FAIMA Business & Management Journal is indexed in international databases: ProQuest, ERIH PLUS, Index Copernicus and Google Scholar.

POLITEHNICA Press
ISSN 2344-4088
ISSN-L 2344-4088
Address: 313 Splaiul Independentei, 060042, Bucharest, Romania
Tel: (+40) 21 402 9074 e-mail: politehnicapress@upb.ro

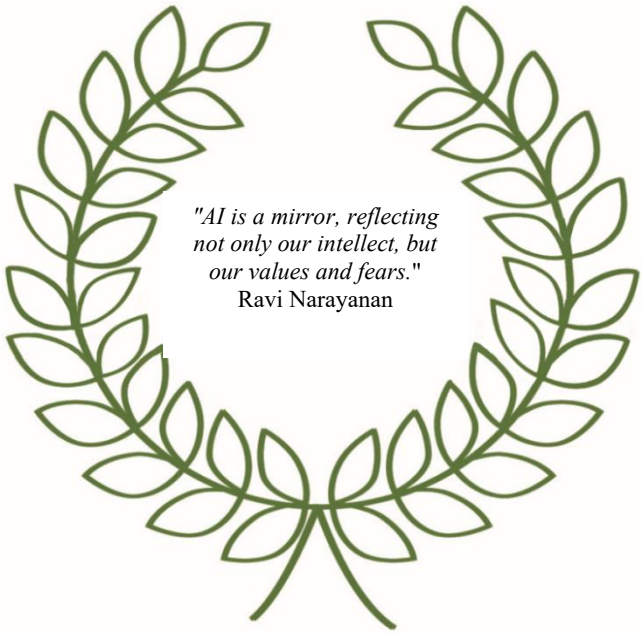
CONTENTS

Technology for the Future

Artificial Intelligence (AI) stands at the forefront of technological evolution, acting as both a catalyst for progress and a subject of ongoing ethical discourse. Its influence spans industries, research, and daily life, reshaping the way we solve problems, interact with technology, and envision the future. From automating complex tasks to unlocking new scientific discoveries, AI is a transformative force that extends far beyond its initial applications, fundamentally altering human potential and societal structures.

One of AI's most promising contributions is its role in sustainability and environmental conservation. Intelligent systems optimize resource management, track climate patterns, and drive innovations in renewable energy, offering new solutions to global challenges. As AI integrates into various sectors, collaboration between experts in technology, ethics, and policy becomes essential to guide its development responsibly. Establishing governance frameworks and ethical regulations ensures AI evolves in alignment with human values, balancing progress with accountability.

However, AI's rapid advancement also presents challenges. Issues such as algorithmic bias, privacy concerns, and workforce disruption highlight the need for responsible oversight. While AI enhances efficiency and decision-making, its increasing autonomy raises critical questions about transparency and accountability. Without proper safeguards, there is a risk of unintended consequences, including misinformation, security threats, and unethical applications. Addressing these concerns requires a collective effort from governments, industries, and researchers to implement safeguards that protect both individuals and society at large.



Yet, beyond its technical capabilities, AI challenges traditional approaches to problem-solving and knowledge discovery. In science, it accelerates breakthroughs by analyzing vast datasets and identifying patterns beyond human perception. In business, it streamlines operations and enhances customer experiences. In everyday life, it personalizes recommendations, improves accessibility, and redefines communication. AI's impact is far-reaching, influencing not only those who develop it but also every individual who interacts with an increasingly digital world.

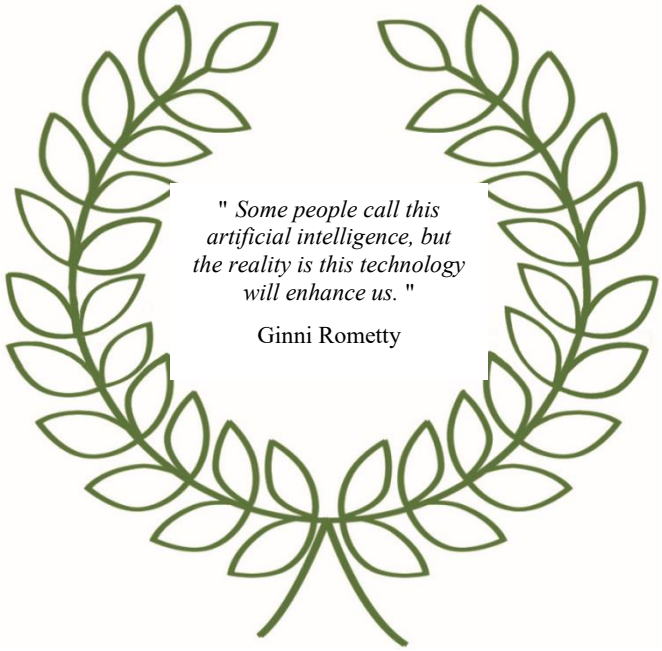
To harness AI's potential while mitigating its risks, a proactive approach to ethical development is essential. Transparent policies, regulatory oversight, and international cooperation can ensure AI remains a force for good. By fostering innovation that prioritizes human well-being, we can shape an AI-driven future that enhances lives, promotes sustainability, and upholds ethical integrity. The path forward requires thoughtful integration of AI into society—one that embraces its benefits while safeguarding against its challenges, ensuring a future where intelligence, both human and artificial, works in harmony.

Artificial intelligence is reshaping the way humans interact with technology by making systems more intuitive, responsive, and adaptive. AI continues to evolve, it raises important questions about the boundaries between human intelligence and artificial cognition.

One of AI's most intriguing aspects is its ability to generate entirely new ideas, solutions, and concepts. By analyzing vast amounts of data, AI can detect patterns and propose innovations that may not be immediately obvious to human thinkers. This capability extends beyond optimization and efficiency—it introduces new ways of approaching challenges, leading to unexpected breakthroughs. However, as AI-generated ideas become more prevalent, the question of originality and authorship arises, sparking discussions about the role of AI in the creative and intellectual domains.

AI's potential to anticipate and influence human behavior is another area of profound significance. By analyzing past actions and preferences, AI can predict future choices with remarkable accuracy, whether in consumer habits, decision-making, or even emotions. While this predictive power can be beneficial in creating more tailored experiences, it also raises concerns about autonomy and free will. If AI systems become too adept at guiding human behavior, there is a risk that individuals may unknowingly be steered toward certain decisions, prompting discussions on the ethics of AI-driven influence and control.

Mirona Ana Maria ICHIMOV
Guest Editor



Problems of Interconnecting Smart Labs

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Abstract

This research examines the development of smart laboratories, focusing on user experiences, operational challenges, and collaboration dynamics. A survey of 43 respondents from various sectors highlights the barriers encountered in lab implementation and collaboration, emphasizing key aspects such as user satisfaction, technological integration, and external partnerships. The study identifies a strong interest in lab interconnection but also reveals a gap between positive perceptions and actual implementation. This discrepancy points to the need for strategic investments in infrastructure, policy frameworks, and standardized processes. Additionally, the research underscores the importance of human resource training and the creation of adaptable platforms to facilitate efficient knowledge exchange and collaboration. Ultimately, the findings contribute to a conceptual framework for smart lab interconnection, providing valuable insights into the challenges and opportunities for driving innovation through collaborative networks.

Keywords: smart labs, networks, interconnectivity, research infrastructure.

"*Success in creating AI would be the biggest event in human history.*"
Stephen Hawking

Introduction

The interconnection of smart laboratories into unified networks is vital for enhancing collaboration, fostering innovation, and addressing complex challenges in modern energy systems. This study investigates the integration of interconnected laboratory networks, evaluating user perceptions, technological priorities, and the potential of shared infrastructures to accelerate progress.

The role of smart labs in testing and implementing innovations is a focal point in literature, particularly regarding the creation of

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environments that support sustainable, iterative experimentation. Challenges include addressing technical and logistical needs, as well as involving multiple actors continuously (Hossain et al., 2019; Tagliazucchi et al., 2024). However, without adequate support, these labs risk underutilization or failure to generate actionable insights, and operational issues can hinder scalability. Distributed Knowledge and Hub-Type Networks highlight the difficulty of scaling networks where knowledge must be shared and updated in real-time.

Challenges include synchronizing data from decentralized sources and ensuring system scalability and accuracy for real-time applications (Cruz et al., 2020; Meidan et al., 2023). Actor Engagement and Open Innovation focus on the need to promote open innovation, manage diverse expectations in public-private collaborations, and balance inclusion with efficiency (Butt et al., 2023; Robaeyst et al., 2021). In the Triple and Quadruple Helix Models, aligning priorities and balancing decision-making across academia, industry, government, and civil society poses challenges to sustainable collaboration (Mandic et al., 2024; Thu Nguyen and Marques, 2022). Similarly, Collaborative Frameworks and the creation of interoperable systems for sharing distributed knowledge remain significant challenges, with concerns around data security and confidentiality in collaborative environments (Chew et al., 2023; Rodriguez-Gallego et al., 2023).

In Education and Collaborative Innovation, the importance of experiential learning in industrial engineering and digital transformation in education is evident, with collaboration and adaptability being key to leveraging new technologies and fostering innovation (Demartini et al., 2020; Kim et al., 2023; Rannastu et al., 2019). The role of Living Labs extends to rural communities, where community engagement and technological integration are crucial for sustainability (Calzada, 2023). In smart cities, urban labs contribute to innovation within governance frameworks, supporting policies that meet urban needs and stimulate citizen involvement (Voorwinden et al., 2023). The integration of sustainability principles in education is also a priority, requiring collaboration across faculties, administration, and students (Martinez-Acosta et al., 2023). Human-Machine Collaboration in industrial environments highlights the challenges of adaptability and safety, particularly in automated processes (Behery et al., 2023). Finally, intersectoral collaborations face challenges in flexibility, data synchronization, and scalability, while also needing to balance diversity and efficiency in innovation processes.

Thus, the literature emphasizes that the success of intersectoral collaboration initiatives depends on the ability to develop adaptable platforms and processes that accommodate the diverse interests of actors and facilitate efficient and secure knowledge exchange. It also highlights the need to establish a network collaboration model, including all involved actors and efficient distributed systems for knowledge sharing.

Research Methodology

The goal of this study is to identify optimal solutions for improving collaborations and interconnection of smart labs. The following specific objectives and hypotheses have emerged:

Objective 1: Understanding how smart labs are integrated into daily workflows.

(H1): The degree of integration of smart labs into daily activities and the challenges encountered significantly influence the level of user satisfaction.

Objective 2: Evaluating the impact of smart labs and associated technologies on productivity and innovation.

(H2): There is a significant positive correlation between the level of internal collaboration and the impact on productivity and innovation due to smart labs.

Objective 3: Identifying the challenges faced in collaboration.

(H3): The presence of mechanisms and procedures in external collaboration contributes to improving access to resources and maintaining effective collaboration in smart labs.

Objective 4: Extracting best practices that can be applied to interconnect smart labs.

(H4): Adopting standardized practices significantly contributes to increasing the efficiency and success of interconnecting smart labs.

Research design. The research design for this study employed a survey method to collect data on the interconnection and collaboration dynamics of smart labs. The survey was structured to capture various aspects of smart lab collaboration, including daily workflow, use of technology, collaboration and interconnection. The survey included both closed and open-ended questions, allowing for a combination of quantitative data and qualitative feedback. By using this method, the study aimed to gain a comprehensive understanding of the current state of smart lab interconnection, the perceived barriers, and the opportunities for improving collaboration and innovation.

Data collection. The data collection process began with a clear definition of the research objectives and the formulation of specific research questions. Thus, the questionnaire was structured to provide detailed answers to these questions, covering key aspects related to the implementation and collaboration in smart labs.

The survey was created on the Qualtrics platform, being anonymous and consisting of 26 questions. The instrument was pre-validated aiming to eliminate any ambiguities and ensure that the questions were appropriate for the research objectives, so that the responses would accurately reflect the perceptions and experiences of the participants.

The survey was distributed online between October 2nd and November 15th, 2024, and the respondents included researchers, engineers, and doctoral students working in such labs. The study sample consisted of 43 representatives working in smart labs. Purposive sampling involved selecting individuals who met specific criteria, being a deliberate choice of participants based on their relevance to our study.

Research Results

The first three questions of the survey (Q1- type of organization, Q2 - role within the institution and Q3 - experience working in the smart lab) were to establish the demography of the respondents (Table 1).

Table 1 – *Demography questions*

Category/Question	Options	Response number	Percentage
Type of organization	**Industry**	**0**	**0%**
	Company	5	10%
	Research Center	9	19%
	University	34	71%
Role within the institution	**Administrative**	8	13.79%
	PhD student	8	13.79%
	IT Support	2	3.45%
	Technician	2	3.45%
	Faculty member	18	31.03%
	Researcher	18	31.03%
	Others (Engineer)	2	3.45%
Experience in working with the smart lab	**6-12 months**	6	14%
	1-2 years	7	16%
	>2 years	30	70%

For the first research question and hypothesis we used multiple linear regression to test whether the independent variables (lab integration - Q4, feedback - Q7, and challenges Q5) significantly predict the level of satisfaction (Q6 - the dependent variable) (Table 2).

Table 2 – *Predict the level of satisfaction*

Metric	Value	P-value
R-squared	0.259	
F-statistic	4.552	0.0079
Coefficient Q4 (Integration)	-4718000	0.849
Coefficient Q5 (Technical Challenges)	-39890000	0.187
Coefficient Q7 (Feedback)	56450000	0.002

The R-squared value is 0.259, indicating that approximately 25.9% of the variation in satisfaction can be explained by the independent variables (Q4 - integration, Q5 - technical challenges, and Q7 - feedback). The F-statistic value is 4.552 with a p-value of 0.00790, suggesting that the model is statistically significant since the p-value is below the significance level of 0.05. The coefficient for Q4 (integration) is -4.718 with a p-value of 0.849, indicating that Q4 does not have a significant effect on satisfaction. Similarly, the coefficient for Q5 (technical challenges) is -3.989 with a p-value of 0.187, suggesting that Q5 does not significantly affect satisfaction. In contrast, the coefficient for Q7 (feedback) is 5.645 with a p-value of 0.002, indicating that feedback has a significant and positive impact on satisfaction. Based on these results, we can conclude that feedback (Q7) has a significant impact on satisfaction (p-value < 0.05), while integration (Q4) and technical challenges (Q5) are not statistically significant predictors of satisfaction.

For the second research question and hypothesis we used multiple regression to assess the extent to which the independent variables (collaboration level Q4, technology importance Q8, maintenance Q9, and challenges Q10) have a direct impact on the dependent variable (impact on productivity and innovation) Q12 (Table 3).

Table 3 – *Impact on productivity and innovation*

Variables	Coefficient	P-value
Q4 (Colabortion)	0.815	0.003
Q8 (importance of technologies)	0.098	0.098
Q9 (Mantainance)	0.0	0.05
Q10 (Challenges)	0.76	0.024

The regression results indicate a significant positive correlation between the level of collaboration (Q4) and the impact on productivity and innovation (Q12), with a coefficient of 0.815 and a p-value of 0.003, supporting the Research Hypothesis (H1). This suggests that as the level of internal collaboration increases, the impact on productivity and innovation also increases, highlighting the importance of collaboration in smart labs. Additionally, technical limitations (Q10) were significantly correlated with the impact on productivity and innovation, with a coefficient of 0.760 and a p-value of 0.024. However, other variables, such as technologies (Q8) and equipment

maintenance (Q9), did not show a significant correlation with the impact on productivity and innovation, implying that these factors are not significant in this context.

For the third research question and hypothesis we used multiple regression to test the extent to which the independent variables (such as collaboration with external partners - Q14, use of external equipment - Q13, selection criteria - Q16, and dispute resolution procedures - Q19) can predict the emergence of collaboration challenges (Q25) (Figure 1).

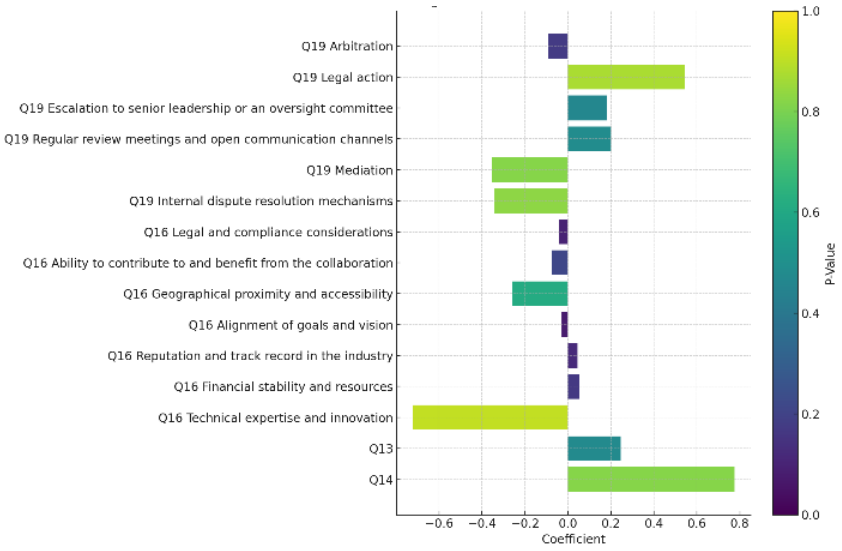

Figure 1 – *Predict the emergence of collaboration challenges*

The regression results reveal the relationships between various factors and their impact on collaboration challenges, with coefficients and p-values indicating the strength and statistical significance of each predictor. Notably, Q19 - Arbitration and Q19 - Legal action demonstrate significant positive coefficients, with p-values approaching zero, indicating a strong and significant relationship with collaboration challenges. Similarly, Q19 - Regular review meetings and open communication channels and Q19 - Mediation exhibit moderate coefficients, suggesting that regular communication and mediation mechanisms help mitigate collaboration challenges. In contrast, Q16 - Technical expertise and innovation, along with Q16 - Financial stability and resources, have coefficients that indicate weaker or non-significant associations, with p-values above the threshold for statistical significance. Finally, Q14 - representing collaboration with external partners and Q13 - the use of external equipment, show weaker or non-significant effects, reflected in their coefficients and relatively high p-values, suggesting that these factors may not significantly contribute to collaboration challenges in this context.

We performed the correlation analysis between Q21 - interconnected lab, Q23 - benefits of interconnection and Q25 – challenges (Table 4).

Table 4 – *Benefits of interconnection*

Variables	**Q21 Lab Interconnected**	**Q23 Benefits**	**Q25 Challenges**
Q21 (Lab Interconnected)	1	-0.22	0.044
Q23 (Benefits)	-0.22	1	0.34
Q25 (Challenges)	0.044	0.34	1

The correlation between Q21 (interconnected lab) and Q23 (benefits of interconnection) is -0.220, indicating a negative and relatively weak relationship. This suggests that as the interconnection of the smart lab with other labs (Q21) increases, the variable Q23 tends to decrease, although this effect is not very strong. The correlation between Q21 (interconnected lab) and Q25 (challenges) is 0.044, showing an extremely weak and nearly non-existent relationship between Q21 and Q25. This implies that there is no significant link between lab interconnection and anticipated challenges. Overall, the interconnection of the smart lab with other labs (Q21) does not exhibit a strong relationship with the variables Q23 and Q25, suggesting that factors related to the benefits and challenges of interconnection are influenced by other elements within the organizational context, rather than being directly linked to whether or not a lab is interconnected.

In order to research the fourth research question and the associated hypothesis, we took a look at multiple survey questions (Figure 2).

The types of collaborations (Q15) such as "Data sharing and analysis" and "Technological transfer" are strongly positively correlated with criteria like "Technical expertise and innovation" and agreements such as "Intellectual Property (IP) Ownership Agreement." "Equipment sharing" shows a moderate correlation with compensation methods like "Combination of Methods." Regarding compensation methods (Q18), "Grant or Funding Allocation" is preferred in collaborations involving "Technological transfer" and "Joint research projects." Collaboration agreements (Q17) involving "Data sharing and analysis" are positively correlated with agreements like the „License Agreement" and "Confidentiality Agreement (NDA)." Finally, the selection criteria (Q16) reveal that "Reputation and track record in the industry" are associated with "Technological transfer."

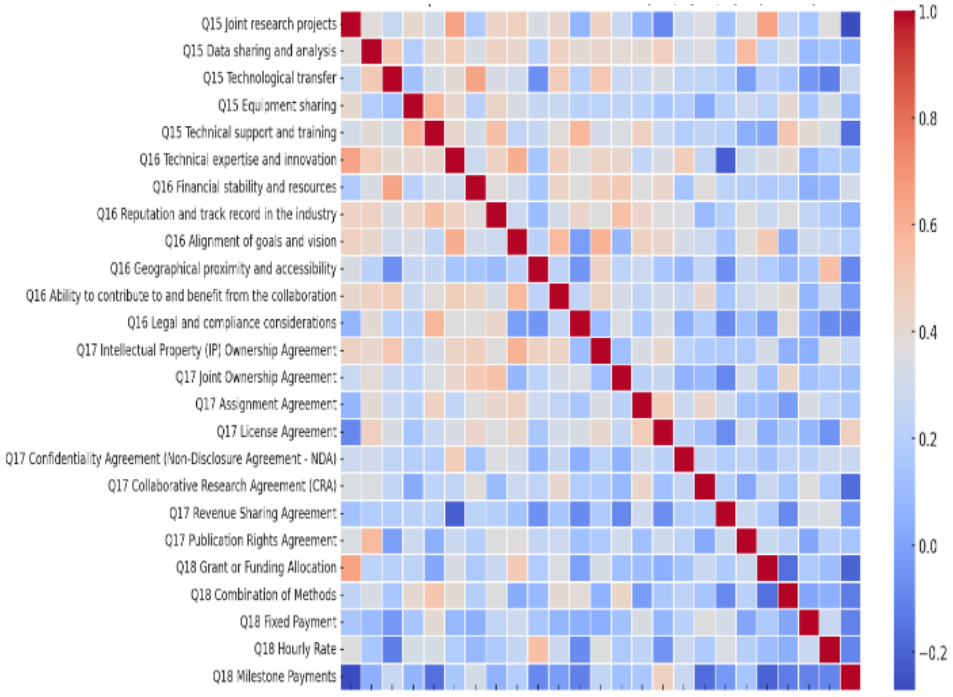

Figure 2 – *Correlation analysis between types of collaborations, Selection criteria, Collaboration agreements, and Compensation methods*

We conducted a correlation analysis between Q19 - procedures for resolving misunderstandings or disputes and Q16 - criteria for evaluating and selecting potential collaborators (Figure 3).

Internal dispute resolution mechanisms are strongly correlated with the use of technical expertise and innovation as selection criteria for collaborators (correlation coefficient: 0.45), indicating that labs focusing on internal dispute resolution prefer partners who contribute valuable technical skills and innovation. Regular evaluation meetings and open communication are significantly correlated with selecting partners based on technical expertise and innovation (correlation coefficient: 0.42), suggesting that transparent communication is linked to prioritizing partners with advanced knowledge and innovation. Mediation is significantly correlated with selecting partners based on their industry reputation and experience (correlation coefficient: 0.49), highlighting that labs using mediation mechanisms tend to value partners with a solid reputation.

Legal actions for dispute resolution are closely linked to selecting collaborators based on their reputation (correlation coefficient: 0.47), emphasizing the importance of transparent relationships, especially in legal challenges. Escalating disputes to senior management is positively associated with aligning goals and vision between collaborators (correlation coefficient: 0.34), indicating that labs valuing strategic harmony may involve senior leadership to maintain alignment during disagreements.

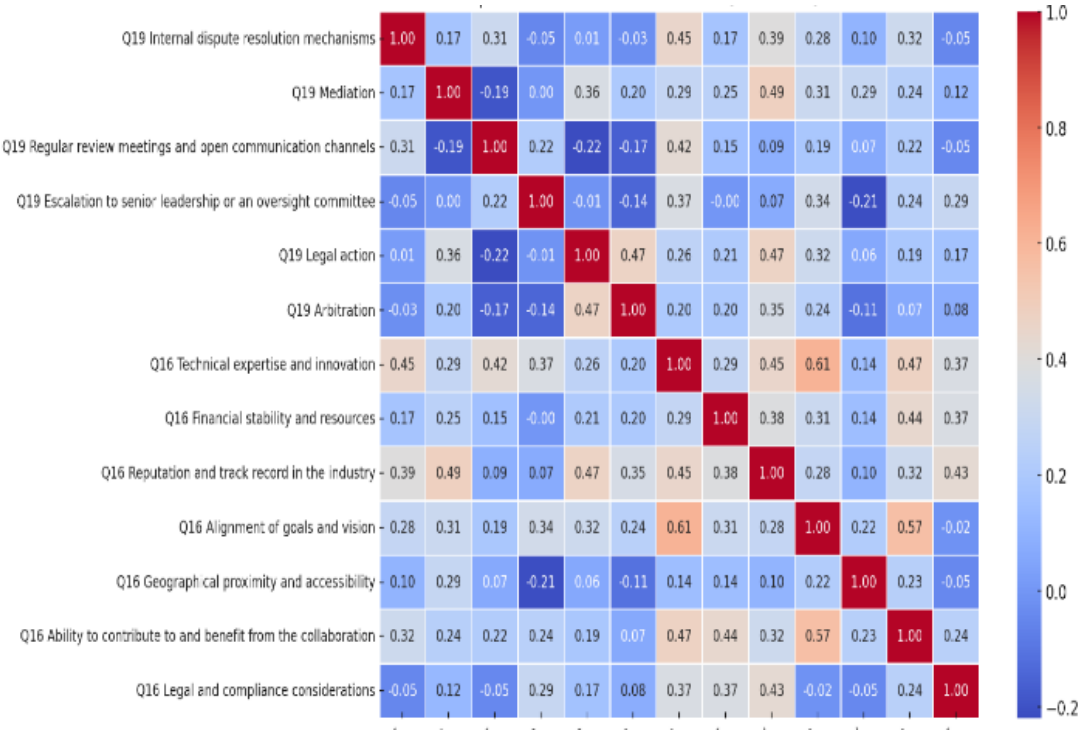

Figure 3 – *Correlation between resolving disputes and selecting potential collaborators*

Additionally, internal dispute resolution mechanisms are positively linked to selecting partners based on mutual benefits and contributions (correlation coefficient: 0.32). These patterns suggest that internal procedures (e.g., dispute resolution, periodic meetings) are strongly tied to selection criteria based on technical expertise, reputation, and goal alignment, while mediation and legal actions are closely related to collaborations prioritizing

reputation and legal frameworks. Significant correlations indicate that the selection of collaborators directly influences how disputes are managed.

