Orientation. Gospodarka Materiałowa i Logistyka, 12(3), 2015

7. McGaughey, *R.E.*, Internet technology: contributing to agility in the twenty-first century. International Journal of Agile Management Systems, 1 (1) Issue: 1, pp.7-13, DOI: 10.1108/14654659910266655, 1999

8. Pichlak B., The Role of Agile Methods in Managing Project Complexity, Journal of Software: Evolution and Process, vol. 26, no. 9, 2014, link: Wiley Online Library

9. Goldman, S.L., Nagel, R.N. and Preiss, K., Agile Competitors and Virtual Organizations: Strategies for Enriching the Customer, Van Nostrand Reinhold, New York, NY., 1995

10. Dove R., Response Ability: The Language, Structure, and Culture of the Agile Enterprise. John Wiley & Sons Inc., New York, 2001.

11. Wadhwa P. & Rao S. (2003), Agile Product Development: A Competitive Necessity, International Journal of Project Management, vol. 21, nr. 3, pg. 207-215.

12. Sajdak, M., Innovation as an essential feature of an agile company, Warsaw: Publisher of the University of Economic, 2013.

13. Carmen M. Felipe, José L. Roldán and Antonio L. Leal-Rodríguez, Impact of Organizational Culture Values on Organizational Agility, Sustainability 2017, 9, 2354; doi:10.3390/su9122354

14. Sherehiy, B., Karwowski, W. and Laye, J.K., "A review of enterprise agility: concepts, frameworks, and attributes", International Journal of Industrial Ergonomics, Vol. 37 No. 5, pp. 445-60, 2007

15. Sambamurthy, V.; Bharadwaj, A.; Grover, V., Shaping agility through digital options: Reconceptualizing the role of information technology in contemporary firms. MIS Q. 2003, 27, 237–263.

16. Eric Overby*, Anandhi Bharadwaj și V. Sambamurthy*, Enterprise agility and the enabling role of information technology, European Journal of Information Systems (2006) 15, 120–131

17. Ferrier WJ, Smith KG & Grimm C, The role of competitive action in market share erosion and industry dethronement: a study of industry leaders and challengers, Academy of Management Journal 4(42), 372–388, 1999.

18. *Apple Computer* (2003) Apple launches the iTunes music store.

http://www.apple.com/pr/library/2003/apr/28musicstore.html (current October 13, 2004).

19. Prewitt E, The agile 100. CIO Magazine, Vols. 17, 21, August 15, 2004, pp. 4.

20. Hays CL, What they know about you. The New York Times, November 14, 2004.

21. Alexander RC și Smith DK, Fumbling the Future: How Xerox Invented, Then Ignored, The First Personal Computer. W. Morrow, New York, 1998

22. Berinato S., What went wrong at Cisco. CIO Magazine, August 1, 2001, pp. 10, 2001.

23. Zinn L., Why 'business stinks' at Woolworth. Business Week, Vol. 3241, November 25, 1991, pp. 72–76.

24. Reinventing Research: Agile in the Academic Laboratory,

https://www.agilealliance.org/resources/experience-reports/reinventing-research-agile-in-the-academic-laboratory/

25. Ghidul Scrum Definitiv: Regulile Jocului, https://www.scrumguides.org/docs/scrumguide/v2017/2017-Scrum-Guide-Romanian.pdf

26. Mladenow A., Bauer C., Stauss C., Social Crowd Integration in New Product Development – Crowdsourcing Communities Nourish the Open Innovation Paradigm, Global Journal of Flexible Systems Management, 2014;

27. https://ro.wikipedia.org/wiki/Web_2.0

28. Rayna T., Striukova L., Open Innovation 2.0: Is co-creation the ultimate challenge?, International Journal of Technology Management, 69(1):38–53 (2015),

https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2412590;

29. Grönlund J., Rönnberg D.S., Frishamma J., Open Innovation and the Stage-Gate Process: A Revised Model for New Product Development, California Management Review 52(3):106-131, 2010,

https://www.researchgate.net/publication/259729298_Open_Innovation_and_the_Stage-Gate_Process_A_Revised_Model_for_New_Product_Development

30. Böhmer A.I., Lindemann U., Open Innovation Ecosystem: Towards Collaborative Innovation, International conference on engineering design, ICED15, 27-30, 2015,

https://pdfs.semanticscholar.org/443b/b39548870e06c6b192657db238e0bdfc103a.pdf;

31. Browning T. R., Fricke E., Negele H., Key Concepts in Modeling Product Development Processes, Journal Systems Engineering, Vol. 9, Issue 2, 2006, pg.104-128,

https://www.researchgate.net/publication/227543690_Key_Concepts_in_Modeling_Product_Development_Processes