The questions related to interconnection reveal a strong interest in lab interconnection, with respondents recognizing its importance for collaboration and innovation. Q20 (opinion on interconnection): Twenty-four respondents consider lab interconnection to be highly favorable, and twelve consider it favorable. There is significant interest in lab interconnection, suggesting that respondents perceive this aspect as essential for collaboration and innovation. Q21 (is your smart lab interconnected with others): Sixty-seven percent of respondents do not have interconnected labs, while thirty-three percent are interconnected with other labs. Despite the general interest in interconnection, most labs are not yet interconnected, indicating a lack of implementation of this system. Q22 (same field partners): Eighty-six percent of respondents collaborate with labs in the same field, suggesting a specialization in collaborations between similar labs. Collaborations focus on related areas, which may increase the efficiency and relevance of joint research (Table 5).

Table 5 – *Opinion on interconnecting smart labs*

Category/Question	Options	Response number	Percentage
Q20 - What is your opinion on interconnecting smart labs to enhance collaboration and innovation?	Very favourable	24	56%
	Favourable	12	28%
	Neutral	7	16%
	Unfavourable	0	0
	Very unfavourable	0	0
Q21 - Is your smart lab interconnected with other smart labs?	Yes	14	33%
	No	29	67%
Q22 - Are your partner smart labs in the same field?	Yes	12	86%
	No	2	14%

Inspection of the responses to Q11 and Q26 reveals several recurring words and expressions. One common theme is Technological Integration and Incremental Adaptation, where many respondents highlight the ongoing technological integration and gradual improvement of systems to address current challenges. These solutions are implemented progressively, adding functionalities as they become available without a fully defined plan. Another key theme is Strategic Planning and Customized Solutions, with some respondents emphasizing the importance of detailed planning and developing tailored solutions to integrate new functionalities, crucial for addressing issues identified in current activities. Additionally, Education and Awareness among Actors focuses on increasing awareness and training among participants, such as teachers and students, aiming to highlight the benefits of smart labs and encourage greater engagement. Standardization and Compliance with Regulations also emerged, with several respondents suggesting adherence to communication standards and compliance with European or national regulations, reflecting concerns for uniformity and system compatibility at the organizational level. Lastly, Unresolved Challenges and Lack of Solutions were

mentioned by some respondents, either noting that clear solutions have not been identified or that the challenges are driven by external factors, such as specific local regulations, beyond their control (Figure 4).

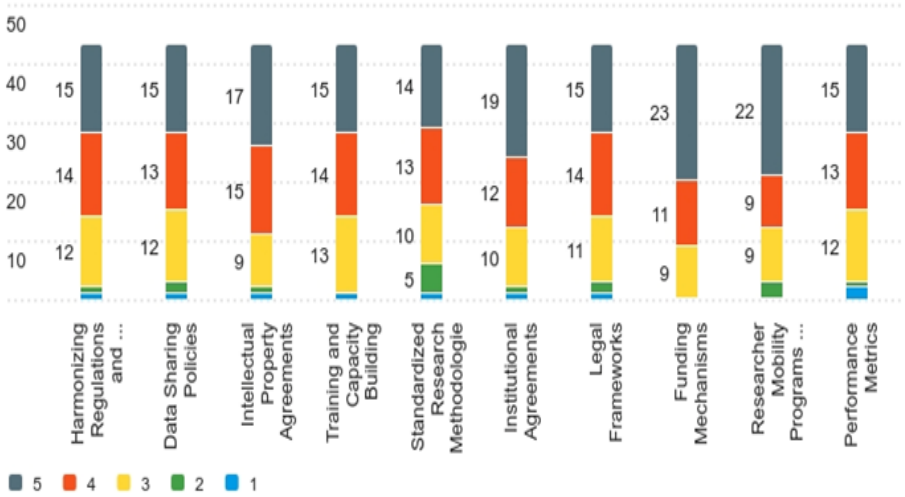

Figure 4 – *Collaboration measures*

The most valued measures for effective collaboration include funding mechanisms (Mean = 4.31, SD = 0.81), which are perceived as essential for the success of collaboration. Researcher mobility (Mean = 4.14, SD = 1.00) is also considered highly important, with access to researchers between labs being a key factor. Institutional agreements (Mean = 4.07, SD = 0.99) are seen as crucial for formalizing relationships between institutions, while intellectual property protection (Mean = 4.05, SD = 0.96) is recognized as a critical factor in securing the rights to research outcomes. On the other hand, some challenges are slightly less prioritized, such as standardizing research (Mean = 3.83, SD = 1.08), which, while important, is not seen as urgent compared to other measures. Additionally, harmonizing regulations and legal frameworks (Mean = 3.93) suggest a need for clearer regulations in international contexts (Figure 5).

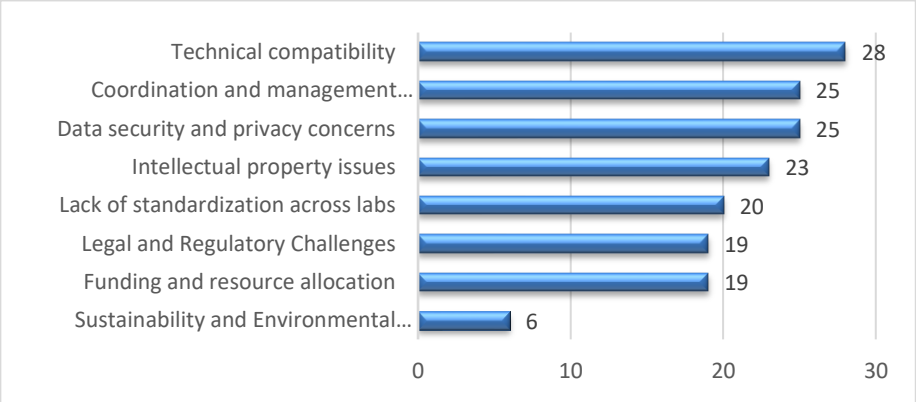

Figure 5 – *Challenges in interconnecting smart labs*

The most common obstacles to collaboration include *technical compatibility issues* (Mean = 0.66), with the lack of interoperability between systems being a major barrier. *Coordination and*

management complexity (Mean = 0.57) is another common challenge, as efficient coordination between partners remains difficult. *Data security and privacy issues* (Mean = 0.57) are also significant concerns, with secure data management being a problematic aspect. Less common obstacles include *sustainability and environmental challenges* (Mean = 0.09), which are rarely perceived as critical barriers, and *lack of standardization between labs* (Mean = 0.41), which, although important, is not seen as the most frequent issue.

Discussion and managerial implications

(H1) can be considered partially valid because integration (Q4) and challenges (Q5) have a significant but relatively weak influence on satisfaction. While questions related to integration (Q4) and satisfaction (Q6) capture the relationship between internal collaboration and satisfaction levels, the weak results suggest that other factors are not included in the analysis. This indicates that while the questions are relevant, they are limited in their ability to explain variations in satisfaction, potentially overlooking the influence of organizational or cultural context, which may affect user satisfaction.

(H2) is validated, as there is a significant positive correlation between internal collaboration (Q4) and its impact on productivity and innovation (Q12). The positive and significant correlation confirms the relevance of the questions, capturing the dynamics of collaboration and innovation outcomes. This supports the notion that internal collaboration is a central component of smart lab success.

(H3) is partially confirmed, as the mechanisms and procedures analyzed (agreements, selection criteria, compensation methods) descriptively contribute to resource access and collaboration efficiency. However, their influence on overall challenges is not clearly demonstrated. While the questions help understand the role of external collaboration and work procedures, their direct impact on general challenges remains unclear, suggesting that the questions are relevant but insufficient for a detailed analysis of challenges.

(H4) is validated, as standardized practices (such as standardized research methodologies) significantly contribute to the efficiency and success of interconnecting smart labs. The questions about standardized methodologies and their impact on interconnection are well-formulated, with their relevance confirmed by results showing a significant influence on the efficiency of collaboration between labs. These questions effectively capture key factors contributing to the success of interconnection and collaboration.

External collaborations are also crucial for the success of smart labs, with 74% of respondents relying on external partners like universities and research centers to access advanced technological resources, directly impacting the lab's innovation and efficiency.

The study emphasizes the necessity of interconnection to enhance collaboration, innovation, and productivity by improving workflows, access to specialized resources, and global research networks. However, financial constraints, lack of standardization, and technical difficulties present significant barriers. Standardized methodologies and human resource training are crucial for successful integration, while international collaboration faces additional challenges such as technical compatibility and regulatory discrepancies.

Increasing funding access through grants and institutional support can alleviate financial barriers, while dedicated mobility programs can facilitate researcher exchange and innovation. Clear intellectual property policies strengthen trust between partners, and harmonizing international regulations simplifies collaboration.

Key recommendations include developing standardized interconnection frameworks for seamless integration, enhancing centralized platforms for real-time data sharing, and advocating for aligned regulations and sustainable funding mechanisms. Addressing infrastructure incompatibility and policy misalignment through strategic investments will further support interconnected laboratory networks, ensuring long-term success in research collaboration.

Conclusions

Regarding the interconnection of smart labs, the data analysis highlights several key findings. A

positive correlation exists between lab interconnection and the perceived benefits of collaboration, particularly in data exchange and accelerated innovation. Collaboration between labs can lead to increased productivity and improved research processes. Despite the lack of interconnection in many labs, the strong interest suggests that it is still seen as important. There is also a discrepancy between the favorable opinions of interconnection and its actual implementation, highlighting that interest does not always translate into action.

Drawing from the findings of this study and aligning them with the literature, successful collaboration between smart labs requires a sustainable network collaboration model. These results contribute to the growing body of research by emphasizing that effective smart lab collaboration is dependent on a structured and well-integrated approach, where standardized protocols, interoperability frameworks, and resource-sharing mechanisms play a pivotal role. Furthermore, they highlight the importance of aligning institutional policies with best international practices to ensure seamless communication and technological compatibility.

The study's limitations include a small sample size of only 43 respondents, which may not fully represent the broader population of smart lab users and developers. With 71% of respondents from academic institutions, the findings may not be generalizable to other sectors like industry or government labs.

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A Bibliometric Analysis of Valorisation of Biomass Waste

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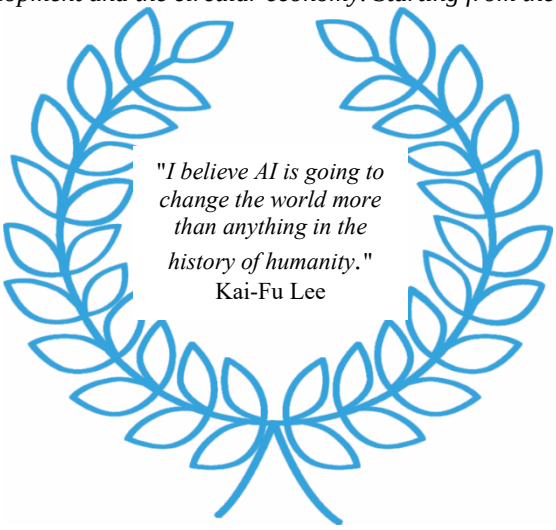
Abstract

The article carries out a bibliometric analysis of the research on the valorization of biomass waste, an increasingly topical topic in the context of sustainable development and the circular economy. Starting from the level of the current realities manifested at the European level regarding the valorization of biomass waste, by presenting the articles we wanted to observe the degree of research through the articles specific to these topics, in the form of an inventory of the publication activity, the database query being elaborated. from the Web of Science platform, resulting in 1436 articles containing the keyword "biomass waste valorization" being filtered as scientific articles, published in the open access system, in the last 5 years and included in the Sustainable Development Goals filter.

Using agricultural biomass waste is a sustainable approach to managing forest and industrial by-products by transforming them into valuable products. Analysis, effect and tools like VOSviewer, highlight research trends, emerging technologies and collaboration between researcher networks. The findings underscore the growing academic interest in the innovative use of agro-industrial wastes, technological advances in biomass processing, and the significant contributions these efforts are making to environmental sustainability.



Keywords: biomass waste valorization, circular economy, VOSviewer

Introduction

The approach of this work starts from the evolution of biomass waste valorization at the European level. Analysing the current trends in the evolution of requirements regarding waste

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treatment, the increase in requirements regarding waste management and the need for sustainable and sustainable development, it emerged that an important factor in the future development of the economic environment represents also the attitude and perspectives regarding waste management. This article aims to analyse, using a bibliometric method, the evolution of research in the field of agro-industrial waste recovery, with an emphasis on technological innovations and their contributions to the circular economy.

Biomass waste recovery mitigates the environmental impact of waste disposal and contributes to the circular economy by converting biomass into bioenergy, biofuels, chemicals and materials. The key technologies involved include anaerobic digestion, pyrolysis, gasification and fermentation, which enable the extraction of energy-rich compounds and the production of high-value chemicals. Biomass waste recovery has significant potential for reducing greenhouse gas emissions, conserving natural resources and creating economic opportunities in the waste management and renewable energy sector. However, challenges such as feedstock variability, process optimization and economic feasibility must be addressed to fully realize the benefits of biomass waste recovery. This summary reviews the current advances, opportunities and challenges in the field, highlighting the importance of continued research and innovation to improve the efficiency and scalability of biomass waste recovery processes.

The utilization of agro-industrial waste is a topic of major interest in the context of the transition to a circular economy and environmental sustainability. Waste generated by agricultural and food industries is a significant source of pollution if not managed properly, impacting soil, water and air health (F.A.O., 2019). At the same time, this waste constitutes a valuable resource that can be transformed into useful products, such as bioenergy, compost, bioplastics or even raw materials for advanced biomaterials (Ravindran and Jaiswal, 2016).

In recent decades, the global volume of agro-industrial waste has increased significantly, fuelled by rapid population growth and increased demand for food products. The sustainable management of these residues is essential to reduce the ecological impact of agricultural and industrial activities (Girotto, Alibardi and Cossu, 2015). In this context, waste valorization strategies have been approached from multiple perspectives, including biotechnologies, chemical conversion processes and the use of microorganisms to transform these residues into high-value products (Negro et al., 2017).

While the concept of biomass waste recovery is attractive, its economic viability is often a challenge. The costs associated with collection, transport, pretreatment and processing can be high, and the market for bio-based products is still developing. Achieving a balance between production costs and market demand for recovered products is crucial.

Literature Review

From the point of view of the circular economy, the valorisation of agro-industrial waste offers a significant potential to close the resource loop, by transforming waste streams into new useful products (Geissdoerfer et al., 2017). This approach not only reduces the pressure on natural resources but also contributes to the decarbonisation of the economy by reducing the greenhouse gas emissions associated with disposing of waste through traditional methods such as landfilling or incineration (Klemeš et al., 2020).

Emerging technologies such as microwave-assisted carbonization and advanced bioprocessing offer promising solutions for converting agro-industrial waste into innovative products such as biochar, biocomposites and biochemicals with high commercial value (Xie, Wang and Ma, 2021). Moreover, microorganisms play an important role in biomass conversion, having the ability to ferment a significant amount of usable carbon from waste to produce valuable goods such as bioethanol and biogas (Tock et al., 2010).

Bibliometric analysis is a valuable tool to understand the dynamics of research in this field. Such an analysis can provide a detailed look at the evolution of the topic of agro-industrial waste recovery, identifying emerging trends, collaborative networks and research gaps (Donthu, Kumar and Pattnaik., 2021). In recent decades, the number of scientific publications dealing with this topic has

grown exponentially, reflecting the global interest in sustainable solutions in waste management and the development of new supply chains for bioresources (De Jong, Jungmeier and Faaij, 2020).

Integrating biomass recovery processes such as anaerobic digestion into existing energy and waste management infrastructure presents logistical and technical challenges. Compatibility with existing systems, the need for new investment and regulatory compliance are common issues. The development of green extraction methods, such as supercritical fluid extraction and microwave-assisted extraction, is gaining traction. These methods allow the efficient extraction of bioactive compounds from biomass without the need for harmful solvents, making the processes more environmentally friendly. These innovations are particularly useful in the food and pharmaceutical industries, where the purity of extracted compounds is paramount. The agricultural industry benefits from innovations that transform agricultural residues and food waste into valuable products. Technologies such as composting, anaerobic digestion and pyrolysis help manage waste and produce biofertilizers, improving soil health and reducing the need for chemical fertilizers. In addition, the utilization of crop residues into biofuels or bioplastics creates new income streams for farmers.

Research Methodology

Taking into account the development of ways to preserve and archive scientific works, through the access of a growing number of teachers and researchers from different areas and fields of research to the results of scientific research, we want through this article to analyse open-access scientific articles, doing so- by applying Web of Science specific filters. Thus, through the analysis undertaken, the authors wish to capture new aspects of the debate, new points of view and new areas of research or reinterpretation according to the experiences of the authors of scientific articles on biomass waste valorisation.

This article is based on bibliometric analysis, which is a systematic and quantitative examination of bibliographic data. It is a powerful tool for organizing and understanding the knowledge present in the selection from the Web of Science database resulting in applying a search tag and specific filters and using scientific tools to process the resulting data through the VOSviewer program (Diaconescu et al., 2024).

Bibliometric research is based on principles from bibliography and statistical bibliography. The results and research of this kind can have some difficulties considering the large volume of information that is growing rapidly in the last period, being difficult to say that in such an approach the entire spectrum of scientific literature specific to a field of scientific interest. The bibliometric research is based on the systematic analysis of the scientific literature on the 1436 scientific research papers, which provided some perspectives on the evolution of biomass waste valorisation approaches (Radu et al., 2023).

The Web of Science database, queried using the search tag *"biomass waste valorisation*", resulted in a number of 8626 articles that include this tag in all the specific fields of an article. Because we wanted to capture topical issues that can be consulted through open access, the following filters were applied: Open access, Publication years 2020-2024, Document Types: Article, Sustainable Development Goals.

We applied the Open access filter because to do the analysis of word density and realization of co-occurrences through the software used in this article, we had to have access to the abstracts of the articles, and this was only safe for the articles published in this format. Of course, by choosing this filter, we can limit the conclusions to the content of the removed articles.

To make a comparison of the density of words and phrases associated with the key *"biomass waste valorisation",* we used the WOSviewer software by applying the *co-occurrence*, author keywords, minimum of 15 co-occurrences filters, resulting in a grouping of 4 clusters, and the specific graphic images of each cluster were subjected to analysis.

Results

A first query of the Web of Science database for the tag "*biomass waste valorisation*", without

filters, resulted in 1436 articles. Because we wanted to capture the most up-to-date aspects regarding the valorisation of biomass waste, we used the following: the scientific papers should be published in the open access system so that we can have access to all the information within our analysis, it should be published in the last 5 years, the scientific works must be articles in such a way as to respect the rigors of preparing our work and the articles must fit into the following sustainable development objectives. The evolution of the number of articles from the selection through successive application of filters on the 1436 results following the application of the label "*biomass waste valorisation*" is presented in Table 1:

Table 1 – *The order of the Web of Science filters used when querying the database*

Filter applied	Filter subcategory	Number of items	Number of articles after filter application
Open acces			2776
Years of publication 2020-2024			2211
Document Types-Article			1837
Sustainable Development Goals	Responsible Consumption And Production	524	1436
	Affordable And Clean Energy	455	
	Good Health And Well Being	203	
	Climate Action	149	
	Sustainable Cities And Communities	105	

(*Source*: Own conceptualization, processing Web of Science database)

Analysis of the density of the phrases or words used in the articles in the selection was carried out with the help of the VOSviewer program, by applying the co-occurrence filter, for all keywords, having an appearance of at least 15 times. 167 words/phrases from the 6822 analysed met this criterion, resulting in 4 clusters, with the following keyword content: cluster 1 -57 items, cluster 2 - 49 items, cluster 3 - 43 items, cluster 4 -18 items.

After processing the data using the VOSviewer program, the words and phrases that have the highest density: *biomass, waste, pyrolysis, pretreatment, circular economy, biochar, convention, food waste, and energy*. From the analysis of the content of the predominant phrases in this analysis, we can conclude that the articles in the selection deal with waste management or the actual process of processing them using chemical methods.

Based on the information contained in each cluster we will deepen the analysis for each cluster separately considering the strength of the links of the keywords with the highest density and the links in these and other clusters, thus:

- for cluster 1 - "keyword *pretreatment* with link strength 663", (figure 1),
- for cluster 2 – "keyword *biomass* with link strength 2184", (figure 2),
- for cluster 3 - "keyword *circular economy* with link strength 624", (figure 3),
- for cluster 4 - "keyword *biochar* with link strength 602", (figure 4).

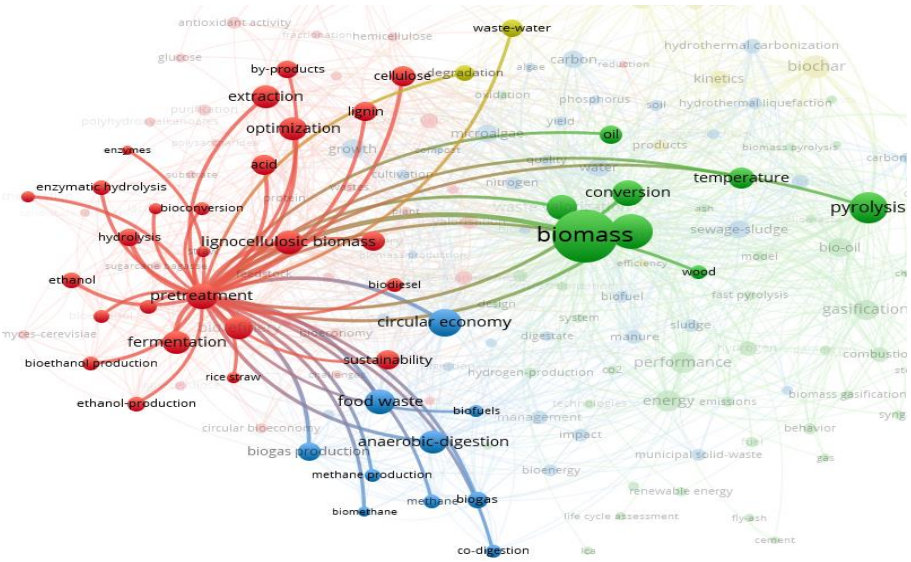

Figure 1 – *Cluster 1 keyword pretreatment with link strength 663*
(Source: Own conceptualization made with the VOSviewer software)

The articles in cluster 1 focus on the chemical and biological aspects of biomass waste valorization, especially related to antioxidant activities, acids and lignocellulosic materials (plant biomass component) and the conversion of materials into valuable products in the current situation where resources are limited. It can be observed that the keyword pretreatment has similarities with cluster 2 regarding the method of biomass transformation (biomass, pyrolysis, conversion, oil) but also with cluster 3 regarding the circular economy and the method of obtaining biomass and the products obtained from it (food waste) , biogas, biofuels, biomethane) Pyrolysis and pretreatment: they are crucial processes in the utilization of biomass. Within the biomass valorization process the need for pretreatment and the complexity of pyrolysis indicate that improving efficiency, reducing costs and scaling up these processes are significant challenges.

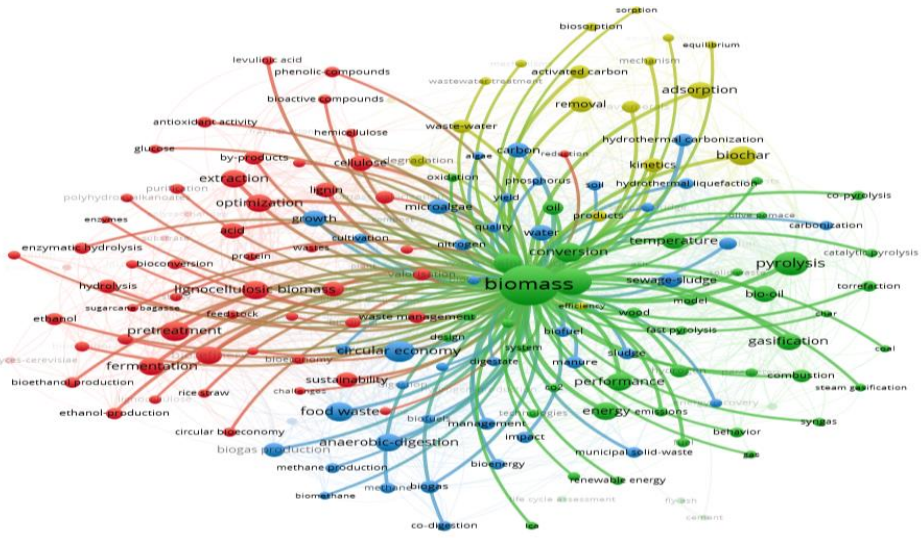

Figure 2 – *Clusterul 2 keyword biomass with link strength 2184*
(Source: Own conceptualization made with the VOSviewer software)

In the second cluster it can be seen that articles have been included that have as their subject the aspects of materials science and modelling of processes derived from biomass waste, such as ash and bio-oil, and their environmental impact including life cycle assessments, extraction oil and oxidation processes Life Cycle Assessment (LCA) is particularly important in this topic, helping to assess the sustainability and overall environmental impact of biomass utilization processes. The keyword of this cluster, biomass, is also found as a topic of analysis in the other 3 clusters in our selection The use of biomass-derived materials, such as activated carbon, faces challenges related to the consistency of material properties.

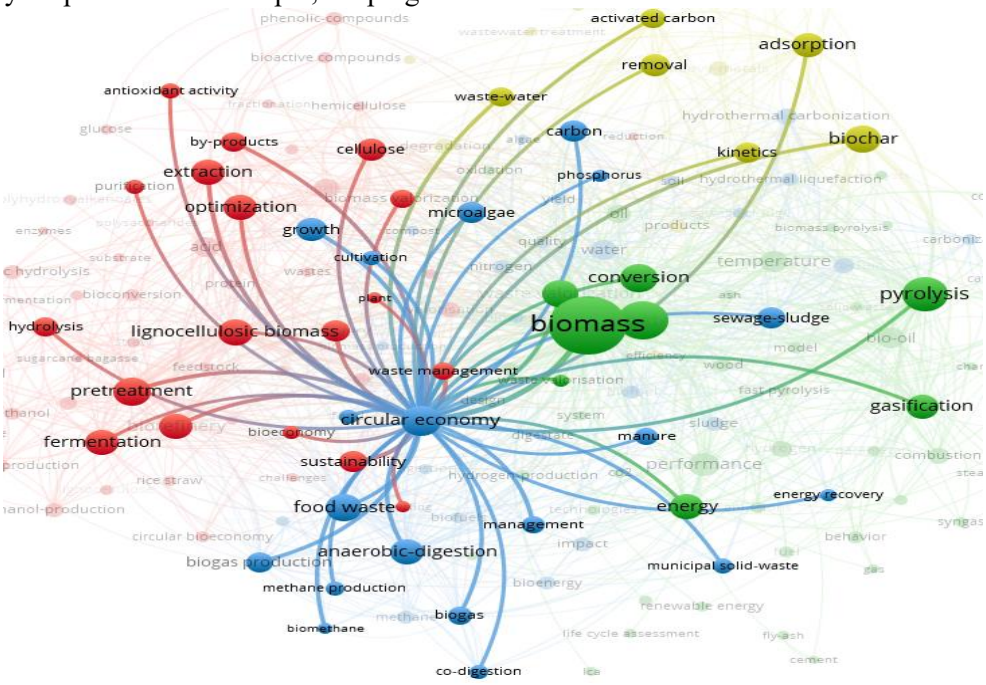

Figure 3 – *Cluster 3 keyword circular economy with link strength 624*
(Source: Own conceptualization made with the VOSviewer software)

Articles in cluster 3 focus on aspects of alternative energy sources and waste-to-energy processes, with an emphasis on materials such as algae and methods such as hydrothermal carbonization Hydrothermal carbonization is one of the key processes that transform wet biomass into solid fuels, highlighting the potential for solutions of transforming waste into energy. centred around environmental technologies for waste treatment and resource recovery. Activated carbon and adsorption processes are essential in the circular economy, especially for wastewater treatment and pollutant capture. It is also observed the connection of the predominant keyword in this cluster, circular economy, with cluster 1 regarding the chemical processes of biomass transformation (fermentation, extraction, pretreatment, hydrolysis), with cluster 2 with the results obtained from biomass transformation (gasification, pyrolysis, conversion, energy) and with cluster 3 with the processes resulting from biomass transformation (adsorption, kinetics, activated carbon).

Pyrolysis, for example, requires precise control of temperature and pressure to optimize yields and quality of output products such as bio-oil and biochar. While biochar production is a valorisation method, there are concerns about its environmental impact, especially if the feedstock is not managed sustainably.

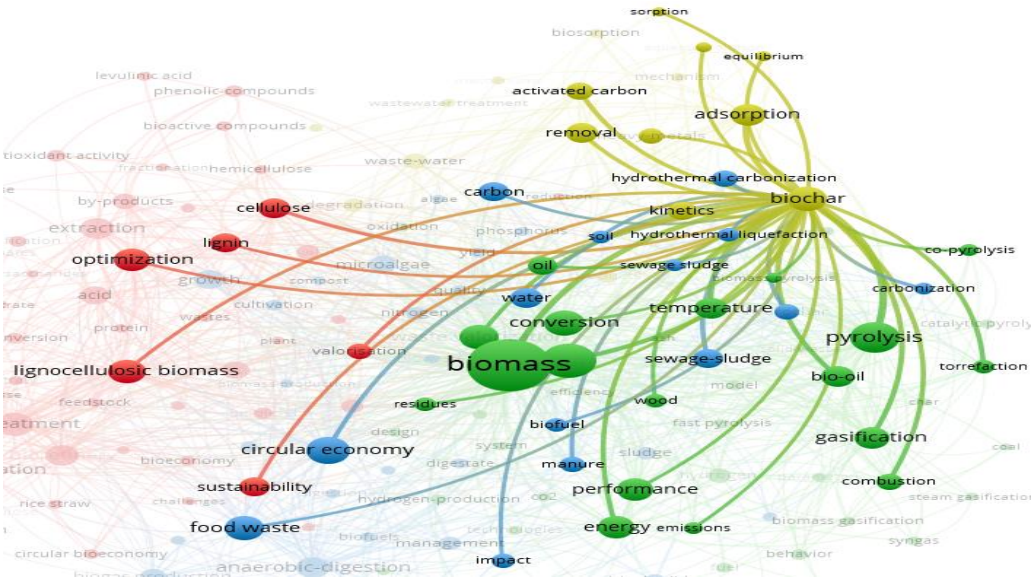

Figure 4 – *Cluster 4 keyword biochar with link strength 602*
(Source: Own conceptualization made with the VOSviewer software)

Articles in cluster 4 focus on aspects of waste treatment and environmental management, particularly involving materials such as activated carbon and processes such as adsorption and bio absorption, Biological and biochemical processes that transform biomass into bioactive compounds and bioenergy including the study of microbial processes, enzyme activity and the production of high-value compounds from biomass. The keyword in this cluster, biochar, has links with cluster 1 regarding biomass processing products (optimization, cellulose,), with cluster 2 on processes related to biomass transformation (gasification, combustion) and with cluster 3 with the management elements of circular economy (carbonization, water, impact) Life cycle analysis of biomass recovery processes must ensure that they provide environmental benefits compared to traditional waste management methods.

Conclusions

Each cluster represents a distinct thematic area within biomass waste recovery, ranging from chemical processes to environmental management and energy recovery. The equal occurrence of keywords within each group suggests that the data set encompasses a wide range of topics within each topic area, with no dominance of one term.

The overall analysis shows that biomass waste recovery encompasses a diverse set of topics, from chemical and materials science to energy production and environmental management. Each theme contributes to the broader goal of turning waste into valuable products while minimizing environmental impact.

The combination of environmental concerns, economic opportunities, technological progress, supportive policies and the need for resource security are all key drivers for innovation in biomass waste recovery. These factors not only promote the development of new technologies but also encourage the adoption of these innovations in various industries.

The authors believe that this article contributes to a better understanding of the valorization of biomass waste, providing valuable insights into the technological, environmental and economic aspects that are essential for understanding the world's expanding policies of sustainable development and effective environmental management.

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" *Artificial intelligence is the science of making machines do things that would require intelligence if done by humans.* "

John McCarthy

Synergy Between Research Projects

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Abstract

Green entrepreneurship is a concept that finds applicability in synergistic research projects. This article explores how collaboration and resource integration in research projects contribute to their efficiency and impact, highlighting the importance of entrepreneurial spirit within scientific intrapreneurship. We analyze collaborations between research teams, organizations, and within scientific clusters, emphasizing the challenges and benefits of this synergy. Additionally, we discuss the role of research infrastructure in optimizing resources and facilitating technological transfer, stressing the positive impact of these practices on the development of a collaborative and sustainable research environment.

Keywords: synergy of projects, technology transfer, research projects, resource allocation, scientific clusters

Introduction

In the scientific community, entrepreneurial spirit is often manifested through intrapreneurial activities. Unlike traditional entrepreneurship, which involves creating and managing a new business, intrapreneurship takes place within existing organizations, such as universities or research institutes (Engzell, Karabag and Yström, 2024). Researchers who submit project proposals for specific funding calls take on the responsibility of initiating and managing research projects. They not only identify problems and opportunities for innovation but also develop solutions and implement strategies (Istrițeanu, Băjenaru and

"By far, the greatest danger of Artificial Intelligence is that people conclude too early that they understand it."
Eliezer Yudkowsky

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Badea, 2022), managing resources and ensuring progress in line with the plans and objectives outlined in their proposals. In the context of modern scientific research, entrepreneurial spirit fosters innovation and technological development, even representing an attractive aspect of the field. In an environment where resources are often limited and the requirements of funding units are constantly changing, researchers are frequently faced with the need to develop and implement synergistic solutions to achieve their proposed goals (Liang et al., 2024). This approach reflects characteristic entrepreneurial traits: creativity, autonomy, and the ability to identify and seize opportunities.

The process of applying for research project funding largely reflects the characteristics of entrepreneurial initiative. Researchers, as intrapreneurs, are responsible for developing and presenting detailed and innovative project proposals, which require rigorous planning and a clear vision of research objectives. They take significant risks, similar to those undertaken by entrepreneurs, as project success is never guaranteed and depends on their ability to navigate a complex and often unpredictable landscape (Dumitrescu, Alexe and Alexe, 2009). Thus, they are constantly exposed to the risk of research failure, with the risk index being directly proportional to the degree of novelty, and the work involved in writing the project proposal represents a speculative risk (Deselnicu and Militaru, 2017). Additionally, managing a research project involves responsibilities like those of an entrepreneur: budget administration, team coordination, risk management and monitoring progress toward objectives.

In this dynamic, researchers are often required to mobilize and optimize available resources, making strategic choices to maximize the impact and efficiency of their projects. This approach closely aligns with entrepreneurial principles, as researchers need to develop innovative solutions for complex problems and adapt quickly to changes. The synergy of research projects leads to an increased number of indicators using minimal resources (Athiel et al., 2023). However, researchers must remain vigilant regarding research ethics. Special attention must be given to avoiding double funding. Researchers must ensure that they do not request double funding for the same research activities or resources, which is not only an ethical requirement but also an essential measure for maintaining integrity and transparency in the research process.

Moreover, collaboration and resource-sharing between research institutions contribute to the efficiency and sustainability of the research process, allowing access to essential equipment and data without the need for duplicated efforts and investments. This not only optimizes resource use but also supports the development of a more collaborative and innovative research environment, like how entrepreneurs collaborate to expand their businesses and access new market opportunities.

Collaboration Between Research Teams

Collaboration between research teams involves addressing scientific problems and advancing interdisciplinary fields, facilitating the tackling of complex issues that cannot be efficiently solved from a single perspective or methodology. This collaboration ensures the integration of diverse perspectives and expertise, significantly impacting the quality and depth of research. By combining knowledge and skills from various domains, research teams can develop more comprehensive and innovative solutions, which promote scientific advancement.

One of the main advantages of collaboration between teams is access to complementary expertise (Fig. 1). Each team brings a unique set of skills and knowledge, contributing to a more comprehensive and in-depth approach to the research problem (Li and He, 2024). This not only improves the quality of the results but also facilitates ongoing professional development for researchers by exposing them to different methods and perspectives. Applying various problem-solving methods helps in developing problem-solving skills and enhancing the ability to adapt to new challenges.

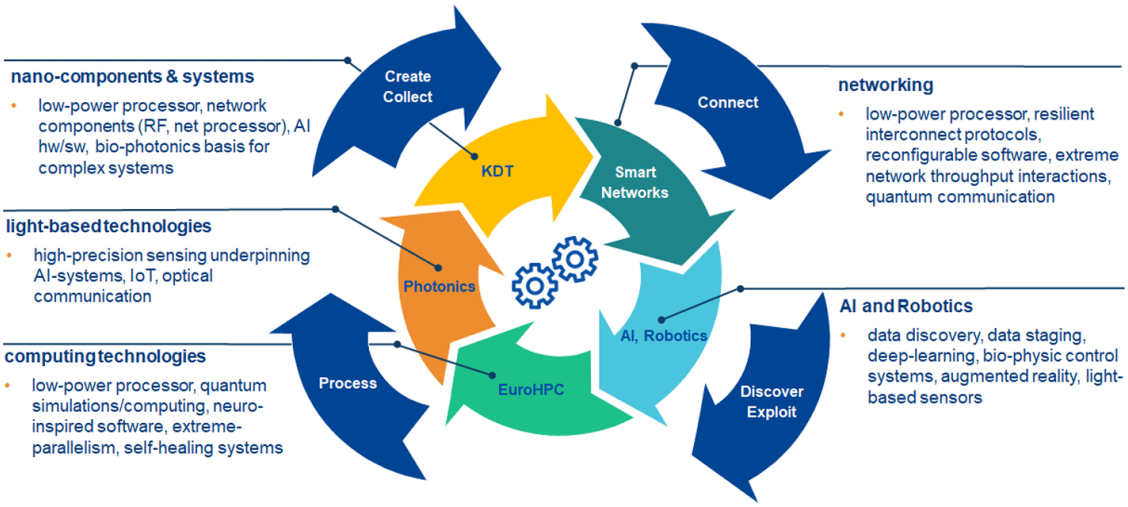

Figure 1 – *Example of inter-play between digital-centric partnerships*
(Source: European Commission, 2022)

Collaboration between teams in research projects significantly enhances the management and optimization of resources, whether financial, material, or human. When teams collaborate effectively, the sharing of knowledge and division of tasks result in more efficient resource utilization. By reducing redundancies and overlapping efforts, teams can minimize costs and make better use of their budget. This cooperative approach helps ensure that every financial resource is used to its fullest potential, allowing for better budgeting and reducing the need for additional funding (Assbeihat, 2016).

In terms of financial efficiency, collaboration enables teams to combine their budgets, eliminating unnecessary duplication of expenditures. This pooling of resources is particularly beneficial in larger projects requiring diverse expertise. It allows for more comprehensive budgeting strategies, often unlocking new funding opportunities that might not be available to isolated teams. Furthermore, collaborative projects are more likely to attract external funding from grant institutions, as joint efforts often demonstrate a broader impact and more innovative potential.

Material resources, such as lab equipment or shared experimental setups, are also managed more effectively in collaborative environments. Rather than each team investing in the same tools or resources, shared use allows for better resource allocation. Teams can use existing materials and equipment more fully, thereby lowering overall costs and avoiding the acquisition of unnecessary assets. This shared approach also promotes sustainability by maximizing the utility of physical resources (Fiscarelli et al., 2021).

Human resources are similarly optimized through collaboration. By bringing together individuals with diverse skill sets and areas of expertise, teams can approach problems from multiple perspectives, resulting in more innovative solutions. Collaboration fosters an environment of knowledge exchange, where individuals can contribute unique insights and skills. This diversity enhances the intellectual resources available to a project, allowing for more efficient problem-solving and better overall performance. Furthermore, collaboration boosts morale and encourages a sense of support and teamwork among members, leading to a more motivated and productive workforce (Fiscarelli et al., 2021).

However, collaboration between research teams can present significant challenges. One of the main difficulties is coordinating efforts among multiple teams. As the number of participants increases, the complexity of coordination also grows, requiring effective communication and synchronization mechanisms. Cultural differences and varying work styles can influence how teams communicate and collaborate, potentially leading to misunderstandings

and conflicts. Managing the communication process is important for ensuring effective collaboration and preventing issues that may arise from cultural and organizational differences (Alexe and Alexe, 2013).

Integrating different methodologies represents another major challenge. Each team may use its own techniques and approaches, and harmonizing these methodologies within a common framework requires a deep understanding and flexible adaptation. It is essential to strike a balance between different methodologies to ensure the coherence and validity of the research results. Time and resource management is also complicated, especially in the context of large projects involving multiple teams and resources.

The analysis of initiatives in various clusters, including Health, Digital, Industry and Space, Climate, Energy and Mobility, Food, Bioeconomy, Natural Resources, Agriculture and Environment, and Other Pillars, highlights the complexity and diversity of cross-sectoral collaborations in research projects. Each cluster has a distinct profile, with varying degrees of interconnectedness and synergies between domains, which influences their ability to address contemporary global challenges. These can be analyzed through the lens of European projects.

The Health Cluster is distinguished by significant collaboration through projects dedicated to the same 50% sector. This orientation suggests that health acts as a pillar of support for other domains, facilitating synergistic collaborations in research initiatives (Fig. 2). For example, the presence of digitization and industry at 12.5% indicates a willingness to integrate innovative technologies in the health sector, while the total absence of contributions from climate and mobility shows the difficulties in creating meaningful links in these areas.

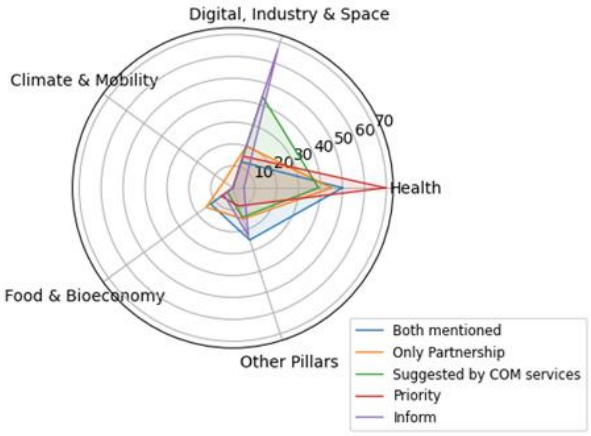

Figure 2 – *Synergy of Health Cluster projects*
(Source: Adapted from European Commission 2022)

Coherence in partnerships is demonstrated by the fact that the health cluster alone supports the other areas, with 45% of resources allocated to health in partnerships. The European Commission's recommendations, indicating 39.1% of resources for health and 43.8% for digitization, underline the interconnectedness of these areas. This sector allocates 12.5% of project resources synergistically to food, bioeconomy, natural resources, agriculture and environment, demonstrating the compatibility of the two clusters.

However, the complete absence of contributions from air conditioning and mobility highlights the challenges faced in integrating them.

The Digital, Industry and Space Cluster is characterized by a predominance of initiatives dedicated to this sector, with 51.6% of the projects focusing on digitization and industry, in a mutually reinforcing way. This structure emphasizes a strong focus on innovation and technological development (Fig. 3). However, the 3.2% share for health in joint projects suggests weak collaboration between these areas, making it difficult to create effective

synergies. Although the digital sector has a significant weight in the initiatives, the links with health are limited, highlighting the challenges faced in integrating them.

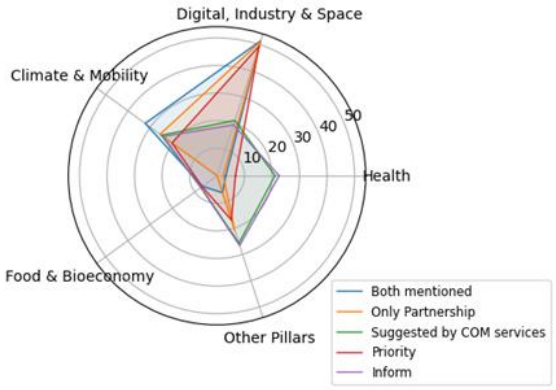

Figure 3 – *Synergy of Digital, Industry and Space Cluster projects*
(Source: Adapted from European Commission 2022)

The coherence of the partnerships is reflected in the allocation of 51.2% of resources to the digital and industry sector, while the health contribution remains modest at only 2.3%. The European Commission's recommendations underline the interconnectedness between these areas, allocating 21.1% of resources to health and a similar share of climate and mobility. The prioritization of digitization, with 49.4% of resources, underlines the importance of this sector in research initiatives. In conclusion, although the Digital, Industry and Space cluster presents a solid structure, the limited interactions with health underline the difficulties to form more effective synergies between these domains. Nevertheless, it remains the most dynamic sector with significant potential for development.

The Climate, Energy and Mobility cluster stands out with a strong focus on environmental and sustainability issues, with 68.9% of projects dedicated to this area. This focus highlights the commitment to climate challenges but also suggests a significant limitation of collaborations with other sectors (Fig. 4). The complete absence of health initiatives indicates a clear separation between these areas, making it difficult to create synergies between health and environmental issues. However, the 24.4% share for the digital and industrial sector shows a significant potential for integrating innovative technologies into climate and mobility approaches, signaling an opportunity to build bridges between these areas.

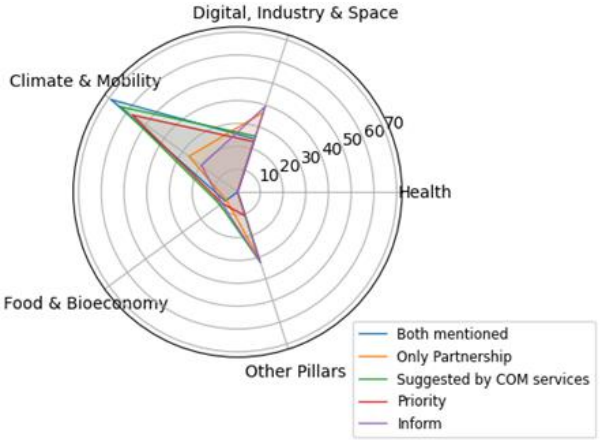

Figure 4 – *Synergy of Climate, Energy and Mobility Cluster projects*
(Source: Adapted from European Commission 2022)

In terms of coherence of partnerships, only 26.5% of resources are allocated synergistically to climate, energy and mobility within the partnerships, while the digital and industry sector receives 36.7%. The European Commission's recommendations, which indicate 63.5% of resources for climate, energy and mobility, underline the recognition of the solidarity of this sector. However, implementation of these recommendations remains a challenge given the lack of collaboration with health. Despite the prioritization of the climate domain, with 57.3% of resources allocated, limited interactions with other sectors suggest the need to step up efforts to build more effective synergies. Thus, the Climate, Energy and Mobility sector remains essential in the context of sustainable development but faces challenges in integrating inter-disciplinary initiatives.

Food, Bioeconomy, Natural Resources, Agriculture and Environment Cluster stands out with a significant and reciprocal focus on food and bioeconomy issues, with 54.2% of synergistic projects dedicated to this area. This structure (Fig. 5) suggests that the food and natural resources sector plays a central role in development initiatives, particularly in relation to the 16.7% share of climate, energy and mobility links. However, the low percentages of 8.3% for health and digitization indicate limited collaboration with these areas, making synergies between them more difficult to achieve. In addition, the complete absence of health contributions in the information initiatives further highlights this separation.

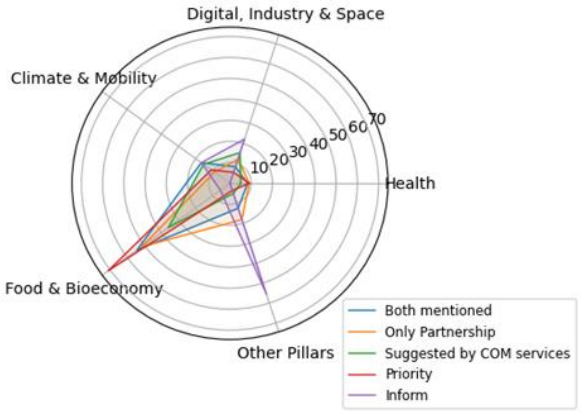

Figure 5 – *Synergy of Food, Bioeconomy, Natural Resources, Agriculture and Environment Cluster projects*
(Source: Adapted from European Commission 2022)

The coherence of solidarity partnerships is reflected in the allocation of 51.5% of resources to the food and natural resources sector within the partnerships. The European Commission's recommendations, which allocate 35.9% of resources to this cluster, underline the recognition of its importance in sustainable development strategies, but also its under-exploited interdisciplinary potential. The prioritization of this sector, with 70.9% of resources allocated, emphasizes its relevance in the current context of food and environment challenges. It is also notable that the food sector enjoys a 55.6% share of information initiatives, suggesting a tendency to integrate this area into broader development discussions. However, the limited interactions with health and digitalization underline the need to strengthen collaborations between these areas to maximize the impact and effectiveness of joint initiatives.