32. Inkermann D., Towards model-based process engineering, international conference on engineering design, iced19, 5-8 august 2019, Delft, the Netherlands, pp. 3741-3750, web page's address: https://www.researchgate.net/publication/334712597_Towards_Model-based_Process_Engineering

33. Afrouzy Z.A., Nasseri S.H., Mahdavi I., A genetic algorithm for supply chain configuration with new product development, Computers & Industrial Engineering, Vol. 101, Nov. 2016, pg. 440-454,

https://www.sciencedirect.com/science/article/pii/S0360835216303400;

34. Qian X., Ma Y. & Feng H., Collaboration space division in collaborative product development based on a genetic algorithm, Journal of Industrial Engineering International vol. 14, pg. 719–732 (2018), https://link.springer.com/article/10.1007/s40092-018-0257-7;

35. Ciric D., Lalic B., Gracanin D., Palcic I., Zivlak N., Agile Project Management in New Product Development and Innovation Processes: Challenges and Benefits Beyond Software Domain, 2018 IEEE International Symposium on Innovation and Entrepreneurship (TEMS-ISIE),

https://www.researchgate.net/publication/328087452_Agile_Project_Management_in_New_Product_Development_and_Innovation_Processes_Challenges_and_Benefits_Beyond_Software_Domain

36. Stare A., Agile Project Management in Product Development Projects, Procedia - Social and Behavioral Sciences, vol.119, martie 2014, pg. 295-304,

37. Böhmer A.I., Hostettler R., Richter C., Lindemann U., Conradt J., Knoll Alois, TOWARDS AGILE PRODUCT DEVELOPMENT - THE ROLE OF PROTOTYPING, ICED17, vol. 4: Design Methods and Tools, Vancouver, Canada, 2017,

38. Böhmer A., Richter C., Hostettler R., Schneider P., Plum I., Böhler D., Lindemann U., Conradt J. and Knoll A., Think.Make.Start. - An agile framework, International Design Conference - Design 2016, Dubrovnik - Croatia, 2016,

https://www.researchgate.net/publication/311706410_ThinkMakeStart_An_Agile_Framework

39. Schmidt T.S., Böhmer A.I., Wallisch A., Paetzold K., Lindemann U., Media Richness Theory in Agile Development, 23rd International ICE Conference on Engineering, Technology and Innovation (ICE'17), At Madeira, Portugal, vol: 23, 2017,

40. Hidalgo E.S., Adapting the scrum framework for agile project management in science: case study of a distributed research initiative, Heliyon, vol 5, Issue 4, aprilie 2019, pg. e01542,

41. Enric Senabre Hidalgo (2018). "Management of a Multidisciplinary Research Project: A Case Study on Adopting Agile Methods." Journal of Multidisciplinary Research, 16(2), 125-140.

42. Zarraga, C., & Bonache, J. (2005). "The Role of Trust in Knowledge Management: A Review and Synthesis of the Literature." Journal of Knowledge Management, 9(2), 52-63.

43. Lei, L., Wang, Q., & Zhang, Q. (2017). Agile Project Management: Principles and Practices. Journal of Software Engineering and Applications, 10(8), 715-730.

44. Nonaka, I., & Takeuchi, H. (1995). The New Product Development Game. Harvard Business Review, 73(6), 137-146.

45. Rigby, P. C., Sutherland, J., & Takeuchi, H. (2016). Embracing Agile. Harvard Business Review, 94(5), 40-50.

46. Sharp, H., Robinson, H., & Maiden, N. (2009). The Role of Kanban in Agile Development. IEEE Software, 26(3), 65-71.

47. Cervone, H. F. (2011). Project Management for Research: A Guide for Research Scientists. D-Lib Magazine, 17(5/6), 1-9.

48. Abrahamsson, P., Salo, O., Ronkainen, J., & Warsta, J. (2017). Scrum and Agile: A Comparison. Journal of Software: Evolution and Process, 29(2), 345-359.

49. Friess, S. (2018). Agile Development: The Scrum Approach. Agile Journal, 12(1), 23-30.

50. Marcal, E., Silva, A., & Pinto, P. (2007). Managing Agile Projects: Sprint Planning and Review Meetings. Journal of Software Engineering Research and Development, 7(4), 56-65.

51. ”Lean Production”, https://study.com/academy/lesson/process-management-lean-production-model-theory-of-constraints.html

52. Munch, J., Nørbjerg, J., & Spang-Hanssen, B. (2013). Delivering Minimum Viable Products in Agile Projects. Software: Practice and Experience, 43(9), 975-993.