The cluster focused on other pillars stands out through a diversity of initiatives (Fig. 6), with a significant share of 28.6% for health and 35.7% for digitalization and industry. This distribution suggests moderate collaboration between these domains, but also a capacity to integrate innovative technologies into healthcare solutions. However, the percentage of 14.3% for climate, energy and mobility, together with 21.4% for food and bio-economy, indicates a fragmented approach without a clear link between health and the other areas.

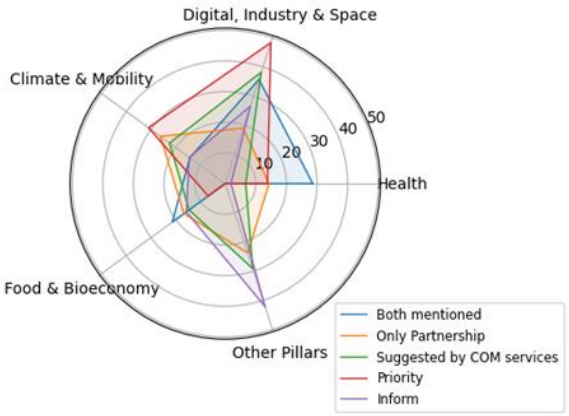

Figure 6 – *Synergy of Other Pillars Cluster projects*
(Source: Adapted from European Commission 2022)

The coherence of partnerships is demonstrated by a variable allocation of resources, with 26.2% dedicated to the climate sector, 19% to digitalization and 14.3% to health. This suggests a capacity for cooperation across sectors but also challenges in mainstreaming these initiatives. The European Commission's recommendations underline this diversity, allocating 38.2% of resources to the digital sector, but also 29.2% to other pillars, which highlights the recognition of the interconnections between these areas.

The prioritization of digitization, with 48.3% of projects, highlights a tendency to invest in innovative technologies, but the 13.8% for health suggests that this sector remains underexploited in the initiatives. Likewise, within the information initiatives, the health sector receives only 1.2% of resources, indicating a lack of visibility and integration of the health sector in the wider development discussions.

Thus, clusters outside the domains discussed above present a varied spectrum of initiatives, limited interactions and asymmetric distribution of resources highlight the need to intensify collaborations between health and the other domains to maximize the impact and efficiency of joint initiatives.

Collaboration between organizations

Cooperation relationships, whether national or international, are often strengthened through strategic partnerships and joint projects, having a positive impact on scientific progress. This collaboration relies on building strong and trustful relationships between institutions, which facilitates the exchange of essential knowledge and resources.

An important aspect of inter-institutional collaboration is influenced by legislative changes that regulate the research and innovation framework, as well as by the eligibility criteria within project calls. Legislation in this area, which includes regulations on data protection, intellectual property rights and funding eligibility criteria, can significantly impact how institutions collaborate and manage their projects. Institutions need to stay attuned to these changes and adapt accordingly to ensure compliance and take advantage of existing opportunities. Discussions and debates within the scientific community about legislative changes are common and can influence research directions and collaboration (Ancona, Cerqueti and Grassi, 2024).

In inter-institutional collaborations, researchers often discuss emerging technologies and available market solutions. These informal discussions or debates can reveal both opportunities and challenges related to the implementation of new technologies. By exchanging information and critically evaluating existing technologies, researchers can identify the most promising solutions and adjust their approaches to better meet current industry demands. This type of discussion helps maintain an updated perspective on the state of technology and guides research towards relevant and applicable directions.

Additionally, transitioning from theoretical research to practical application of results can often

be complicated by technological and financial obstacles. Challenges encountered during the implementation process can lead to misunderstandings between researchers and industry professionals, as each party may have different expectations and goals. Industry feedback, even in unofficial forms, can uncover real problems and challenges, helping to adjust research efforts to better meet market needs.

By fostering effective communication and mutual understanding, research institutions can enhance the impact and efficiency of their collaborations, thereby advancing scientific knowledge and tackling complex challenges.

Collaborating between organizations during the development of research projects provides a powerful way to save or earn resources. One of the most effective ways to save resources through collaboration is by merging financial, material, and human assets. This enables organizations to avoid duplicating efforts and costs by sharing lab spaces, equipment, or even personnel. According to research, collaborating on research and development projects helps in expediting workflows, sharing costs, and reducing risks. This shared resource model can significantly lower the financial burden on individual organizations while also making better use of existing materials and infrastructure (Starmind, 2024).

In addition to saving resources, collaboration between organizations can also lead to earning opportunities, particularly through partnerships and grants. Many organizations, especially academic institutions, find that collaborating on research projects makes them more attractive candidates for external funding, such as government grants or private-sector investments. These collaborations often demonstrate a broader potential impact due to the diverse expertise and resources being merged, which can lead to better funding opportunities. Research also shows that collaborative projects between universities and industries not only expand networks but can also lead to new commercial ventures, creating potential revenue streams for both partners (University of Minnesota, 2024).

Moreover, collaboration helps in sharing intellectual property and expertise, which reduces the need for costly external hires or consulting services. It also creates opportunities for commercialization of research outcomes, such as licensing patented innovations or collaborating with industry to bring research findings to market, further generating revenue. Through strategic collaborations, organizations can also access new markets or industries they might not otherwise reach, offering an additional avenue to earn resources (DealHub, 2024).

There are various specialized tools for analyzing collaborations between organizations, such as Web of Science - Core Collection, InCites Journal Citation Reports, Derwent Innovations Index, and Clarivate Analytics. These platforms allow the identification of academic partnerships and affiliation relationships between institutions.

This information is extremely useful for both affiliates and non-affiliates, as it provides a clear perspective on the academic collaboration networks of the institution. For affiliates, the data allows the identification of strategic partners, facilitating the development of new collaborations or strengthening existing ones. It also enables the evaluation of the impact of their own research and access to a broader network of knowledge and resources. For non-affiliates, this information is valuable for identifying potential collaborators, understanding the influence and connectivity of an institution within its research field, and accessing relevant studies published in collaboration with a selected organization.

Membership in scientific clusters

Adhering to scientific clusters is a strategic move for strengthening collaborations between research institutions and has become standard practice in the scientific and technological fields (Li and He, 2024). Clusters are networks of organizations, laboratories, and centers of excellence that share common interests and goals in a specific domain, facilitating the integration of resources and expertise. These networks significantly contribute to scientific and technological advancement through collaboration and synergy among their members.

One of the main benefits of being part of a scientific cluster is the extended access to resources. Access to these shared resources enables the execution of complex and ambitious projects that would typically be challenging for individual organizations to undertake alone.

Additionally, scientific clusters facilitate the exchange of information and best practices among network members. Collaboration based on common standards and methodologies enhances research efficiency and fosters the development of innovative solutions. By integrating emerging knowledge and technologies, clusters enable the continual updating of research methodologies and the promotion of best practices in the field. This collaborative approach helps overcome individual barriers and creates a conducive environment for innovation.

Moreover, membership in a scientific cluster supports the development of international partnerships, expanding collaboration opportunities and access to global resources. By integrating into international networks, organizations can explore new funding opportunities and gain greater recognition within the global scientific community. This international context facilitates the transfer of knowledge and best practices between different regions and cultures, thereby enhancing the impact and relevance of research. Furthermore, international collaboration can lead to the creation of ambitious global projects that address complex and large-scale issues.

As a relevant example, the International Federation of Robotics (IFR) encourages synergy between research projects and industry through various means that facilitate collaboration and knowledge exchange among researchers, companies, and international organizations. Through the "Innovation and Entrepreneurship in Robotics and Automation Award," the IFR recognizes cutting-edge innovations that combine advanced research with practical applications. This award stimulates the development of efficient technological solutions that can be implemented in industry (Robotics, 2024), thereby connecting researchers directly with companies (Mascarenhas, Ferreira and Marques, 2018).

Additionally, the IFR organizes international events, such as the International Symposium on Robotics (ISR), where researchers and industry experts can discuss trends and innovations in robotics. These events provide a framework for networking, idea exchange, and the initiation of partnerships between academic and industrial projects.

Furthermore, providing access to global statistics and news from the field is another asset of the IFR. It collects and distributes detailed statistics about the industrial and service robot markets worldwide, allowing researchers to better understand technological and economic trends in the industry (Barbu and Militaru, 2018). This data is used by researchers to identify emerging fields, assess the technological impact of innovations, and find opportunities for the practical application of their research. Such frameworks encourage international collaboration among organizations.

The Code of Ethics of the General Association of Engineers in Romania (AGIR) represents a set of fundamental principles that regulate the professional activity of engineers, establishing rigorous standards of competence and integrity (AGIR, 2024). It defines the practical quality and moral responsibilities associated with the profession, integrating technical, scientific, economic, and social requirements into an ethical framework designed to ensure the positive impact of engineers on society and the environment. The professional responsibilities of engineers, as outlined in the Code, impose strict compliance with professional and deontological norms, emphasizing technical excellence, social responsibility, and adherence to high moral values. Competence, creativity, honesty, professionalism, and social responsibility are considered essential elements in an engineer's activity, serving to guarantee durable and sustainable results from economic, technical, and ecological perspectives. Throughout their professional activities, engineers must act according to fundamental deontological principles, which include conducting work at the highest standards of quality and professionalism, as well as demonstrating behavior that enhances the prestige of the profession. The Code highlights the importance of devotion to the profession, continuous development of individual competencies, and promoting teamwork, thereby ensuring a climate of trust and mutual respect in professional relationships. The balance between the desire for professional affirmation and modesty is regarded as a fundamental principle for ensuring ethical evolution in one's career.

The Code prohibits unfair competition practices, such as defamatory advertising, exploiting a position of power, or unjustified criticism of other engineers. Among these rules, the acceptance of tasks is highlighted as being contingent upon possessing the appropriate competencies; in cases where the expertise of another specialist would be more suitable, they must seek their advice. Thus, collaboration is viewed as a strategic tool for achieving scientific excellence.

Nevertheless, membership in scientific clusters also comes with challenges that require careful management, such as differences in objectives, work styles, and organizational cultures, which can lead to conflicts and delays. Additionally, issues related to intellectual property and the sharing of research results are frequently encountered. There is a need to establish clear agreements on intellectual property rights and the use of research results in order to avoid legal conflicts and disputes between group members.

Another critical aspect is securing funding and managing resources. Although clusters provide access to shared resources and infrastructure, securing initial funding and financial sustainability poses significant challenges. Organizations need to be prepared to invest their own resources and participate in joint fundraising efforts to support the cluster's operation and growth. In this regard, developing effective funding strategies and collaborating with strategic partners can help maintain and expand the cluster's impact. Often, affiliation with scientific clusters also involves paying a subscription fee.

Research infrastructure

Research infrastructure is a key factor in inter-institutional collaborations, providing a fundamental framework for science. Efficient collaborations between institutions allow for the optimal use of existing infrastructure, contributing to resource savings. A notable example is when an institution has access to modern or rare and costly research facilities. In such cases, other institutions can request access to these resources without needing to individually invest in the purchase and maintenance of the equipment.

This collaboration model significantly reduces costs and facilitates advanced research that would otherwise be impossible due to budget constraints. For instance, if a research institution has access to high-precision testing equipment, other institutions can use this equipment through collaboration agreements, thereby optimizing resource use and avoiding redundant investments.

An essential aspect of this model is technology transfer, which enables the integration and application of knowledge and innovations developed by collaboration partners. Technology transfer refers to the process by which technologies and innovative solutions are moved from their developers to other entities that can implement or further develop these technologies. Through collaborations, institutions can access not only equipment but also the associated technologies and knowledge, thus facilitating the development of advanced and applicable solutions in new contexts.

For example, if an institution has developed advanced technology for data analysis, other collaborating institutions can benefit from using this technology without needing to develop their own solution. Additionally, this often involves professional training of researchers on how to use innovative technologies.

In the context of research infrastructure, collaboration is also pivotal for the development and maintenance of facilities. For example, certain research infrastructures, such as high-performance computing centers or cleanroom laboratories, require constant maintenance and updates to meet necessary standards. Through collaboration between institutions, the costs and responsibilities of maintaining these facilities can be shared, ensuring that they remain functional and efficient.

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The Romanian online databases EERIS (European Research Infrastructure System) and Brainmap play a crucial role in advancing research and development across the country. EERIS serves as a centralized platform that provides access to Romania's research infrastructure, facilitating the efficient use of available resources. By offering a comprehensive inventory of equipment, facilities, and other research tools across institutions, EERIS enables researchers to optimize resource sharing, avoid duplication of efforts, and minimize costs. This promotes collaborative research both nationally and internationally, fostering innovation by ensuring that state-of-the-art infrastructure is accessible to a wide range of research teams.

Brainmap, on the other hand, focuses on mapping and linking researchers to their relevant fields of expertise. It is designed to promote collaboration by allowing users to identify and connect with experts in various disciplines. This is especially important in fostering interdisciplinary research, where the convergence of different fields can lead to breakthroughs and innovation. Brainmap helps streamline the process of forming research partnerships, ensuring that the right expertise is matched to the right project.

Together, EERIS and Brainmap not only enhance Romania's research capabilities by improving access to critical resources and expertise but also contribute to the country's overall competitiveness in the European and global research landscape. These platforms support strategic planning and the more efficient allocation of resources, making them indispensable tools for modern research ecosystems.

Dissemination of results

Disseminating results is a fundamental step in scientific research, helping to capitalize on the knowledge gained and transfer it to the scientific community and the general public (Opstoel et al., 2024). An effective dissemination strategy not only ensures recognition of researchers' work but also facilitates the application of results in practical contexts and future research.

Publishing in specialized scientific journals is one of the most popular methods of dissemination. The peer review process, especially the "double-blind peer review" system, where both authors' and reviewers' identities are kept anonymous, ensures an impartial and reliable assessment of the research quality. This rigorous process enhances the credibility and impact of publications, making the results accessible and usable to other researchers in the field (Atwani et al., 2024).

Additionally, access to specialized literature enables researchers to leverage existing data and discoveries, saving time and resources. Instead of replicating experiments that have already been conducted, researchers can analyze and use published data to develop their own projects. Thus, the publication of results contributes to the overall efficiency of research and the advancement of collective scientific knowledge.

Nowadays a plenitude of databases gathers scientific articles for the benefit of worldwide research. The use of specialized literature databases is instrumental in optimizing the resource economy of research projects. By providing immediate access to a wealth of peer-reviewed literature, these databases significantly reduce the time required for literature reviews and background research. This accelerates the initial stages of a project and allows researchers to build upon established findings rather than initiating their work from foundational principles. As a result, the overall time investment in preliminary research is minimized, allowing teams to focus more on the experimental and analytical phases.

From a financial perspective, access to article databases helps avoid the costs associated with purchasing individual studies or conducting repetitive experiments. Many databases offer institutional subscriptions or open-access articles, making high-quality information readily available without excessive expenditure. This ensures that research funds can be allocated more efficiently, with a greater portion directed towards critical project needs, such as equipment procurement or data collection efforts.

Additionally, the databases provide insights into validated methodologies and experimental techniques, reducing the likelihood of errors and material waste. By adopting these established methods, research teams can streamline their workflows, minimize the use of physical resources,

and enhance the precision of their experiments, contributing to overall resource efficiency and project cost-effectiveness.

The concept of 'open access' allows free access to scientific research without financial barriers. By removing economic constraints, open access publications facilitate wide and rapid dissemination of knowledge, contributing to better international collaboration and helping to avoid unnecessary duplication of research.

In support of this model, transformative agreements facilitate the transition from the traditional subscription-based model to open access. These agreements enable researchers to publish freely and access valuable articles, ensuring a more equitable distribution of knowledge and contributing to the democratization of access to scientific information.

Also, conferences facilitate the dissemination of results and represent an opportunity for creating synergies between researchers from different projects. By participating in such events, author teams can be formed to collaborate on publishing joint papers, maximizing the impact of each project and saving resources. This approach allows for achieving multiple performance indicators for various projects through a single expense.

Collaborations between authors from different research teams offer the opportunity to combine their expertise and resources, increasing the quality and relevance of the results. Instead of each team organizing its own events and managing associated costs separately, a single joint article or report, resulting from a conference presentation, can meet the dissemination requirements for several projects simultaneously. These synergies contribute to saving organizational resources and optimizing their use, creating a multiplier effect in knowledge mobilization and the collective advancement of science.

Finally, the proper and timely dissemination of results through rigorously reviewed and freely accessible publications plays a central role in advancing science and in the efficient use of existing research resources.

The synergy between research projects can also include supply chain management. A relevant example is the continuity of studies on carbon footprint, which involves sourcing products from suppliers who have conducted carbon footprint assessments for their products. By adopting this model, the carbon footprint study of the final product will rely on the supplier's analysis, continuing with the manufacturing processes carried out at the client's site. In this way, the supplier's research and development team can provide a solid foundation for the client's research and development team. For example, Mercedes has stated that it requires such studies and declarations from suppliers to support its sustainability mission (Mercedes-Benz Group, 2024). Thus, synergy in research projects requires creativity and is a process of proactively analyzing opportunities.

Conclusions

In conclusion, efficient resource management proves to be essential for maximizing the impact and effectiveness of scientific research projects. Collaboration between research teams, partnerships between organizations, and membership in scientific clusters are essential strategies for optimal resource use, thereby facilitating the execution of complex and innovative projects.

The first aspect to mention is the extensive access to resources, which is one of the greatest advantages of collaboration. Within scientific clusters, organizations benefit from advanced infrastructure and equipment that they might not be able to access individually. This not only reduces costs and avoids duplicated efforts but also enables the conduct of large-scale research.

Collaboration between research teams aids in integrating diverse perspectives and expertise, contributing to a more efficient use of financial, material, and human resources. It reduces costs, promotes sustainability, and fosters a richer intellectual environment, making the research process more effective and productive overall. Combining knowledge and skills from different fields helps in developing innovative and comprehensive solutions, reflecting strategic resource management and effective coordination. This type of collaboration enhances research quality and facilitates access to complementary resources, thereby increasing the impact and relevance of the obtained results.

On the other hand, collaborations between organizations emphasize the importance of resources and best practice exchange. These partnerships allow institutions to access emerging technologies and innovative solutions without needing to invest individually in their development. Organizational collaboration in research projects not only saves costs by merging resources and expertise but also opens opportunities to earn resources through partnerships, external funding, and commercialization efforts. Furthermore, discussions and collaborations about available technologies contribute to identifying the most effective solutions and adjusting existing resources to better meet the current demands of industry and research.

Research infrastructure also plays a fundamental role in facilitating inter-institutional collaborations. Sharing infrastructure allows for resource savings and ensures the optimal use of equipment and facilities. EERIS and Brainmap are key Romanian online databases that enhance research by promoting resource sharing and collaboration. Together, these platforms improve Romania's research efficiency, promote innovation, and strengthen the country's competitiveness in the global research landscape by streamlining access to critical resources and expertise.

Similarly, scientific article databases enhance resource efficiency by saving time, reducing costs, and ensuring access to reliable, peer-reviewed research, allowing researchers to optimize methods and allocate resources more effectively.

In conclusion, the sustainable allocation of scientific research resources represents a step toward green entrepreneurship. Moreover, careful and strategic management of resources not only optimizes research budgets but also supports innovation and continuous development in a globalized and interconnected environment.

***Acknowledgements*:** This work was supported by the (1) Research Program Nucleu within the National Research Development and Innovation Plan 2022-2027, carried out with the support of MCID, project no. PN 23 43 04 01; (2) CERMISO Center – Project Contract no. 159/2017, Programme POC-A.1-A.1.1.1-F; and (3) Support Center for international CDI projects in the field of Mechatronics and Cyber-MixMechatronics, Contract no. 323/22.09.2020, project co-financed from the European Regional Development Fund through the Competitiveness Operational Program (POC) and the national budget.

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" AI is neither good nor evil. It's a tool. It's a technology for us to use."
Oren Etzioni

Stimulating Entrepreneurship in the Green Sector

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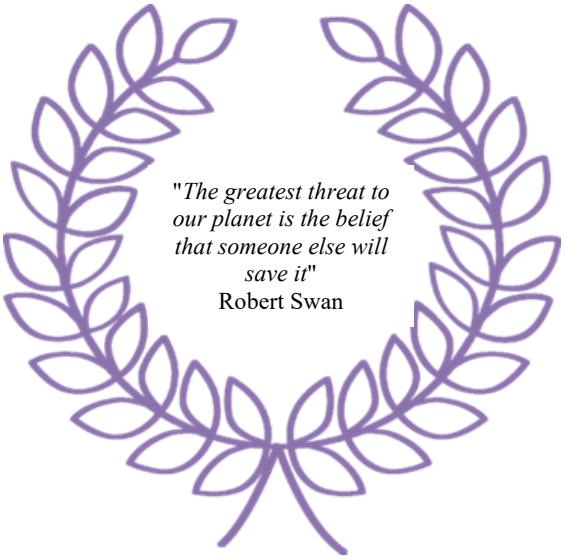
Abstract

The main objective of this article is to identify how European initiatives and policies stimulate entrepreneurship in the green sector. The European Union has as zero priority a political and social consensus around climate change. The challenges of the 21st century need a unity-centered approach with a common goal of preventing environmental degradation and shaping a sustainable society. Thus, in this paper, we have presented how entrepreneurship can become a viable solution for the transition to a green economy. The main approach at the European level is called the European Green Pact which has climate neutrality by 2050 as its main commitment. It emphasizes the need for a holistic approach to accelerating a modern, circular, and competitive sustainability-oriented economy. In conclusion, a proactive connection between the public and private sectors is the key green sector development to combat climate change through a circular economy.

Keywords: European Green Pact, sustainability, European Union, entrepreneurship, green sector, circular economy.

Introduction

Before delving deeper into the chosen topic, it is necessary to define what the European Green Deal is and what initiatives it proposes for the area of green entrepreneurship. This European pact was officially launched by the European Commission in December 2019 on strong friction on climate change (Bogoslov et. al., 2022). Its goal is climate neutrality by 2050 at the European level outlining a framework conducive to transforming the EU into an economically and socially equitable society. The initiatives proposed in this pact focus on the following areas of interest: climate, environment, transport, industry, energy and agriculture. The



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objective of the industrial strategy is to actively support industry in its responsibility to be a permanent catalyst f or economic growth through innovation and change. Strengthening Europe-wide resilience and promoting competitiveness can create the enabling framework for European industry to become a global driving force in the drive towards climate neutrality. Another relevant mechanism in the European Green Deal is the Just Transition Facility which provides financial and technical support for regions facing the transition to a low-carbon economy. At the business level, financial support for research and innovation is provided through various European programs or governments, a concrete example is the NRRP(national recovery and resilience plan) which allocates significant amounts for the transition to low-carbon technologies. The main beneficiaries of the Just Transition Fund are SMEs and start-ups which can become a pillar in the economy at micro level (European Council, 2024).

In a free-market environment, every human action inherently possesses an entrepreneurial quality. The continuous pursuit of profit opportunities marks entrepreneurial activity, whether these are identified through discovery or actively created. Essential elements defining entrepreneurship include a relentless focus on profit, the willingness to assume risks and manage uncertainty, capital ownership, specialized expertise, and a drive for innovation (Topan, 2013; Foss and Klein, 2012; Mises, 1998).

At the European level, a transition towards sustainable entrepreneurship is sought through certain programming that funds the transition to a proactive economy. The LIFE program is an essential tool for the development of initiatives aimed at nature conservation, carbon reduction, digitalization and the promotion of green technologies. Another program is the European Regional Development Fund, which provides significant sums for resource efficiency. European policies have eco-friendly regulations on developing innovative and sustainable solutions for SMEs. An emerging and pro-active policy framework fosters the emergence of sustainable enterprises with efficiency as their main quality through six relevant mechanisms: resource prioritization, competence building, sustainable market creation, network sharing, collaborative replication and impact assessment. Complying with these mechanisms at the micro-industry level can drive a permanent interconnection between enterprise creation, system transformation and impact reorientation that have the just transition to an emerging economy as the ultimate factor (Watson, Nielsen and Wilsin, 2022).

At the core of the European Green Deal Industrial Plan is the enhancement of the competitiveness of European industry with net zero emissions and a continuous accelerating transformation towards climate neutrality. The European Union is strongly committed to creating the enabling framework for expanding European capacity to produce green technologies. The position publicly expressed after the Green Deal vote by European Commission President Ursula von der Layen reveals the responsibility of our generation for the green technology revolution for a sustainable future. The four key pillars of the industrial plan are: a predictable and simple regulatory environment, fast access to finance, increasing skills and open trade for resilient supply chains. The predictable and simple regulatory pillar aims to create a simpler, faster and more predictable framework that guarantees the necessary number of raw materials and ensures that users can benefit from the low costs of renewable energy. Three initiatives underpin this work: the Net Zero Emissions Industry Initiative, the Critical Raw Materials Initiative and electricity market reform. A second pillar is fast access to finance by simplifying the grant process for Member States. The European Commission is facilitating the use of EU funds to finance innovation, production and deployment of clean technologies, focusing on REPowerEU and InvestEU. Reinforcing the necessary skills is another important pillar showing an exponential increase in the necessary skills by preparing a dual system of education. The last pillar is open and fair trade by cooperating at the international level to ensure the functioning of trade in accordance with the principle of fair competition and the principle of free trade, based on commitments undertaken with EU partners and the work of the World Trade Organization. The European Union assumes its

responsibility to become a shield against unfair trade practices and a supporter of free trade agreements through permanent forms of cooperation (European Commission, 2024).

The European Green Deal supports a foundation at the heart of a dual transition, green and digital. Industry has a responsibility to gradually reduce its carbon footprint by providing affordable technological solutions and developing new business models. The strategy has been updated due to the Covid-19 pandemic which has brought new challenges for today's society and the industry at mass level. The crisis caused by Covid-19 led to a 6.3% downturn in the EU economy, a 60% of SMEs reporting a drastic drop in turnover in 2020, a 24% drop in the volume of business transactions and an alarming 45% of firms expecting to reduce their investments in 2021 (European Commission, 2024). A 55% reduction in carbon emissions by 2030 and a complete decarbonization of the economy by 2050 is the boldest goal of the European Green Deal that can only be achieved with a fair distribution of funds across all major sectors of the economy (Ruiz, Moreno and Perez, 2023).

The focus area for this paper is the Industrial Strategy for Europe, which is based on green transitions towards climate neutrality. Sustainability has become a global priority given that climate change is felt regardless of the area, European policies play an essential role in stimulating entrepreneurship in the green sector since 2020. After the crises that have occurred in Europe in recent years such as the COVID-19 pandemic and the Russian Ukrainian War, the European Union has changed its perspective regarding green investments because a predictable business environment is needed. The volatility of programs is much accentuated in the post-covid era, thus programs such as the European Green Deal, Horizon Europe and InvestEU, develop the sector and encourage ecological innovation. In this difficult context for entrepreneurs, European initiatives not only support start-ups and businesses, but also outline a framework in strategies where the objectives of reducing carbon emissions and protecting the environment become priority zero. This article explores the challenges of contemporary society and presents the main European policies that support green entrepreneurship, as well as the challenges that 21st century entrepreneurs face in the process of adapting to new environmental regulations.

Methodology

Bibliographical analysis has been the basis of the present work with information processed from academic sources, but also from the online environment. The academic and online sources, together with the people in the field of European affairs (politicians, experts, specialists) are a key factor in understanding the concrete understanding and formulating the terminology as accurately as possible in order to create a coherent framework. In the current situation, the official website of the European Commission is the main reliable source worldwide with information available in real time and with materials elaborated as detailed as possible with prominent statistics. For this reason, we have used this source throughout the paper together with academic articles addressing the topic on the website - ScienceDirect. Another relevant source in this article is Eurostat (Statistical Office of the European Union) where high-quality statistics and indicators are published allowing comparative assessments at the level of European countries and regions.

Other communication mechanisms used in this article are represented by official platforms, such as specialized portals such as EU Green Deal, Horizon Europe and InvestEU, which provide detailed information on strategies, funding and regulations, as well as news that appears daily on the media agenda. These platforms are constantly updated to reflect legislative changes and new funding opportunities and helped me to provide an accurate framework for this article.

Results and Discussion

The European Green Pact has opened a plethora of funding at the European level on different areas of interest that have environmental protection at the EU level at their core. Thus, we can see from Eurostat data that the amount of investment for environmental protection at the European level is 69 billion euros in 2022. EU spending related to

environmental protection has seen a high growth of 24% between 2019-2022. The highest value of investment in the public-private area is in wastewater and waste management services, where most subcontractors are SMEs or firms in the recycling industry. In 2022, they accounted for 44% (wastewater) and 25.7% (waste) of the total environmental protection investment. The list goes on with 10.5% of the investments were mostly for air protection, 7.8% for radiation protection, environmental research and development including education area, 6% for soil and groundwater protection, 4.4% for biodiversity and landscape conservation, and the lowest value for noise reduction. In Figure No. 1 we can see the billions of euros invested in the area of environmental protection.

Other relevant data reveal that there are 44 billion Euro, with a share of more than 60% of the total investments in environmental protection were spent by SMEs. Professional environmental service providers (such as private companies involved in waste and wastewater collection and treatment) and non-specialized manufacturing companies purchase technology and equipment to reduce the environmental impact of their production processes (equipment that reduces emissions to air). The share of public and non-profit sector investment was 35% of total investment. Looking at the ratio of investment in environmental protection to total investment, it will be around 2.5% in 2022, with a ratio of corporate investment of 2% and a ratio of government investment of 4.8% (European Commission, 2024) The role of European policies to promote entrepreneurship in the green sector is crucial for promoting sustainable development and innovation in the internal and external market. Partnerships between border regions encourage cooperation to improve and harmonize rules and procedures for cross-border service provision, deployment of workers and use of digital tools. The development of the global Start-up Nations program for young entrepreneurs is essential in creating an international framework to promote the exchange of knowledge and experiences in the field of green entrepreneurship.

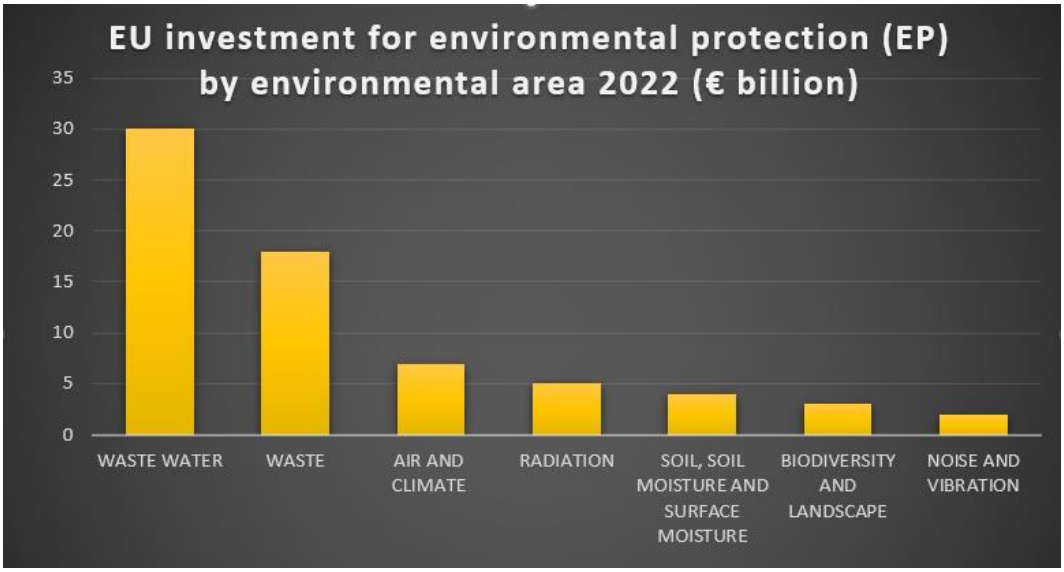

Figure 1 – *EU investment to protect the environment 2022*
(Source: Eurostat, 2022)

Supporting Member States in implementing the Late Payments Directive by creating monitoring and enforcement tools will also contribute to improving business conditions for green companies. Working with Member States to develop national standards set at EU level is crucial for accelerating the development of small and medium-sized enterprises and high-tech start-ups in the European internal market. European policies therefore form the basis for creating a favorable environment for

business growth and innovation in the green sector, contributing to the transition to a more sustainable and greener economy.

Green public procurement is an essential tool in European policy to promote sustainability and environmental protection. The program is designed to encourage authorities across the European Union to buy more environmentally friendly goods and services. Through the PAPV, it generates high demand for green products and technologies. The European Union supports green entrepreneurship through various initiatives and programs. COSME provides funding and support for innovative and sustainable solutions. All these efforts to promote green public procurement and green entrepreneurship should lead to environmental protection and job creation. The concept of sustainability is very important from an entrepreneurial perspective as it has a major impact on the way companies are managed and perceived in the post-industrial society. Fundamentally, entrepreneurs who embrace and promote sustainability take responsibility not only for the short-term profitability of their businesses, but also for their impact on the environment and the communities in which they operate daily. With growing concerns about climate change, environmental degradation and social inequality having become a leitmotiv, the concept of sustainability at the macro level is becoming increasingly relevant and necessary for the success and sustainability of businesses of all kinds. In Figure 2, created with the tool WordArt, we can see the conglomeration of connections resulting from the term sustainability. The entrepreneurs of the future use ethical and responsible business practices that consider their impact on the environment, employees, communities and the economy.

By adopting sustainable strategies and practices, the entrepreneurs of the future can gain significant competitive advantages, including enhancing brand reputation, increasing long-term customer loyalty and attracting sustainable investment. It will also help to build a more resilient and fairer economy that ensures the well-being and prosperity of future generations. In today's ever-changing society plus the complex challenges of the 21st century, embedding sustainability into a company's core structure is crucial for entrepreneurs to achieve long-term success and have a positive impact on society and the environment.

Figure 2 – *Sustainability conglomerate*

Significant investments have led to the ambitious European Green Deal targets of 20%, reflecting recognition of the important role of the private sector in financing the transition to a green economy. In this context, consistent and concrete strategies have been adopted, innovative regulatory frameworks have been developed and smart tools have been introduced to be as proactive as possible.

National governments have also played an important role in financing the transition process by sending the right price signals and directing public spending towards sustainable policies, but also by setting up bodies to oversee the implementation of eco-friendly policies. Environmental degradation is expected to have an increasingly strong impact on society and automatically on economic activity at micro or macro level. It can cause extreme and damaging weather events, affect human health and limit access to natural resources. The European Green Deal covers several key priorities, including protecting the EU's natural capital, the transition to a resource-efficient economy and protecting people from environmental pressures. Member States are implementing reforms and further developing environmental policies and strategies to address these challenges (European Comission, 2019).

The tangible investments with long-term implications under the European Green Deal underline the importance of involving the private sector in financing the transition to a modern green economy. By adopting strategies tailored to the needs of contemporary societies, developing innovative regulatory frameworks and implementing smart and applicable instruments, the European Union and its Member States aim to accelerate this process to create a more sustainable framework. National governments are the basis for allocating public funds for sustainable policies, as well as by creating bodies to monitor their implementation. The impact of environmental degradation on society and the economy is becoming increasingly evident in agriculture but also in the social sphere, manifesting itself in extreme weather events, public health problems and reduced access to natural resources.

Green public procurement has driven demand for more sustainable goods and services and reduced the carbon footprint of public services. Through strong governance frameworks, decision-makers can take responsibility for future generations and effectively and responsibly implement the policies and actions needed to combat climate change and promote more sustainable and resilient economies. In this way, through sustained efforts at the European and national level, politicians and institutions have demonstrated a strong commitment to achieving the objectives of the European Green Deal and are building confidence in greener and more prosperous societies and economies. Through the priorities set out in the Green Deal, such as protecting the EU's natural capital for the next 30 years, transitioning to a resource-efficient economy and reducing pressure on the population in the short and medium term, Member States continue to adapt their environmental policies and strategies based on EU priorities. Their success depends on continued and reciprocal cooperation between the public and private sectors, the use of innovative financial instruments and maintaining a strong and dynamic long-term commitment to sustainability.

Figure 3 – *Green job pathway*
(Source: Adapted after Lijfering, S.and Lacey, N., 2022)

Taking all of this into account, Figure 3 illustrates a pathway for green jobs, emphasizing the significance of these components in fostering growth within the green job sector. The elements highlighted in this pathway include the adoption of circular economy principles to drive growth, the integration of sustainable practices across various industries, the enhancement of incentives for green entrepreneurship, the development of green skills, and the elevation of awareness regarding the importance of the green sector.

Conclusions

In conclusion, the presented article highlights the importance of European policies in developing entrepreneurship in the green sector, focusing on the European Green Deal and the commitment to climate neutrality by 2050. These policies therefore stimulate innovation and development towards a green and circular economy, contributing to the fight against climate change and to building a more sustainable society. By promoting a holistic approach and active cooperation between the public and private sector, European policies accelerate the transition to a circular economy with a clear focus on overall sustainability and provide opportunities for entrepreneurs to innovate and succeed in this emerging sector. It is essential in this process that policy makers, government institutions and entrepreneurs work together to develop and implement initiatives and policies that promote and support the growth of entrepreneurship in the green sector.

The topic chosen in this paper is complex due to the changes at the European level and the novelty of the topic because the pact was published at the end of 2020. This had implications on the analysis carried out due to the limitations on certain statistics that have not yet been analyzed at the mass level and there are still legislative changes. The transition in an incipient form towards the circular economy and the volatility of the field of green entrepreneurship is still in its infancy in terms of definition from an academic point of view. The complex nature and applicability of the topic in our society influences both statistical analysis and the clarification of the concept of green entrepreneurship from an academic perspective. Green entrepreneurship is an incipient field but with immense prospects for the future. In this context, it is essential that decision-makers, government institutions and entrepreneurs collaborate to develop policies and initiatives that support the growth of this sector, thus ensuring economic, social and environmental benefits in the short, medium and long term.

The role of European policies in stimulating entrepreneurial initiatives in the green sector is therefore crucial for building more sustainable and climate-resilient economies, leading to environmental, social and economic benefits in the short, medium and long term. The novelty of the paper stems from the way the topic is approached and the specificity of the literature review that prioritizes the impact of policies in European SMEs and industry. The challenges in this study arise from the dynamic nature of the field and the continuous evolution of economic practices, thus it is imperative to have a continuous and adapted approach in research on similar initiatives and European society.

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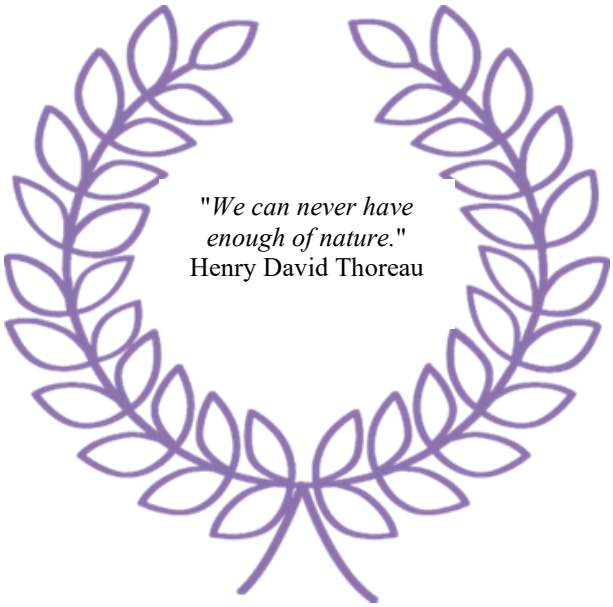

Impact of AI and NLP on Agile Methodologies

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Abstract

The contemporary software development landscape is marked by rapid innovation, transformation, and continuously evolving consumer demands. Agile methodologies were developed to address these challenges, serving as a bridge between innovative technology and market needs while promoting adaptability, communication, collaboration, and iterative progress. However, Agile practices still face significant challenges in managing complex projects efficiently. Integrating AI-driven tools, particularly those utilizing Natural Language Processing (NLP), enhances Agile environments by automating repetitive tasks, providing immediate insights, and supporting data-driven decision-making. This research investigates the impact of AI and NLP on Agile environments through a case study of ING Bank, highlighting their transformative potential in optimizing operational processes and fostering an innovative organizational culture.

Keywords: Agile methodologies, Artificial Intelligence (AI), Natural Language Processing (NLP).

Introduction

The current software development framework is impacted by swift innovation, transformation, opposing competition, and ever-evolving continuous consumer demands. Considering this, Agile methodologies were conceived to overcome these challenges, acting as a bridge between innovative technology and current market demands, stimulating adaptability, communication, collaboration, incremental and iterative progress (Beck et al., 2001). Agile practices continue to face significant challenges, despite their extensive scope and success, especially in managing compound, dynamic projects in an efficient manner.

Agile AI-driven tools incorporate the evolutionary potential of artificial intelligence

"*I do think there should be some regulations on AI.*"
Elon Musk.

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within, particularly in an Agile landscape. Based on this, these progressive technologies behave like alchemists attempting to transform base metals into precious metals, such as gold, encouraging AI to develop and efficient Agile processes effectively (Smith and Anderson, 2022). In this context, a pivotal component of these AI-powered tools is represented by Natural Language Processing (NLP), which empowers the analysis of vast volumes of textual data collected within Agile environments.

Agile Alchemists can be perceived as transformative vectors in the technological spectrum, offering immediate insights, automating repetitive activities, and leveraging the data-driven decision-making process. This is feasible by integrating complex NLP algorithms and different ML (machine learning) approaches. In this context, this approach enables agile teams to explore the intricacies of contemporary software development with remarkable accuracy and efficiency (Johnson et al., 2023). NLP, for example, can be utilized to examine multiple aspects, such as sentiment in terms of team communications, backlog item prioritization, review and outline sprint retrospectives based on stakeholders' feedback, generating team effectiveness and well-being.

The culture of resilience and continuous improvement promoted by Agile methodologies is also supported by the confluence of multiple innovative and integrative factors, such as AI and NLP. In consideration of the above information, this research article explores the multifaceted implementation and utilization of Agile AI-driven tools and NLP, analyzing how they affect different aspects of project management, such as team dynamics. This is embodied through a central research question, more precisely: *How can AI-powered tools with the use of NLP impact the Agile environments?* The answer to this research question is constructed through a case study on a multinational banking and financial services corporation ING, using in-depth analysis. The main objective of this study is to elucidate the fundamental role of these Agile alchemist tools in modeling the software development framework future (Williams, 2021).

Agile Principles

In a world marked by continuous technological breakthroughs, with evolving market needs, constant change is both necessary and difficult, especially to adapt to a changing culture. In this context, Agile methodology can be defined as a modern project management and software development framework that encourages adaptability, communication and collaboration, incremental and iterative delivery. Therefore, Agile started as a value-driven approach to developing software, created to streamline activities and processes on complex and dynamic projects. Since then, it has emerged into a philosophy or mindset containing a set of strongly defined values and principles (Malakar, 2021).

The Agile Manifesto, created in 2001 by a collective of seventeen software developers, signifies a fundamental shift in software development philosophy towards flexibility, collaboration, and customer-centric approaches (Agile Manifesto, 2001). It articulates four core values: prioritizing *individuals and interactions over processes and tools,* emphasizing the importance of human collaboration in achieving project success; valuing *working software over comprehensive documentation,* which underscores delivering functional products rather than exhaustive paperwork; encouraging *customer collaboration over contract negotiation,* promoting active customer engagement throughout the development process; and embracing *responding to change over following a plan,* highlighting adaptability in the face of evolving requirements.

These values are operationalized through twelve guiding principles that advocate for early and continuous delivery of valuable software, welcoming changing requirements - even late in development - to provide competitive advantage, and delivering working software frequently (Table 1) (Agile Alliance, 2001). They emphasize close cooperation between business stakeholders and developers, building projects around motivated individuals, and favoring face-to-face communication for efficiency. The principles also recognize working software as the primary measure of progress, promote sustainable development

practices, and encourage continuous attention to technical excellence and good design to enhance agility. Moreover, they value simplicity, endorse self-organizing teams for optimal outcomes, and stress the importance of regular reflection and adjustment to improve effectiveness. Collectively, the Agile Manifesto and its principles provide a foundation for methodologies that enhance responsiveness, product quality, and stakeholder satisfaction in software development.

Table 1 – *Agile Principles*

Our highest priority is to satisfy the customer through the early and continuous delivery of valuable software.
Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.
Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.
Business people and developers must work together daily throughout the project.
Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.
The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.
Working software is the primary measure of progress.
Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.
Continuous attention to technical excellence and good design enhances agility.
Simplicity–the art of maximizing the amount of work not done–is essential.
The best architectures, requirements, and designs emerge from self-organizing teams.
At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly.

(Source: Agile Alliance, 2001)

The Agile methodology encourages a rapid response to changing stakeholders' requirements, ensuring projects' relevance and alignment with their needs. For example, frameworks like Scrum and Kanban embody Agile in practice by encouraging enhanced flexibility, a continuous improvement in culture, collaborative and transparent workflows. Also, different academic reviews by Behrens et al. (2021), Magistretti, Trabucchi (2024), and Moloto et al. (2022) highlight the impact that Agile projects on organization's success, emphasizing this approach's benefits and the challenges it faces in distinct multiple contexts.

AI on Agile Methodologies

Artificial intelligence (AI) embodies the advancement of computer systems that prevail in completing activities that are traditionally associated with human cognitive capabilities. Its importance is reflected by its potential to improve efficiency, generate innovation, and stimulate the development across diverse industries, such as: healthcare, finance or education (Russell and Norvig, 2021). An example which supports this idea is represented by the implementation of AI applications, including: virtual assistants, recommendation algorithms, automotive industry, more exactly the autonomous vehicles (AV), and medical imaging are reshaping these sectors (Esteva et al., 2017; Bojarski et al., 2016; Jiang et al., 2017). Leading academic institutions, such as Stanford and Harvard University are main contributors to AI research, focusing on the development of human-centered AI and continuously addressing ethical considerations (Clark et al. 2021). Based on this, the pivotal role of the academic world in shaping the future of AI is highlighted by Stanford's Institute for Human-Centered AI and Harvard's numerous publications on AI ethics (Whittaker et al., 2018; Etzioni and Etzioni, 2017). In this context, Agile

methodologies underline the importance of iterative and incremental development, generating continuous feedback, and being supported by collaborative team efforts. The integration of AI into Agile frameworks expects to improve the decision-making process, automate repetitive tasks, and increase team efficiency (Beck et al., 2001). Moreover, research demonstrates that AI-driven tools are able to considerably optimize resource distribution, risk management, and project predictions by utilizing predictive analytics and machine learning (ML) techniques (Smith and Anderson, 2022).

NLP in Agile Frameworks

Natural Language Processing (NLP) technologies facilitate the examination and interpretation of unstructured textual data produced by Agile teams. For instance, in Agile environments, NLP applications encompass sentiment analysis, automated meeting minutes, and backlog prioritization influenced by customer feedback. Research has indicated that NLP can improve collaboration through increased efficient communication, minimize documentation volumes, and optimize backlog administration (Johnson et al., 2023). Amidst these considerations, it can be mentioned that NLP-powered tools can scrutinize team communications to detect any possible challenges, errors and enhance the team dynamics.

Contemporary research has underscored the evolutionary impact of AI-driven tools within Agile frameworks. Based on this, Cabrero-Daniel (2023) performed a meta-analysis focused on the role of AI in Agile development, accentuating the advantages of incorporating AI for continuous integration and provision. His analysis also discovered important areas of improvement, including the necessity for potential specialized sociotechnical knowledge and ethical reflections. Analogously, Chinta (2021) analyzed the effects of AI-driven automation on Agile project management, remarking enhancements in collaboration, communication, operational efficiency, and decision-making processes.

By critically assessing these previous research papers, it can be observed that although AI instruments provide major benefits, including improved decision-making process and predictive analytics, they deliver challenges such as resistance to change and ethical considerations. The requirement for specialized knowledge, expertise and the potential displacement of numerous positions are significant challenges to extensive implementation.

In spite of the encouraging development, gaps are still present in the existing literature. Advanced research on the long-term AI impact on Agile practices is scarce and the indirect challenges connected with its implementation and integration have not been thoroughly addressed. Also, studies often focus on specific tools or case studies, lacking a comprehensive analysis of AI's broader implications on Agile methodologies.

This research article intends to address these gaps by delivering a holistic analysis of AI-powered Agile tools, exploring their implications on Agile methodologies. In pursuing this objective, it aims to provide a more nuanced understanding of the effective integration of AI into Agile practices to improve software development workflow.

When integrated with NLP, AI-driven Agile instruments provide considerable opportunities for enhancing software development practices. Based on the case study of ING, this research seeks to offer important insights into the effective application of these tools in determining the future of Agile project management approaches.

AI and NLP on ING Bank

ING is a multinational company in the banking and financial services area. It encountered various difficulties in sustaining agility and receptiveness, especially in the context of a highly regulated and contentious landscape with a dynamic competitive market. Based on this, ING made a step forward in its transformative journey, improving its Agile practices through the implementation of AI-driven tools integrated with natural language processing (NLP) to optimize operational processes, enhance the decision-making process, and promote innovation, fostering an Agile mindset across the organization.

Research Methodology. This case study analyses the impact of implementing Artificial Intelligence (AI) and Natural Language Processing (NLP) into Agile practices at ING, a multinational banking and financial services organisation. This research aims to investigate and understand how AI-driven tools using NLP can improve Agile frameworks, particularly within highly regulated and competitive domains.