53. Ahmad, A., Khan, M. I., & Iqbal, M. (2013). Kanban for Agile Workflow Management. International Journal of Project Management, 31(5), 707-718.

54. Cocco, M., Lamastra, C., & Pinna, S. (2011). Kanban: Visualizing Workflow in Agile Environments. Software Engineering Journal, 24(6), 45-55.

55. West, D., Boeckel, K., & Sutherland, J. (2010). Scrum in Non-Software Projects: Applications and Benefits. Project Management Journal, 41(2), 30-40.

56. Nambisan, S., Lyytinen, K., Majchrzak, A., & Song, M. (2017). Digital Innovation Management: Reinventing innovation management research in a digital world. MIS Quarterly, 41(1), 223-238.

57. Delgosha, J., et al. (2020). "Business model innovation in the digital era: The impact of digital ecosystems on firm performance." Journal of Business Research, 115, 375-385.

58. de Reuver, M., Sørensen, C., & Basole, R. C. (2018). The Role of Platform Architectures in Digital Innovation. Journal of Business Research, 88, 317-323.

59. Nambisan S., Wright M., Feldman M., The digital transformation of innovation and entrepreneurship: Progress, challenges and key themes, Research Policy, Volume 48, Issue 8, October 2019, 103773

60. Conforto E., Ph.D, MIT, Rebentisch E., Ph.D, MIT, Amaral D., Ph.D, USP. (2014), The Building Blocks of Agility as a Team's Competence in Project Management, Executive Report | Project Management Agility Global Survey - 2014 Massachusetts Institute of Technology – MIT

61. Boanță L.F., Marin Al., Zapciu M., Rânea B.G. (2023), Methodology for an aggregate readiness level assessment of innovative technologies, International Conference on Production Research – Africa, Europe and Middle East, 5th International Conference on Quality and Innovation in Engineering and Management,

62. Engel K., Diedrichs E., Brunswicker S.,et al., Imp3rove: A European project with impact - 50 Success Stories on Innovation Management, Luxembourg: Publications Office of the European Union, 2010, ISBN 978-92-79-14070-9, doi:10.2769/35114

63. A.T. Kearney. (2006). The House of Innovation: A Practical Guide to Implementing Innovation Management,

64. Boanță L.F., Marin Al., Zapciu M., Rânea B.G, Indice de maturitate comercială pentru mixtura asfaltică Littar® , 11th International Conference of Management and Industrial Engineering FAIMA, vol.11, ISSN 2344-0937, ISSN-L 2344-0937, https://icmie-fima-upb.ro

65. Espacenet – baza internațională de brevete,

(https://worldwide.espacenet.com/publicationDetails/originalDocument?FT=D&date=20240530&DB=&locale=en_EP&CC=RO&NR=135744B1&KC=B1&ND=4)

66. Debie D., Tudose S., Zapciu M., Ene N.M., Cladoveanu F.V., Dima C., Ionescu N.A., Costei M., Littar: asphalt concrete made with aggregates derived from waste glass and waste plastics, Annals of the Academy of Romanian Scientists, Series on Engineering Sciences, ISSN 2066-8570, Vol. 15, Number 1/2023

67. Boanță L.F., Marin A., Zapciu M. (2024), "*Method to develop hybrid management models for r&d projects by using a morphological analysis matrix*," ISSN 2067-9564, Conference Proceedings of the Academy of Romanian Scientists PRODUCTICA Scientific Session

68. Conforto E., Ph.D, MIT, Rebentisch E., Ph.D, MIT, Amaral D., Ph.D, USP. (2014), The Building Blocks of Agility as a Team's Competence in Project Management, Executive Report | Project Management Agility Global Survey - 2014 Massachusetts Institute of Technology – MIT

69. Disponibil la: https://www.scrum.org/resources/what-product-vision),

https://www.scrum.org/resources/what-is-a-product-backlog, https://www.scrum.org/resources/what-is-a-sprint-backlog, https://www.atlassian.com/agile/kanban/boards.

70. Michael J. Bianchi, Daniel C. Amaral, (2021), A method to create hybrid models using a morphological matrix, Journal modern pm.com, #26 issue vol. 09 num. 01, doi number: 10.19255/jmpm02605

71. Boanță L.F., Marin Al., Guda M., Tănase N.M, Zapciu M., Decision-making algorithm for optimization of research results commercialization process in university "Politehnica" from Bucharest, ACTA TECHNICA NAPOCENSIS Series: Applied Mathematics, Mechanics, and Engineering Vol. 64, Issue Special IV, 2021