A qualitative approach was selected to obtain an in-depth comprehension of ING's transformative process. This method is adequate for reviewing complex phenomena within a factual, concrete context, allowing for a comprehensive analysis of organizational practices and innovations (Yin, 2018). Data were collected was represented by: document and semi-structured interviews analysis, observational data, and a comprehensive literature review. More exactly, an in-depth review of an interview with Bart Schlatmann, former Chief Operating Officer (COO) of ING Netherlands, generated direct insights into the organization's Agile transition and AI implementation. Semi-structured interviews allow flexibility to investigate emerging areas of interest while supporting a consistent line of inquiry (Kallio et al., 2016). The document analysis research stage included examination and interpretation of ING's internal reports, strategy documentation, and numerous references on the integration of AI-powered tools and Agile approaches, as well as industry reports, and academic articles related to ING's technological proposals. This integrative approach augments interview data and generates a holistic perception of context and implementation tactics (Bowen, 2009).

Despite the fact that direct observation was restricted, secondary accounts of ING's Agile practices were analyzed to infer operational dynamics. Observational data improve the study's quality by offering tangible examples of practices and interactions within Agile frameworks (Creswell and Poth, 2018). A coprehensive literature review on AI, NLP, Agile methodologies, and their convergence in organizational frameworks was also conducted. This situates the study within a complex and wider theoretical framework and selects best practices and potential challenges (Webster and Watson, 2002).

The data analysis stage included thematic review, where data were systematically coded to identify patterns and key subjects related to AI integration, Agile transformation, efficiency gains, and compliance improvements (Braun and Clarke, 2006). Codes were organized into overarching topics such as improvement of operational processes and strategies, evolved decision-making, promotion of innovation, and enabling an Agile mindset. Thematic analysis encourages the selection of significant patterns across qualitative data (Nowell et al., 2017). Triangulation was utilized by cross-verifying findings from different data sources to validate consistency and reliability, enhancing the credibility and depth of the analysis.

Contextual review valuated the banking industry's regulatory framework and competitive landscape to contextualize ING's initiatives, as well as examined emerging AI and NLP technologies relevant to Agile practices. Analysing the wider context allows for a accurate interpretation of findings (Bhattacherjee, 2012). Validity and reliability were supported through subject checking, where key findings were cross-validated with subject matter experts (SMEs) to confirm accuracy and relevance (Birt et al., 2016).

Ethical considerations included maintaining confidentiality by using publicly accessible data or data with proper authorization, adhering to proper citation, and respecting intellectual property rights. No confidential or proprietary information was disclosed.

In conclusion, the methodology utilized for this study provides a exhaustive landscape to investigate how AI-driven tools, more exactly those utilizing NLP, impact Agile frameworks in a highly regulated industry. By implementing multiple qualitative approaches, the research focuses on ING's strategic integration of AI and its alignment with Agile principles - highlighting operational optimization, improvements in the decision-making processes, and the promotion of innovation.

Implementation. ING implemented a suite of AI-driven instruments, such as: NLP-based virtual assistant, automated reporting solutions, and an innovative data analytics board. In this context, the NLP virtual assistant was conceived to support Agile teams with daily task management, meeting

minutes, and extracting key information from extensive volumes of text data. NLP was utilized by the automated reporting solution to produce regulatory compliance documentation. On the other hand, the data analytics platform employed AI to detect trends and practices in customer financial conduct.

The results are presented în Table 2.

Table 2 – *AI and NLP integration under Agile*

Result	Description	Data to support the results
Enhanced Efficiency	The NLP-based digital assistant considerably decreased the time and effort invested in administrative tasks by its users, enabling them to concentrate on project development and optimization strategies (Zhao, 2024).	Administrative task management was improved with a reduction of **30%** from the average admin task time (Zhao, 2024).
Improved Compliance	Prompt and concrete creation of regulatory compliance reports is supported by the automated reporting platforms, decreasing risk probabilities, such as data quality, data system errors and non-compliance (Dergaa et al., 2023).	Compliance reports accuracy rate generated by the virtual assistant – **95%** compared to previous manual process accuracy of **80%** (Dergaa et al., 2023).
Data-based decision-making process	The innovative data analytics board generated actionable information on customer financial behavior, permitting ING to customize and adapt their services and products to enhance customer satisfaction (Dergaa et al., 2023).	Customer satisfaction scores increased to **15%** due to tailored and prompt service and product delivery (Dergaa et al., 2023).

Consequently, ING built and crossed the bridge to a smart agilisation integrating AI and NLP-based technologies. This initiative generated process optimization, operational efficiency and improved customer satisfaction. Based on this, ING demonstrated the positive impact of this innovative approach on operations and, ultimately, customer satisfaction (Figure 1).

These examples illustrate how ING uses AI and NLP-based technologies enabling Agile principles like collaborative teamwork, communication, customer satisfaction, adaptability to change, sustainable development and technical excellence (Table 3).

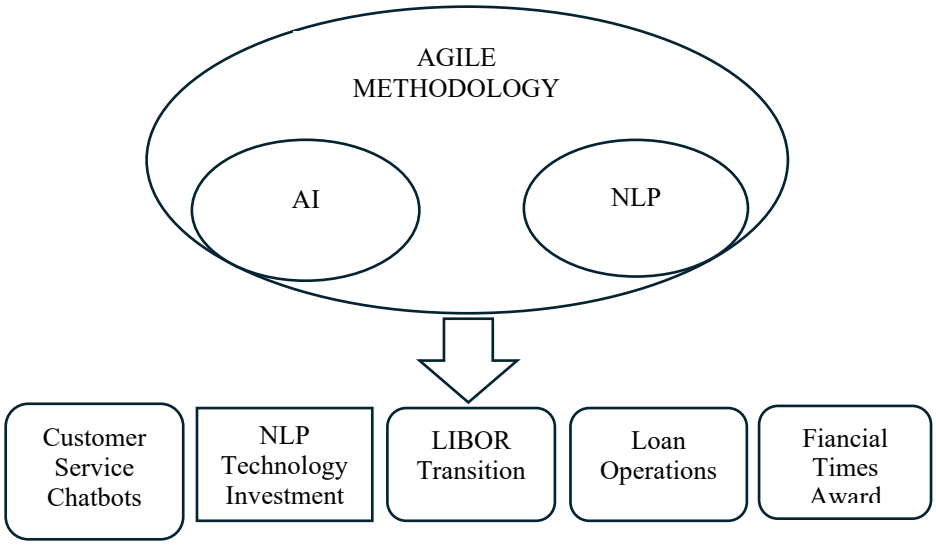

Figure 1 – *ING use of AI and NLP*

Table 3 – *Examples of ING AI and NLP integration*

Example	Description	Agile Principles met
Customer Service Chatbots	Since 2017, ING has been utilizing virtual assistants – chatbots to create an enhanced customer service experience (ING, 2022).	Customer Satisfaction
NLP Technology Investment	ING invested €4.5 million in NLP technology, more exactly, this was allocated to a London-based natural language processing provider named Eigen Technologies. The investment was made to improve data extraction capacity in sectors such as trade finance and small to medium-sized enterprise (SME) banking. This partnership was conceived to hasten ING's digital evolution and increase operational efficiency (ING, 2022).	• Collaboration; • Communication; • Adaptability to change; • Sustainable development.
LIBOR Transition	Eigen's NLP technology was leveraged by ING in manual task automation, therefore, human error during the LIBOR (London Inter-bank Offered Rate) migration. This approach generated several positive outcomes for the LIBOR transition, such as: 75% decrease in project completion time and 60% cost reduction associated with it (ING, 2020).	• Collaboration; • Communication; • Adaptability to change; • Sustainable development.
Loan Operations	The integration of AI and NLP technologies offered ING the opportunity to provide quicker and customized loan services, enhancing customer satisfaction. This initiative can be perceived as a breakthrough in the financial services spectrum as the loan processing timeframe was reduced, from days to minutes (ING, 2022).	• Customer Satisfaction; • Adaptability to change; • Sustainable development.
Fiancial Times Award	At the Financial Services Award at the Financial Times Intelligent Business Forum in 2020, ING and Eigen Technologies received the Financial Services Award for their innovative approach and collaborative effort on the LIBOR transition. This award represents the tangible value ING generated for all its stakeholders through creative and innovative approaches (ING, 2020).	• Collaboration; • Communication; • Sustainable development; • Technical excellence.

Also, in terms of Agile integration, the interview of Bart Schlatmann, Former Chief Operating Officer at ING Netherlands (Table 4), provides a qualitative set of data, highlighting the strategic approach behind ING's Agile transformation. This interview also serves as a pivotal element in demonstrating ING's emphasis on customer centricity and adaptability, two fundamental Agile principles.

Table 4 – *Interview with Bart Schlatmann, Former ING Netherlands COO*

Question	Response
Interviewer: What prompted ING to introduce this new way of working?	Bart Schlatmann: *We have been on a transformation journey for around ten years now, but there can be no let up. Transformation is not just moving an organization from A to B, because once you hit B, you need to move to C, and when you arrive at C, you probably have to start thinking about D. In our case, when we introduced an agile way of working in June 2015, there was no particular financial imperative, since the company was performing well, and interest rates were still at a decent level. Customer behavior, however, was rapidly changing in response to new digital distribution channels, and customer expectations were being shaped by digital leaders in other industries, not just banking. We needed to stop thinking traditionally about product marketing and start understanding customer journeys in this new omnichannel environment*.
Interviewer: How do you define agility?	Bart Schlatmann*: Agility is about flexibility and the ability of an organization to rapidly adapt and steer itself in a new direction. It's about minimizing handovers and bureaucracy, and empowering people. The aim is to build stronger, more rounded professionals out of all our people. Being agile is not just about changing the IT department or any other function on its own. The key has been adhering to the "end-to-end principle" and working in multidisciplinary teams, or squads, that comprise a mix of marketing specialists, product and commercial specialists, user-experience designers, data analysts, and IT engineers—all focused on solving the client's needs and united by a common definition of success* (Schlatmann, 2025).

In this context, the interview offered by Bart Schlatmann highlights the continuous transformation at ING, which is in concordance with the principles of the agile methodology, especially its focus on continuous improvement and flexibility. This reflects the need for organizations adopting AI and NLP to continue to be open to technological development and continuously evolving customer needs. The progression from conventional product or service marketing to a client journey-centered strategy demonstrates the agile focus on customer collaboration, AI and NLP supporting this transition through the utilization of data analytics to improve comprehension and awareness of customer behavior and customize service delivery.

Based on this, Schlatmann's defines agility as organizational adaptability to new directions. It can be explored and enhanced by AI and NLP, which offer predictive analytics and automation features, highlighting another fundamental agile principle, more exactly the principle of consistently delivering value while minimizing inefficiencies. By reducing task concessions and empowering the workforce, ING aims to build a responsive and dynamic organizational structure, with AI offering a critical function in automating standard repetitive tasks and allowing human resources to develop strategic programs.

At ING, the integration of multidisciplinary teams is essential for perpetuating agile practices. Also, the inclusion of AI and NLP within these agile teams can considerably improve their efficacy. For example, data analysts leveraging AI can reveal insights that support the decision-making process, while NLP can help enhance the intra-team communication by examining and interpreting interactions. This collaborative approach is important in the delivery process of comprehensive solutions that define agile methodologies.

Ultimately, Schlatmann's focus on the "end-to-end principle" demonstrates the need to offer comprehensive results that generate real value to all stakeholders, including customers. The implementation of AI and NLP into this framework generates efficiency and effectiveness, being in concordance with agile methodologies.

Considering these findings, through the NLP and AI-driven tools' integration, ING managed to improve its Agile practices and processes, generating enhanced efficiency and effectiveness, improved compliance levels, and a data-driven

decision-making process. Based on this, this case study illustrates the major impact of AI and NLP on revolutionizing Agile frameworks in a highly regulated industry, answering to the central research question: *How can AI-powered tools with the use of NLP impact the Agile environments?*.

Discussion of Results

The implementation of Artificial Intelligence (AI) and Natural Language Processing (NLP) computing into ING's Agile methodologies supports an elaborate strategy to improve organizational agility and responsiveness within the financial services industry. This case study demonstrates how AI and NLP can be essential in improving the operational and decision-making processes and creating an innovative organizational culture in concordance with the Agile principles, forming an agile mindset.

ING obtained considerable advantages through the integration of AI-powered tools such as NLP-powered virtual assistants, automated reporting solutions, and advanced data analytics platforms. The NLP-powered virtual assistant (chatbot) diminished the administrative workload within the Agile teams by handling repetitive tasks, documenting, and reporting meeting notes, and extracting important data from large text datasets. This alleviation in governmental actions allowed agile teams to focus their resources more on project advancement and strategic projects.

Furthermore, the automated reporting systems have considerably enhanced the accuracy and timeliness for regulatory compliance documentation. The precision for compliance reports increased from 80% to 95%, reducing the risks correlated with data quality and system errors. Moreover, the data analytics platform utilized AI to detect trends and patterns in customer financial behavior, enabling ING to customize its services, improving customer satisfaction by 15%.

While ING's integration of artificial intelligence (AI) and natural language processing (NLP) into their Agile methodologies is impressive, several limitations suggest it may not be a universal solution for the entire financial industry. Firstly, ING's unique ecosystem—with ample resources and an innovation-driven culture—raises questions about the replicability of their success in smaller institutions or those with rigid hierarchies. The assumption that similar outcomes can be achieved elsewhere overlooks the significant adjustments required in different organizational contexts. Secondly, focusing solely on ING's case fails to account for regional, regulatory, and cultural differences that other banks might face. For instance, stringent data privacy laws in certain countries could severely limit the use of AI and NLP technologies. Additionally, the case study emphasizes successes but glosses over potential implementation challenges, such as employee resistance due to automation fears and the learning curve associated with integrating AI tools into existing workflows. Moreover, while a 15% increase in customer satisfaction is noteworthy, this study does not explore the sustainability of these results over time, especially considering the rapid evolution of technology that could render current solutions obsolete.

To address these limitations, future research should explore several key areas. Conducting a cross-industry analysis involving regional banks, credit unions, and fintech startups could identify universally beneficial factors versus those specific to ING's context. Investigating the impact of technological changes on employee morale and job security is essential to develop strategies that are sensitive to human elements within organizations. Examining customer demographics would determine whether the increase in satisfaction spans all segments or is concentrated among tech-savvy users, thereby assessing the universal applicability of the positive outcomes. Additionally, studying how different regulatory landscapes affect the implementation and success of AI and NLP tools is crucial, as factors like strict data protection laws can significantly hinder technological effectiveness in certain regions. Addressing ethical considerations such as data privacy, consent, and algorithmic bias is necessary to maintain customer trust. Finally, assessing the adaptability of these systems to future technological advancements will ensure their long-term viability and the sustained benefits for a broader range of organizations in the financial sector.

Considering these findings, this case study underscores the integration of AI and NLP with fundamental Agile principles such as collaboration, communication, customer satisfaction, adaptability to change, sustainable development, and technical excellence. For example, the implementation of NLP-based virtual assistants in the customer service area, illustrates the principle of customer satisfaction. At the same time, financial investment in NLP technology highlights the relevance of adaptability and sustainable growth.

Conclusion

To put it succinctly, the case study of ING highlights the evolutionary potential of AI and NLP information technologies in improving Agile methodologies within the banking and financial services spectrum. The implementation of these smart technologies generated considerable enhancements in operational efficiency, regulatory compliance, and overall customer satisfaction. By adopting an Agile mindset and utilizing AI and NLP technologies, ING managed to explore the technicalities of a heavily regulated environment, demonstrating the extensive impact of AI and NLP on Agile practices.

The awareness raised by ING's experience highlights the importance of continuous improvement and adaptability, flexibility to sustain a competitive advantage, especially in the context of a highly competitive market. As more financial organizations implement AI and NLP solutions, ING's experience provides significant and constructive lessons for improving Agile methodologies and creating impactful organizational progress. This case study enriches the vaster discourse of how AI-driven tools can innovate Agile organizational systems, especially in sectors defined by strict regulations and extremely dynamic market conditions.

Acknowledgements: This work was supported by a grant from the National Program for Research of the National Association of Technical Universities - GNAC ARUT 2023.

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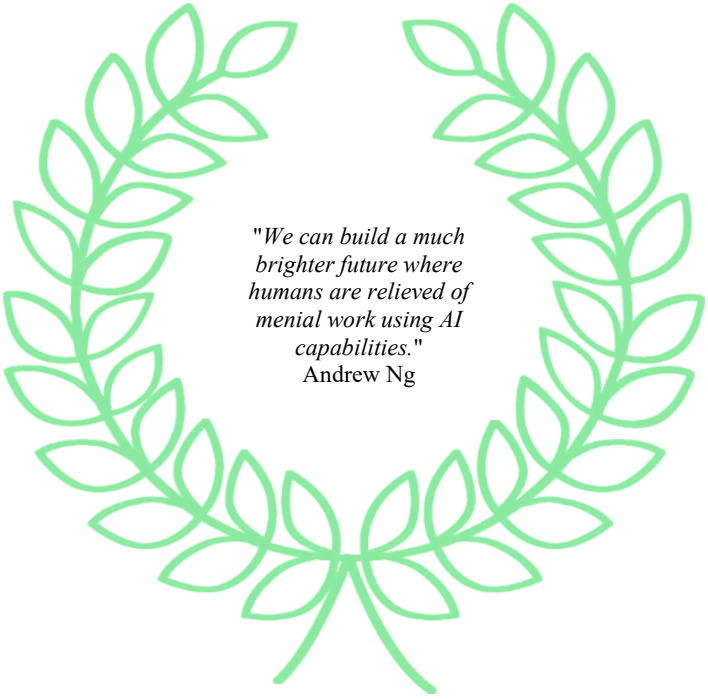

Trends in the Use of Machine Learning in Financial Risk

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Abstract

Financial risk assessment's growing complexity—historically driven by traditional models (Altman, 1968; Ohlson, 1980)—has led to the adoption of machine learning (ML) techniques for improved credit risk, bankruptcy, and fraud detection. Despite these advances, ML-based financial risk research remains fragmented, with contributions concentrated in select disciplines and regions. This study uses descriptive bibliometric analysis to examine the evolution, distribution, and impact of ML-driven financial risk research. Analyzing 3,838 articles from Scopus and Web of Science from 2000–2024, our findings reveal a marked surge in publications post-2015—predominantly in computer science and decision sciences—while finance and economics remain underrepresented. Metrics such as CiteScore and SNIP show higher visibility in AI-focused journals, whereas finance outlets exhibit more uncited documents. These results underscore the need for enhanced interdisciplinary collaboration and future network-based analyses to elucidate intellectual linkages.

Keywords: machine learning, financial risk prediction, bibliometric analysis, credit risk.

Introduction

Assessing financial risk is increasingly vital in today's complex economic landscape, where institutions and policymakers depend on predictive models for credit risk, bankruptcy, and systemic vulnerabilities. Traditionally, methods like Beaver's univariate analysis (Beaver, 1966), Altman's Z-score (Altman, 1968), and Ohlson's logistic regression (Ohlson, 1980) have been used to gauge financial stability, yet they often miss the non-linear dynamics of modern markets (Xia et al., 2017).

With the surge in large-scale financial data, machine learning (ML) techniques have emerged as

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transformative tools for financial risk prediction. Advanced ML methods—including ensemble learning, deep learning, and explainable AI (XAI) approaches—have shown superior performance compared to classical models (Breiman, 2001; Louzada et al., 2016; Doshi-Velez and Kim, 2017), enabling more robust credit scoring, bankruptcy forecasting, and fraud detection.

This study conducts a bibliometric analysis of ML-driven financial risk research, focusing on publication trends, research productivity, and geographical distribution to identify key themes, leading contributors, and gaps warranting further exploration.

Research Methodology

This study employs descriptive bibliometric analysis to assess the evolution of machine learning (ML) research in financial risk prediction. Bibliometric analysis is a well-established method for examining the structure and dynamics of academic research (Small, 1973; Kessler, 1963; Moed, 2005) and provides an effective means of tracking publication trends, identifying leading contributors, and highlighting underrepresented areas. Data was obtained from Scopus and the Web of Science (WoS) Core Collection, which together offer comprehensive coverage of peer-reviewed literature across disciplines—particularly in applied machine learning and financial risk modeling.

A structured bibliometric search was conducted across Scopus and WoS for publications from 2000 to 2024 that focused on ML-driven financial risk prediction, encompassing topics such as credit risk, bankruptcy prediction, loan default, and credit scoring. To ensure consistency in the selection criteria, a duplicate removal process was implemented. This process identified and removed 1,341 overlapping records between the two databases, resulting in a final dataset of 3,838 unique records. Given that Scopus provided a significantly larger volume of relevant studies, the analysis primarily relies on Scopus-based insights, with WoS data serving as a validation source (Donthu et al., 2021).

The descriptive bibliometric analysis was conducted using the analytical tools available within Scopus and WoS. These platforms enabled the systematic examination of publication trends over time, geographical distribution of research output, and journal impact—assessed via metrics such as CiteScore and SNIP. All statistical and graphical outputs were generated directly from these platforms, ensuring both accuracy and reproducibility. This data-driven approach facilitates the identification of emerging research trends and gaps within the field of ML-based financial risk prediction.

Results and Discussion

The increasing complexity of financial risk assessment has driven a rise in machine learning (ML)-based research. Before 2010, the field was underdeveloped, with fewer than 20 papers per year in Scopus. Between 2011 and 2015, research activity grew with the adoption of advanced methods such as support vector machines (Min and Lee, 2005), decision trees, and ensemble models. A significant transformation began after 2015, when annual publications surged past 300—coinciding with the broader adoption of deep learning architectures—including CNNs and LSTM networks (Jingyuan et al., 2023), ensemble techniques like XGBoost (Chen and Guestrin, 2016) and Random Forests (Breiman, 2001). The increasing focus on explainable AI (Doshi-Velez and Kim, 2017) further enhanced ML models in credit risk and bankruptcy prediction. By 2024, ML-driven financial risk models had become integral to academic discourse and practical decision-making, marking a shift from exploratory to structured, high-impact research.

The publication venues exhibit a interdisciplinary focus (Figure 1). Most papers appear in journals centered on artificial intelligence, decision sciences, and computational finance rather than in traditional finance outlets. For instance, Expert Systems with Applications leads with 163 papers (Barboza et al., 2017), while Lecture Notes in Computer Science (93 papers) and IEEE Access (43 papers) underscore the growing industry–academia interaction (Chen and Guestrin, 2016).

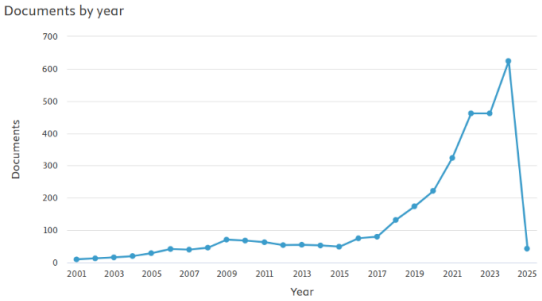

Figure 1 – *Annual publication trend of ML in financial risk prediction*

This trend suggests that ML applications in financial risk prediction are mainly disseminated through outlets emphasizing methodological and computational innovations, with traditional finance journals remaining underrepresented. The limited presence of ML-based studies in finance-specific venues may indicate that finance researchers continue to favor classical econometric approaches, contributing to a divergence between AI and traditional financial research (Figure 2).

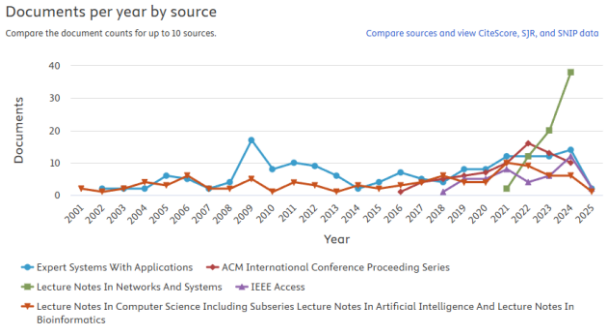

Figure 2 – *Top Publishing Journals and Conferences by year*

Assessing journal impact using metrics such as CiteScore, normalized source impact per paper (SNIP), and uncited document analysis offers insights into the visibility and influence of ML-driven financial risk research. CiteScore - measuring average citations per article - shows Expert Systems with Applications leads with a CiteScore of 13.8, indicating robust citation activity. Similarly, high CiteScores for IEEE Access and Lecture Notes in Computer Science underscore ML's prominence in computational intelligence. In contrast, finance-specific journals exhibit lower CiteScores, suggesting that ML-based risk research remains largely anchored in AI and decision sciences rather than traditional finance (Figure 3).

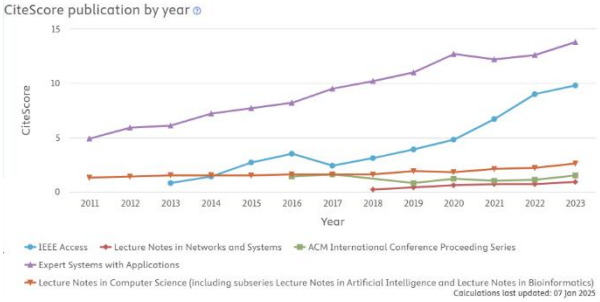

Figure 3 – *CiteScore distribution across leading journals by year*

SNIP, which adjusts for disciplinary differences by providing a field-specific view of journal impact, further elucidates these trends. For example, Expert Systems with Applications not only exhibits a high CiteScore but also a SNIP of 2.41, indicating a strong normalized impact within its field. In contrast, IEEE Access, despite its high citation counts, shows a lower SNIP—reflecting its broader technological scope rather than a dedicated focus on financial risk applications (Figure 4).

The divergence between CiteScore and SNIP highlights that journals with high SNIP and moderate CiteScore may be more relevant within the ML-finance domain. Conversely, high CiteScore but low SNIP journals may enjoy broader interdisciplinary reach.

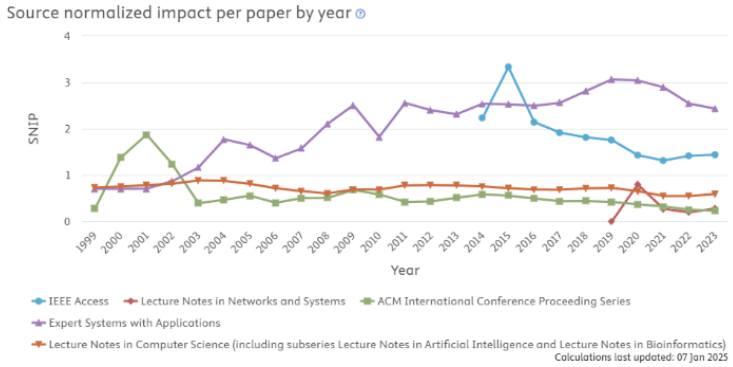

Figure 4 – *Source normalized impact per paper by year*

The analysis of uncited documents is crucial for understanding academic impact and the adoption of research. Data reveals notable differences in the citation impact across various publication venues (Figure 5). Specifically, Expert Systems with Applications consistently exhibits a lower percentage of uncited documents, suggesting that research published there tends to receive greater academic attention and impact. Conversely, IEEE Access and Lecture Notes in Networks and Systems show an increasing trend in the proportion of uncited papers in recent years, indicating that work disseminated through these channels may be less integrated or recognized within the broader scholarly community. Meanwhile, Lecture Notes in Computer Science maintains a moderate and stable rate of uncited documents over time, reflecting a consistent yet modest impact. These findings underscore the variability in citation performance, highlighting the importance of publication venue selection in shaping the academic influence of ML-based financial risk prediction research.

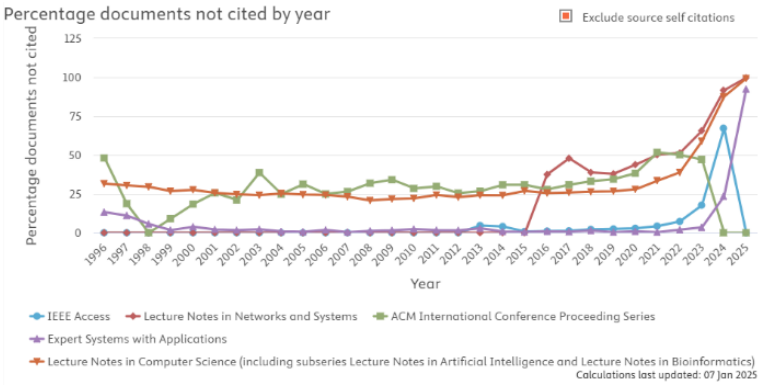

Figure 5 – *Uncited document analysis by year*

The concentration of research activity in machine learning (ML) applications for financial risk prediction is evident among a few highly active researchers and institutions. This clustering

suggests that expertise is often localized in specific academic and research centers rather than broadly distributed across global networks. Among the leading contributors, V. Ravi and B. Baesens have made significant strides in credit risk modeling and bankruptcy prediction. Ravi's review of statistical and intelligent techniques for bankruptcy prediction emphasizes the integration of ML methods into financial decision-making (Kumar and Ravi, 2007), while Baesens et al. (2003) benchmarked various classification algorithms, offering insights into scalable ML methodologies.

Additional key contributors include C.F. Tsai, whose work on hybrid AI models for business failure prediction has helped refine predictive approaches (Huang et al., 2008), and C. Mues, whose research on modeling Loss Given Default (LGD) using decision trees has advanced risk assessment frameworks (Thomas, Mues, and Matuszyk, 2010). Collectively, these researchers have enhanced the interpretability, accuracy, and applicability of ML-driven financial risk models (Figure 6).

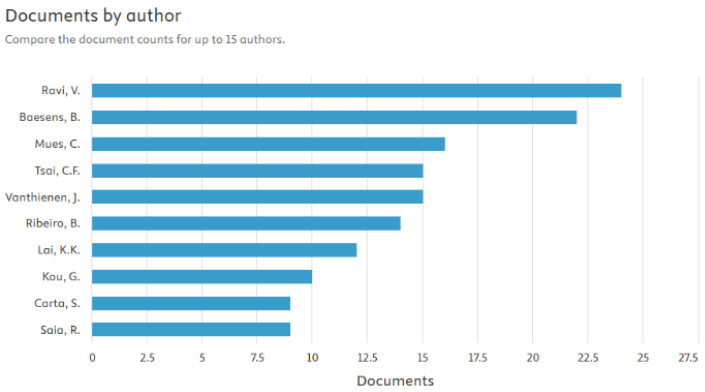

Figure 6 – *Leading authors in ML-finance research*

The institutional landscape mirrors this concentration. A small number of universities and research centers produce a substantial share of the publications. For example, the Chinese Academy of Sciences leads with 35 papers, reflecting China's dominant position in AI research and its growing emphasis on ML in financial applications. Similarly, institutions such as Sichuan University (29 papers), KU Leuven (27 papers), and the University of Southampton (28 papers) have emerged as key hubs. Despite this concentration, a clear geographical disparity remains. While China leads in academic output, the United States lags behind, despite its strong AI and fintech ecosystem (Figure 7).

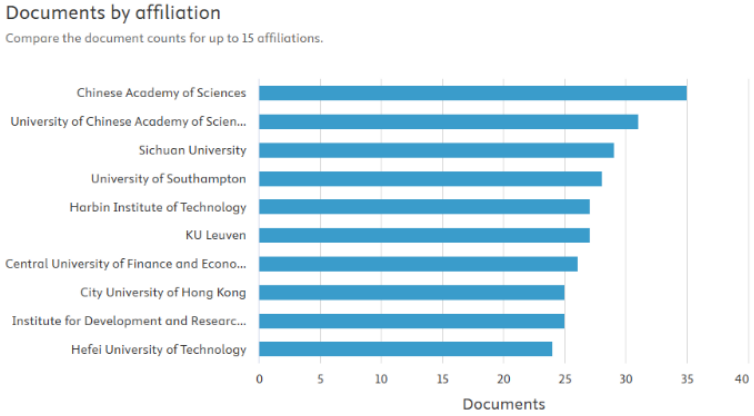

Figure 7 – *Institutional contributions to ML-finance research*

This discrepancy may suggest that a significant portion of U.S.-based AI research in finance is industry-driven and confined to proprietary datasets rather than disseminated through academic channels. Consequently, there is a pressing need for enhanced interdisciplinary collaboration between finance scholars and AI researchers, as traditional finance and economics perspectives appear underrepresented in the current literature.

In terms of regional coverage, the global landscape of ML-based financial risk prediction research reveals significant imbalances. Analysis indicates that research output is heavily concentrated in a few countries, with China leading by a substantial margin (Figure 8). This dominance reflects China's aggressive AI research funding, rapid market expansion, and strategic initiatives that integrate ML into financial risk modeling. Following China, India and the United States are notable contributors. Indian research output is characterized by its emphasis on credit risk modeling tailored to microfinance and emerging economies, whereas the U.S., despite its robust fintech ecosystem, shows lower academic publication volumes. This discrepancy may suggest that much U.S.-based AI research in finance is industry-driven, with findings often confined to proprietary datasets (Breiman, 2001; Chen and Guestrin, 2016).

European contributions, while significant, appear more decentralized, which contrasts with the concentrated output observed in China. Additionally, emerging markets - such as Romania with only 17 indexed papers - are markedly underrepresented, potentially due to factors such as data accessibility, limited research funding, or regulatory constraints.

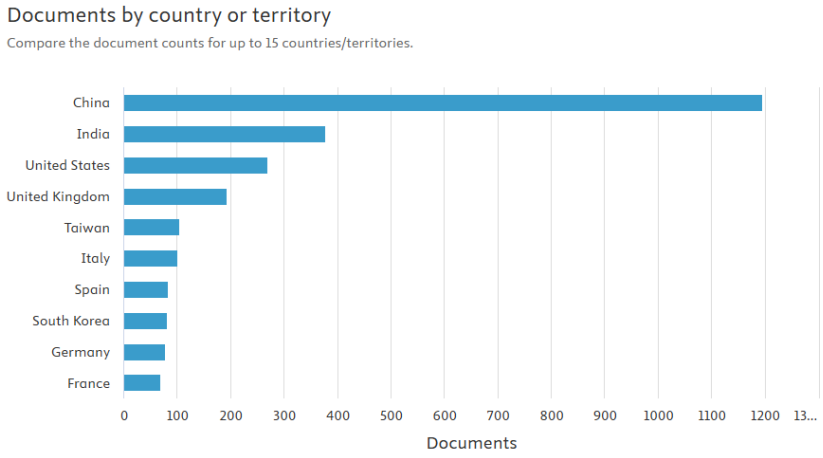

Figure 8 – *Geographic distribution of ML-finance research*

Research on ML-based financial risk prediction is predominantly published in computer science, decision sciences, and business analytics rather than in traditional finance journals. This pattern—shaped by methodological and classification practices—raises questions about whether ML is viewed as an external tool or a core component of financial analysis. Bibliometric selection targeting ML in financial risk confirms that most studies emerge from technical disciplines. In contrast, finance and economics are underrepresented, indicating a slower integration of ML into traditional financial models. Moreover, the prominent role of engineering and applied mathematics underscores the reliance on quantitative modeling, algorithmic stability, and advanced computational techniques, highlighting that effective financial risk modeling depends on both AI and robust statistical methods (Figure 9).

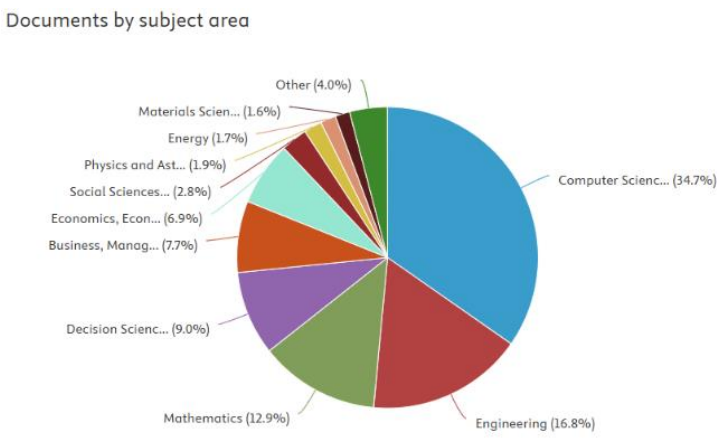

Figure 9 – *Subject area distribution of ML-finance research*

To validate the findings based on Scopus data, an analysis of the Web of Science (WoS) Core Collection was conducted. While Scopus offers broader coverage of applied AI and fintech research, WoS serves as a complementary source to verify trends and subject area distributions. The comparison confirms that ML-finance research follows a similar trajectory in both databases, notably reinforcing the significant post-2015 surge in addressing AI-driven financial risk assessment.

The overlap of 1,341 documents indicates that high-impact research is consistently indexed across these platforms, ensuring a reliable representation of key contributions. Moreover, the subject area classification in WoS mirrors that of Scopus: dominant categories such as computer science, decision sciences, and interdisciplinary applications account for the majority of publications, whereas traditional business finance and economics continue to hold a smaller share (Figure 10). This convergence across databases reaffirms that ML applications in finance are predominantly approached from a technical perspective rather than through conventional financial theoretical frameworks.

Figure 10 – *Subject area distribution of ML-finance research*

Conclusions

This bibliometric analysis of ML-based financial risk prediction research reveals several significant trends. First, the marked increase in publication output after 2015 highlights a shift from exploratory to high-impact, structured research in this field. However, the analysis also uncovers

persistent challenges, such as the continued reliance on traditional financial models and the limited integration of ML methodologies within core finance journals. The study shows that high-impact AI and decision sciences journals dominate publication venues, as evidenced by superior CiteScore and SNIP values, whereas finance-specific outlets are largely underrepresented. This disparity underscores the need for greater interdisciplinary collaboration to bridge the methodological and theoretical divides between AI and traditional finance.

Furthermore, the regional imbalances—most notably China's dominance in research output compared to the underrepresentation of emerging markets—point to significant opportunities for expanding the global reach of ML applications in financial risk assessment. Future research should focus on network-based bibliometric methods to map intellectual linkages and incorporate emerging themes such as explainable AI to enhance model interpretability. By addressing these gaps, future studies can facilitate the integration of advanced ML techniques into mainstream financial practice, ultimately improving the accuracy and robustness of risk prediction models and contributing to more resilient financial systems.

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Impact of Supply Chain Management in Organizational Performance

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Abstract

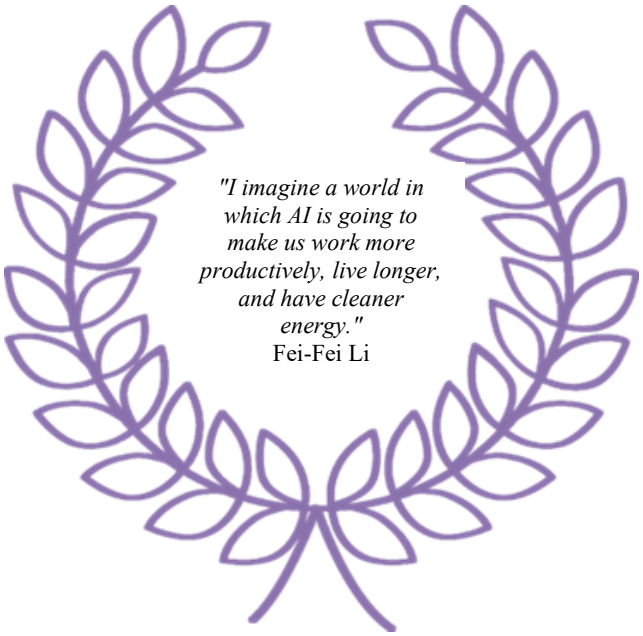
This research explores the relationship between sustainable supply chain management and organizational performance at Procter & Gamble. This study aims to test the impact of economic supply chain management on customer relationship management, competitive advantage, and organizational execution by collecting and analyzing information from the industry of FMCG (fast moving consumer goods). This paper is recommended to demonstrate the hypothesized relationship between supply chain economic management, customer relationship management, competitive advantage, and organizational execution. The measurable investigation supports the positive relationship between customer relationship management and competitive advantage on the one hand and organizational execution on the other hand. The result recommends that effective execution of supply chain economic administration will assist in making progress in customer relationship administration, and competitive advantage.

Keywords: innovation, KPIs, performance, supply chain management.

Introduction

Sustainable supply chain management (SSCM) refers to the integration of environmentally and socially responsible practices throughout the supply chain. It involves considering the environmental, social, and economic impacts of supply chain activities and making decisions that minimize negative effects and promote sustainability (Rezaee, 2017). Here are some key aspects of sustainable supply chain management:

➢ Environmental Considerations: SSCM involves reducing the environmental impact of supply chain activities. This includes practices such as energy conservation, waste reduction, water management, sustainable sourcing, and emissions reduction. Adopting sustainable practices can help mitigate climate change, protect ecosystems, and conserve natural resources.



➢ Social Responsibility: SSCM incorporates social responsibility principles into supply chain

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practices. This involves respecting human rights, promoting fair labour practices, ensuring safe working conditions, and supporting ethical sourcing. It also encompasses initiatives to support local communities, foster diversity, and inclusion, and promote responsible supplier relationships.

➢ Collaboration and Transparency: SSCM emphasizes collaboration and transparency throughout the supply chain. This includes engaging suppliers, customers, and other stakeholders in sustainability initiatives, sharing information about sustainability performance, and working together to address shared challenges. Collaboration and transparency help build trust, promote shared values, and drive sustainability improvements.

➢ Risk Management: SSCM focuses on identifying and managing risks associated with sustainability issues. This includes assessing and addressing risks related to climate change, resource scarcity, social unrest, regulatory compliance, and reputational damage. By proactively managing sustainability risks, organizations can enhance resilience and reduce potential disruptions in the supply chain.

➢ Supplier Engagement: Engaging suppliers is a crucial aspect of SSCM. Organizations work closely with suppliers to ensure they meet sustainability requirements, adhere to ethical standards, and continuously improve their sustainability performance. Supplier engagement can involve capacity building, training, audits, and collaboration on sustainable innovation.

➢ Performance Measurement and Reporting: SSCM involves measuring and reporting sustainability performance across the supply chain. This includes tracking key performance indicators (KPIs) related to environmental, social, and economic impacts. Transparent reporting enables organizations to monitor progress, identify areas for improvement, and communicate their sustainability efforts to stakeholders.

➢ Circular Economy and Reverse Logistics: SSCM promotes the principles of the circular economy by minimizing waste, promoting recycling and reuse, and designing products for longevity and recyclability. It also involves implementing effective reverse logistics processes for product returns, recycling, and responsible disposal.

Implementing sustainable supply chain management practices can lead to various benefits, including cost savings, improved reputation, enhanced stakeholder relationships, and reduced environmental impact (Figure 1). It requires collaboration, long-term commitment, and continuous improvement efforts throughout the supply chain to create a more sustainable and resilient business model (Adomako et al., 2021).

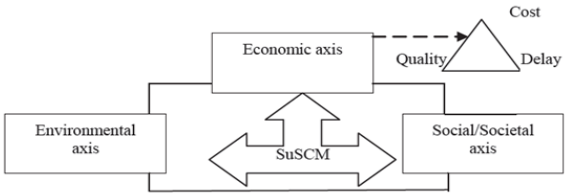

Figure 1. *Sustainable Supply Chain Management*
(Source: Petersen et al., 2000)

The performance of an organization refers to its ability to achieve its goals, objectives, and desired outcomes effectively and efficiently (Revell, 2007). It is a measure of how well an organization performs in various aspects of its operations and the results it delivers. Here are some key factors that contribute to organizational performance:

➢ Strategic Planning: Organizations with strong performance engage in strategic planning to set clear goals, define strategies, and allocate resources effectively. Strategic planning provides a roadmap for the organization and ensures alignment between different functions and departments.

➢ Leadership and Management: Effective leadership and management are crucial for organizational performance. Strong leaders provide direction, inspire and motivate employees, and foster a positive and productive work culture.

Efficient management ensures effective utilization of resources, proper coordination, and efficient decision-making.

- Organizational Structure and Governance: A well-designed organizational structure and governance system contribute to performance. A clear hierarchy, well-defined roles and responsibilities, and effective communication channels facilitate coordination and decision-making within the organization.
- Human Resources Management: Performance-oriented organizations recognize the importance of human resources and invest in talent acquisition, development, and retention. They create a supportive work environment, offer opportunities for growth and development, and recognize and reward employee performance.
- Operational Efficiency: Organizations that perform well focus on operational efficiency and process improvement. They streamline workflows, eliminate waste, and optimize processes to enhance productivity and reduce costs.
- Customer Focus: Organizations that prioritize customer satisfaction and meet customer needs tend to perform well. They understand their target market, gather customer feedback, and continuously improve products, services, and customer experiences.
- Innovation and Adaptability: High-performing organizations embrace innovation and adaptability. They encourage creativity, invest in research and development, and embrace change to stay ahead of the competition and meet evolving customer demands.
- Financial Management: Effective financial management is essential for organizational performance. Organizations need to manage budgets, control costs, optimize revenue generation, and ensure financial stability to support growth and sustainability.
- Performance Measurement and Evaluation: Organizations that perform well establish performance metrics and regularly monitor and evaluate their performance. They use key performance indicators (KPIs) to track progress, identify areas for improvement, and make data-driven decisions.
- Stakeholder Engagement: Engaging with stakeholders, including customers, employees, suppliers, and the community, contributes to organizational performance. Strong stakeholder relationships foster trust, collaboration, and support, which can enhance the organization's reputation and overall performance.

It's important to note that various internal and external factors influence organizational performance and can vary across different industries and contexts. High-performing organizations continuously assess their performance, adapt to changing circumstances, and strive for continuous improvement (Figure 2).

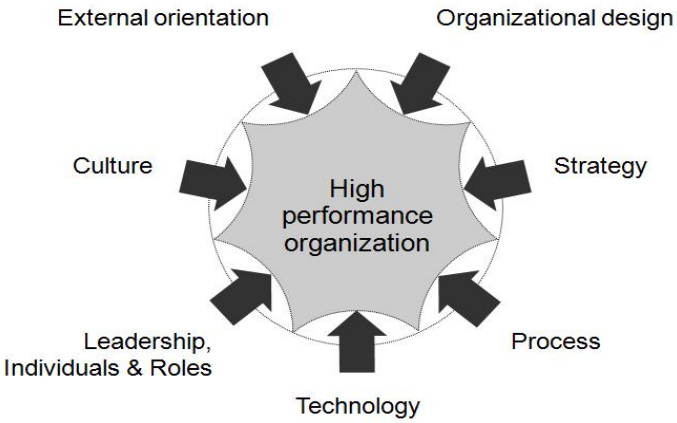

Figure 2 – *Performance Organization*
(Source: Sitharam and Hoque, 2016)

State of the Art

The relationship between sustainable supply chain management (SSCM) and organizational performance has been the subject of theoretical research in the field of operations management and sustainability (Adomako et al., 2020). Several studies have explored this relationship and identified potential positive impacts of SSCM on organizational performance. Here are some key findings from theoretical research:

- Cost Reduction and Efficiency: Implementing sustainable practices in the supply chain, such as energy-efficient processes, waste reduction, and responsible sourcing, can lead to cost savings and improved operational efficiency. This can positively impact the financial performance of organizations.
- Risk Mitigation: Sustainable supply chain practices can help organizations mitigate risks related to environmental, social, and regulatory factors. By proactively managing sustainability risks, organizations can enhance their resilience and reduce disruptions in their supply chain, leading to improved overall performance.
- Reputation and Brand Image: Adopting sustainable practices can enhance an organization's reputation and brand image. Consumers, investors, and other stakeholders increasingly value and prefer companies that demonstrate environmental and social responsibility. A positive brand image can lead to increased customer loyalty, market share, and financial performance.
- Stakeholder Relationships: Organizations that prioritize sustainability in their supply chain can build stronger relationships with stakeholders, including suppliers, customers, and communities. Collaborative efforts toward sustainability can enhance trust, collaboration, and cooperation, leading to improved performance and competitiveness.
- Innovation and Competitive Advantage: Sustainable supply chain practices often drive innovation and can lead to the development of new products, processes, and business models. Organizations that embrace sustainability as a driver for innovation may gain a competitive advantage by offering differentiated and environmentally friendly products or services.
- Regulatory Compliance and Market Access: Sustainable supply chain management helps organizations comply with environmental regulations and meet sustainability standards imposed by regulators and customers. Compliance with regulations and sustainability requirements can open up new market opportunities and improve access to customers who prioritize sustainability.
- Long-Term Value Creation: By integrating sustainability into the supply chain, organizations can create long-term value for themselves and society. Sustainable practices that consider economic, social, and environmental aspects contribute to a more sustainable and resilient business model, leading to sustained performance over time.

It is important to note that various factors, such as industry context, organizational culture, and specific sustainability practices implemented can influence the relationship between SSCM and organizational performance. Additionally, empirical research is needed to validate and quantify the impacts of SSCM on organizational performance (Figure 3).

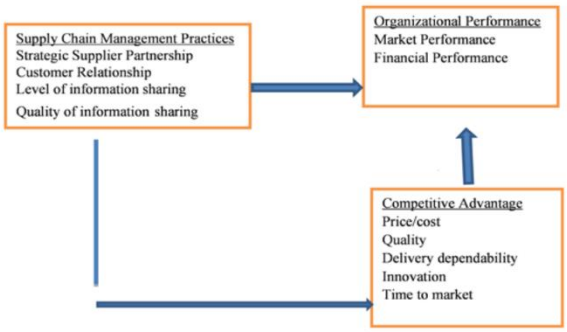

Figure 3 – *The Relationship between SSCM and organizational performance*
(Source: Revell et al., 2007)

When it comes to sustainability performance, organizations can focus on a set of key indicators and practices to assess and improve their sustainability efforts. Here are some common elements of sustainability performance for organizations in the industry:

- Environmental Impact: Organizations can measure and reduce their environmental footprint by tracking indicators such as greenhouse gas emissions, energy consumption, water usage, waste generation, and pollution. Setting targets to decrease these impacts over time demonstrates a commitment to sustainability.
- Carbon Footprint and Climate Change Mitigation: Assessing and managing carbon emissions is a crucial aspect of sustainability. Organizations can measure and report their carbon footprint, set reduction targets aligned with climate goals, and implement strategies to mitigate their impact on climate change.
- Resource Efficiency: Organizations can focus on optimizing resource use by implementing measures to conserve energy, water, and raw materials throughout their operations. This includes adopting energy-efficient technologies, implementing water management practices, and promoting circular economy principles to minimize waste generation.
- Sustainable Sourcing and Supply Chain: Organizations can prioritize sustainable sourcing practices by working with suppliers that adhere to ethical and environmentally responsible standards. This can involve assessing supplier sustainability performance, promoting fair labour practices, reducing supply chain emissions, and ensuring the traceability and responsible sourcing of raw materials.
- Social Responsibility and Ethical Practices: Organizations can demonstrate social responsibility by upholding ethical practices in their operations and supply chains. This includes promoting fair labour practices, ensuring safe working conditions, respecting human rights, and supporting diversity, equity, and inclusion within the organization and throughout the value chain.
- Stakeholder Engagement: Engaging with stakeholders, including employees, customers, local communities, and NGOs, is essential for sustainable performance. Organizations can involve stakeholders in decision-making processes, seek feedback on sustainability practices, and collaborate on initiatives that address social and environmental challenges.
- Innovation and Product Development: Organizations can prioritize sustainable innovation to develop products and services that have reduced environmental impact, promote social well-being, and address sustainability challenges. This can include developing eco-friendly products, incorporating sustainable design principles, and promoting responsible consumption patterns.
- Community Engagement and Social Impact: Organizations can actively engage with local communities and contribute to their social and economic development. This can involve supporting community initiatives, investing in social projects, and promoting education and skill development programs.
- Long-Term Strategy and Commitment: Sustainability performance is a long-term commitment. Organizations need to develop a clear sustainability strategy, set goals and targets, and integrate sustainability into their overall business strategy. Continuous improvement and regular review of sustainability performance are essential to drive progress.

These elements provide a framework for organizations to assess and enhance their sustainability performance. Each organization may have specific priorities and areas of focus based on its industry, size, and stakeholders. It's important to align sustainability efforts with recognized frameworks and standards, such as the Global Reporting Initiative (GRI), the United Nations Sustainable Development Goals (SDGs), and industry-specific certifications or guidelines (Figure 4).

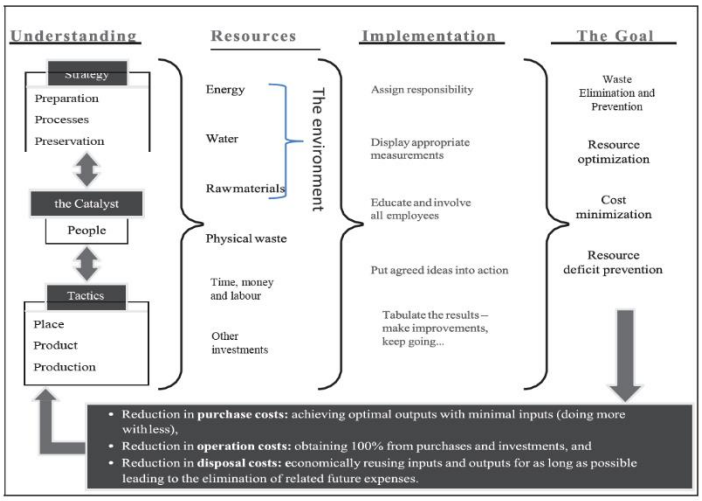

Figure 4 – *Sets of Sustainability in SCM*
(Source: Schaltegger et al., 2000)

Research Methodology

This research is a qualitative study, using document study and literature review, review of already existing written materials such as archives, annual reports, research articles, guidelines, policy documents. In this study, empirical research is used to document supply chain management practice in the FMCG industry. The term 'empirical' (meaning knowledge based on real-world observations) is used here to describe field-based research using data collected from natural situations or experiments, from annular reports and documents.

The objectives of research on Sustainable business are: Natural, social, and financial requests are considered the three columns of trade supportability. Within the corporate world, they're some of the time alluded to as the triple bottom line, a sustainability-focused system for surveying a company's social and natural effect and the general economic value it makes. This can be a flight from the conventional concept of the foot line, which assesses all endeavors in terms of their short-term impact on benefits (Deloitte and Tohmatsu, 2007).

Natural maintainability garners the foremost consideration from businesses. It requires companies to centre on moving forward vitality effectiveness in information centers and other offices and on lessening their carbon impression, bundling squander and water utilization, among other natural issues. Social supportability centers on corporate social duty and being a trade that clients, the encompassing community, workers and speculators need to bolster. Companies practising social supportability are exhorted to embrace reasonable labour hones and contribute to long-term community connections by giving back to the neighborhood community, among other steps, (Ammenberg and Sundin, 2005).

Financial supportability centers on long-term commerce benefits and incorporates exercises such as corporate administration, chance administration, administrative compliance, moral commerce hones and bookkeeping straightforwardness (Delmas and Terlaak, 2002), (Figure 5).

These three categories are commonly alluded to by the acronym ESG (*natural, social and administration*). ESG is another system that makes a difference in companies recording their trade hones, advances, and related dangers and openings as a portion of commerce maintainability endeavours. Businesses can at that point degree their victory in these zones utilize different ESG measurements and report them freely. ESG rating offices utilize revelations and other information to donate companies' ESG scores, which financial specialists and other partners can consider when assessing organizations.

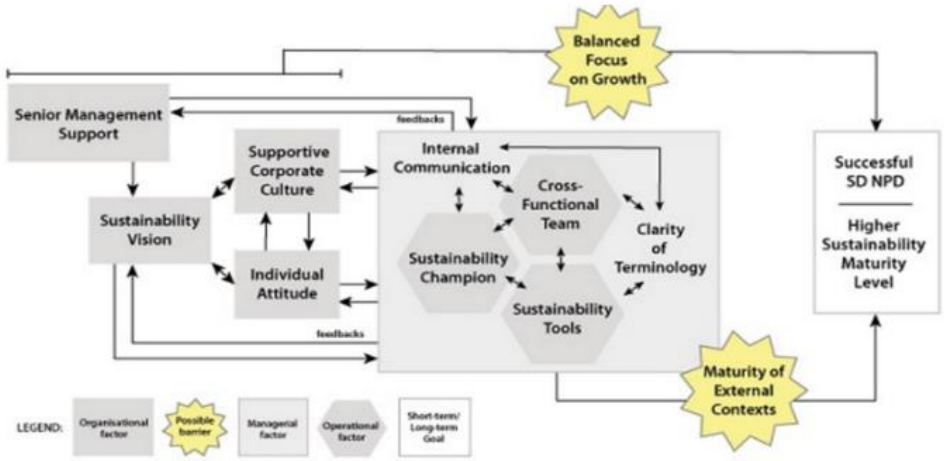

Figure 5 – *Objectives in SSCM*
(Source : De Jager, 2009).

Research Results

In 2021 P & G expanded their supply chain goal to include all P&G categories, in line with the goals endorsed by our Science-Based Goals Initiative. By taking a closer look at our Scope 3 emissions, they now know that ~10% of their ingredients (which equate to ~500 individual ingredients) are responsible for ~90% of their supply chain emissions, allowing them to focus on where they can generate the most change and advance better solutions. Further quantitative progress will be reported in 2023.

While the 2022 shipment results showed a slight increase in emissions intensity, P&G's efforts to increase intermodal shipping and optimize container fill rates have yielded improvements in emissions intensity from finished goods shipping. These improvements have not overcome industry-wide disruptions in the maritime freight supply chain. P&G is optimistic that their further acceleration in key regions and the normalization of the global landscape will lead to reductions in the coming year.

P&G updates the major Scope 3 emissions categories annually, based on estimates from LCA (Life Cycle Assessment) data as well as other available data sources. Previous updates have shown that ~98% of their Scope 3 emissions come from just four categories: Goods and Services Purchased, Upstream Transportation and Distribution, Use of Products Sold, and End-of-Life Treatment of Products Sold. As such, we intend to focus annual updates on these key categories. P&G also includes an estimate for the Business Travel category, which represents emissions from business travel flights and is based on the miles flown by their employees. They included Business Travel because it is a category of interest to their employees and their business travel partners can track employee air travel miles and provide this data. They will periodically assess all Scope 3 categories to determine the relative contributions of the key categories we report on and we will report emissions from the 5 categories listed above annually (De Jager, 2009).

P&G does not report emissions in the Downstream Transportation and Distribution category due to insufficient data to accurately estimate this category. This category includes greenhouse gas emissions from transportation and distribution after delivery to customers and their distributors. Their ability to track and measure this part of the supply chain is very limited given the very diverse distribution channels around the world, presented in Table 1.

Table 1 – *Progress versus Goals at P&G*

2030 Goal	FY 22/23 Progress
Reduce Scope 1 & 2 GHG emissions by 65% (vs. 2010 baseline)	58% reduction - exceeded original goal of 50% and updated goal to 65%
Purchase 100% renewable electricity globally	>99% renewable electricity globally
P&G manufacturing facilities will be carbon neutral for the decade (2020-2030)	P&G continues to drive progress toward this goal. For residual emissions they do not eliminate this decade, they will advance natural climate solutions to balance the remaining emissions.
Reduce global upstream finished product freight emissions intensity by 50% vs. 2020 baseline	4% increase due to supply chain challenges requiring longer, less favourable lanes and modes of transportation.
Reduce supply chain emissions by 40% per unit of production vs. 2020 baseline	~8% reduction within three priority categories, (Fabric Care, Beauty Care, Baby Care) that account for 85% of their total supply chain GHG emissions baseline.

(Source: P&G, 2024)

Key Performance Indicators

Key Performance Indicators (KPIs) are important metrics used to measure and track the performance of sustainable supply chain management (SSCM) initiatives. Here are some common KPIs that organizations can use to assess the effectiveness of their sustainable supply chain practices:

- Carbon Footprint: Measures the total greenhouse gas emissions (GHG) produced across the supply chain, including direct and indirect emissions. It helps track progress in reducing carbon emissions and achieving carbon neutrality goals.
- Energy Efficiency: Measures the energy consumption and efficiency of supply chain operations. This KPI helps identify energy-saving opportunities, track energy reduction targets, and promote energy-efficient practices.
- Water Usage: Measures the amount of water consumed and discharged throughout the supply chain. It helps identify areas where water conservation measures can be implemented and track progress in reducing water usage.
- Waste Generation: Tracks the volume of waste generated throughout the supply chain. It helps identify opportunities for waste reduction, recycling, and waste diversion strategies.
- Supplier Sustainability Performance: Measures the sustainability performance of suppliers, such as their adherence to environmental and social standards, certifications, and compliance with ethical practices. It helps assess the sustainability of the supply chain and identify areas for improvement.
- Ethical Sourcing: Measures the extent to which suppliers adhere to ethical sourcing practices, such as fair labour practices, human rights, and responsible sourcing of raw materials. This KPI ensures compliance with ethical standards and promotes responsible supply chain practices.
- Supply Chain Transparency: Measures the level of transparency and traceability within the supply chain, including visibility into supplier practices, certifications, and social and environmental impacts. It helps ensure supply chain integrity and promotes responsible sourcing.
- Supplier Diversity: Measures the inclusion and diversity of suppliers in the supply chain. This KPI tracks the percentage of diverse suppliers and ensures equal opportunities for suppliers from different backgrounds and demographics.
- Social Impact: Measures the positive social impact generated through supply chain practices, such as job creation, community development, and support for local economies. It helps assess the social value created by the supply chain.
- Stakeholder Engagement: Measures the level of engagement and collaboration with stakeholders, including employees, suppliers, customers, and communities. This KPI tracks the effectiveness of

stakeholder engagement initiatives and the integration of stakeholder feedback into supply chain decision-making.

These KPIs provide a starting point for organizations to measure and evaluate the sustainability performance of their supply chain. However, it's important to tailor KPIs to specific organizational goals, industry context, and stakeholder expectations. Choosing the right KPIs and regularly monitoring them can help organizations drive continuous improvement in sustainable supply chain management (Figure 6).

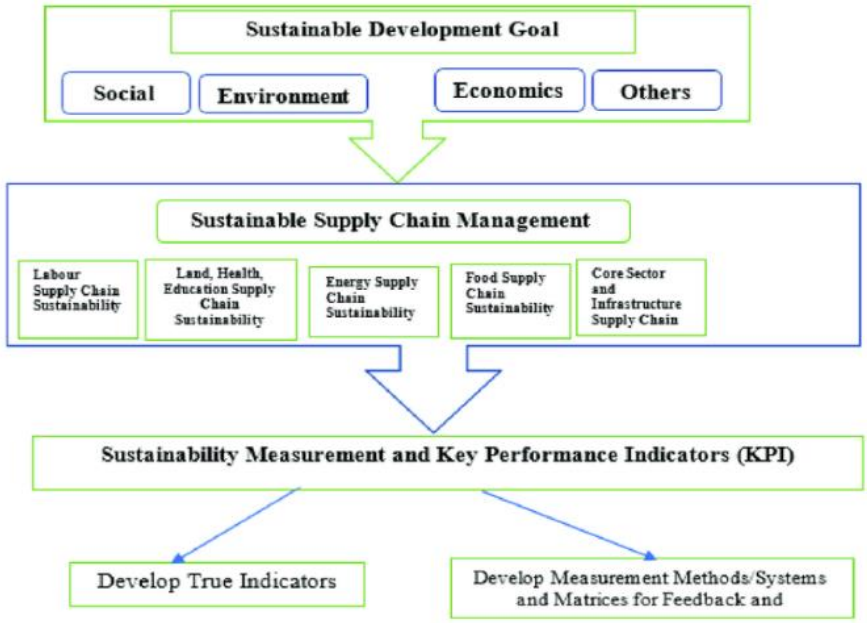

Figure 6 – *Sustainability KPIs.*
(Source: Deloitte and Tohmatsu, 2007).

Conclusions

In this paper, Businesses encounter not just financial challenges but also environmental concerns if they want to survive; companies must navigate through social and societal challenges at the national level and the global economy. Truly, if they are not If they successfully tackle these three challenges, they will achieve their goals shortly.

The transition from SCM to SSCM requires a vigorous intuition between organizational efforts and organizational complexity in terms of absorbing SSCM elements into an organization's supply chain programs, as well as an additional commitment to perform more than is essential for current supply chain programs to coordinate a required SSCM element into normal plans Consequently, Organizations are presently required to discover and execute imaginative arrangements that can be maintained, not just inside their claim divisions, but through the entire supply chain, to cope with modern advancements and movement patterns, thereby extending organizational execution.

This study found a solid relationship between SSCM and organizational performance (OP) and showed that SSCM has an obvious relationship with money-related outcomes and organizational execution. The article has highlighted and substantiated the notable value of supply chain analytic selection in improving business execution. Through an intermediary method, these competencies and commitments are interpreted into an improved firm execution, illustrating that although in huge organizations SCM includes a coordinated effect on the company.

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"Nowadays, the idea of AI is not really science fiction anymore - it's just science fact."
Lisa Joy

Banking Contracts in the Context of Digitalization

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Abstract

In the total activities of credit institutions of the banking nature, a significant share is represented by bank lending. Bank lending contracts are the basis for granting bank loans. The new challenges that have emerged on the credit market, materialized in: the online environment, the emergence of new digitalized credit products, artificial intelligence, led to the development of the European Directive on consumer credit agreements and the repeal of Directive 2008/48/EC, which could no longer ensure the security of credit agreements under these conditions. The purpose of the paper is to address the novel aspects and the concrete, sustainable support for sustainability for the parties involved in credit contracts, which the European Directive for the harmonization of national legislation with European requirements brings.

Keywords: pre-contractual information, grouping practice, sustainable support.

Introduction

Banking is a specialized "professional" commercial activity, the Bank plays a role of „customer's cashier" (Turcu, 2013). In a bank loan agreement, its parties are represented by the bank and its client, the credit consumer. The bank offers credit to obtain profit for the bank, on the one hand, and to satisfy the needs of its customers, on the other hand (Tirlea, 2014). The bank's clientele is a special clientele that benefits from special services. From this point of view, we appreciate that, strictly related to bank lending services, those consumers of bank loans implicitly become customers of the respective bank (Tirlea, 2017). Bank credit is considered to be „loans granted by banks to legal entities and individuals" (Armeanic and Cojocaru, 2023). To finance customers' credit needs, banks must meet

customers' expectations and needs in terms of promptness (Tirlea, 2014). If in the logical sequence, credit holds a primary position, interest represents the condition of its opportunity and

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efficiency (Trenca, 2020). Over time, interest in some situations has also been one of the causes of abusive clauses in credit agreements.

Imperfections contained in bank credit contracts and in the additional documents to the credit contract or to the framework credit agreement may lead to the identification of abusive clauses. To avoid unfair terms any contract concluded between traders and consumers will include clear, unambiguous contractual clauses (Law No. 193/2000; Tirlea, 2015).

The principle of contractual good faith is implemented to justify the annulment of certain irresponsibility or non-performance clauses, which create significant imbalance in contractual relations" (Plotnic, 2012). The pre-contractual stage is the beginning stage in the process of granting the credit and building the credit agreement. Practically this stage represents a filter for the bank in verifying its potential clients, in granting loans (Tirlea, 2014). A significant share in banking activity is held by lending activity.

A significant share in banking activity is held by lending activity (Tirlea, 2024). Today, the banking system must respond to market demands to support clients with profitable businesses (Tirlea, 2013), in the context of digitalization and artificial intelligence. For this reason, the Directive represents a balancing support for the parties to the credit contract. On the one hand, professionals and on the other hand, consumers of credit. The loan contract is regulated as a synalgmatic contract, both parties being mutually and correlatively obligated (Chibac et al., 2024). Consumer protection „represents one of the most important objectives of competition regulations (Gorincioi, 2019).

During the period 2010-2024, the effects of credit contracts were diverse. The time horizon of 2010-2024 proved the existence of numerous cases of abuse in credit contracts that were resolved in the courts, because of the finding of imbalances in credit contracts. Today, we are witnessing the diversification of lending products. The trend of online lending products is one of continuous growth and diversification. The openness is towards the online space, towards virtual connections that anyone can access. The specialized literature speaks of "smart contracts", „economic interoperability", „virtual interaction", „personalized financial advice in the virtual world".

Among the development opportunities for banks, we find a new environment, Metaverse:

1. Metaverse represents an online universe of virtual interaction, which on the one hand encompasses the experience of virtual reality, and on the other hand is a virtual platform based on the Web 3.0 concept to ensure economic and experiential interoperability (Neuralt, 2021; Caprian and Tirlea, 2024).
2. Web 3.0 (or Web3) is the third generation of the World Wide Web, which is intended to be decentralized, open to all, and built on blockchain technologies and developments in the Semantic (Web *What, 2000*; Caprian and Tirlea, 2024).
3. It is the result of the combination of new technologies such as blockchain, virtual reality and augmented reality brought together in a new environment (Kadar, 2024; Caprian and Tirlea, 2024).
4. In the context of the metaverse, „banks can facilitate transactions, offer virtual currencies, provide security, enable smart contracts, and provide personalized financial advice in the virtual world" (Finley, 2022; Caprian and Tirlea, 2024).
5. We become "a world without centralized companies, where people have control over their own data and transactions are recorded transparently on blockchains or databases that can be searched by anyone" (Neuralt, 2021; Caprian and Tirlea, 2024).

The online universe, the current digitalization environment, requires rapid change, adaptability to the new, to organization, to financial discipline, continuous knowledge, and ensuring a unitary framework for the harmonization of national legislation of the member states under clear conditions of sustainability and durability in terms of credit contracts.

For these reasons, we are witnessing changes to European regulations on credit contracts, which require continuous adaptability to the new to respond to the new requirements of the digital environment. It is natural for an alignment to the new requirements of financial discipline.

We note that, from this perspective, the European Directive of the European Parliament and

of the Council of 18 October 2023 on consumer credit agreements on the one hand and repealing Directive 2008/48/EC on the other hand, adopts concrete minimum measures for professionals, concrete measures to protect and safeguard credit buyers, but also establishes concrete deadlines for the harmonization of the legislation of the Community Member States on credit agreements as well as subsequent verification deadlines regarding the transposition of the Directive into the national legislation of the Member States of the European Union.

To carry out the work, the following methods were applied: historical research method, observation, analysis, qualitative analysis, examination of opinions from the specialized literature, synthesis.

Two synthesis tables were built regarding: 1. the definitions given to some concepts to understand their meaning in a unified way and 2. The areas in which the European Directive on consumer credit agreements and repealing Directive 2008/48/EC does not apply.

Results Obtained

In order to clarify the unified meaning of the concepts contained in Directive (EU) 2023/2225 of the European Parliament and of the Council of 18 October 2023 on consumer credit agreements and repealing Directive 2008/48/EC, the following definitions shall apply, which have the following meanings (Table 1).

Table 1 – *Definition of concepts*

No.	CONCEPTS	DEFINITION OF CONCEPTS
1.	Consumer	"consumer" means a natural person who is acting for purposes which are outside his trade, business or profession;
2.	Creditor	means a natural or legal person who grants or promises to grant credit in the exercise of his own commercial, economic or professional activity;
3.	Credit contract	means a contract whereby a creditor grants or promises to grant a consumer credit in the form of deferred payment, loan or other similar financial facilities and which is not a contract for the continuous provision of services or for the supply of goods of the same kind, where the consumer pays for them in instalments over the period of their supply;
4.	Accessory service	means a service provided to the consumer in connection with the credit agreement;
5.	Total cost of credit for the consumer	means all costs, including interest, commissions, taxes and any other type of costs which the consumer has to bear in connection with the credit agreement and which are known to the creditor, with the exception of notary fees; the costs for ancillary services related to the credit agreement, in particular insurance premiums, are also included in the total cost of the credit for the consumer if, in addition, obtaining the credit or obtaining it according to the terms and conditions offered is conditional on the conclusion of a contract for the provision of such ancillary services;
6.	Total amount payable by the consumer	means the sum of the total value of the credit and the total cost of the credit to the consumer;
7.	Effective Annual Percentage Rate or "APR"	means the total cost of the credit to the consumer, expressed as an annual percentage of the total amount of credit and calculated as provided for in Article 30;
8.	Loan interest rate	means the interest rate expressed as a fixed or variable percentage applied annually to the amount of the loan drawdown;
9.	Fixed interest rate on the loan	means the interest rate on the credit agreed by the creditor and the consumer in the credit agreement for the entire duration of the credit agreement or several interest rates on the credit agreed by the creditor and the consumer in the credit agreement for partial periods for which the interest rates on the credit are set exclusively as a specific fixed percentage; if not all the interest rates on the credit are set in the

		credit agreement, the interest rate on the credit shall be deemed to be fixed only for the partial periods for which the interest rates on the credit are set exclusively as a specific fixed percentage agreed at the time of conclusion of the credit agreement;
10.	Total loan amount	means the cap or the total amounts made available under a credit agreement;
11.	Durable support	means any instrument which allows the consumer to store information addressed to him personally, in such a way that it is accessible for future consultation during a period of time appropriate to the purpose of the information, and which allows the faithful reproduction of the information stored;
12.	Credit intermediary	means a natural or legal person who does not act as a creditor or notary and who does not merely connect, directly or indirectly, a consumer and a creditor and who, in the course of his own commercial, economic or professional activity, in return for remuneration which may take the form of money or any other agreed form of payment: a) presents or offers credit agreements to consumers; b) provides assistance to consumers by carrying out preparatory or other pre-contractual administrative activities relating to credit agreements other than those referred to in point (a); or c) concludes credit agreements with consumers on behalf of the creditor;
13.	Pre-contractual information	means information which is provided before the consumer enters into obligations under a credit agreement or, where applicable, by sending a credit offer and which the consumer needs to be able to compare different credit offers and to take an informed decision on whether to conclude the credit agreement;
14.	Creating profiles	means profiling as defined in point 4 of Article 4 of Regulation (EU) 2016/679;
15.	Binding practice	means the offering or sale of a credit agreement as part of a package together with other distinct financial products or services, where the credit agreement is not made available to the consumer separately;
16.	Grouping practice	means the offering or sale of a credit agreement as part of a package together with other distinct financial products or services, the credit agreement also being made available to the consumer separately, but not necessarily under the same terms or conditions as when offered bundled with the said products or services;
17.	Counseling services	means personal recommendations addressed to a consumer in relation to one or more transactions relating to credit agreements and the provision of which constitutes an activity distinct from the granting of credit and the activity of credit intermediary referred to in point 12;
18.	Overdraft facility	means an explicit credit agreement under which a creditor makes funds available to a consumer in excess of the current balance of the consumer's current account;
19.	Exceeding the "Overdraft" credit limit	means a facility granted to a consumer, funds exceeding the current balance of the consumer's current account or the agreed overdraft facility;
20.	Linked credit agreement	means a credit agreement in which: a) the credit or services in question serve exclusively to finance a contract for the supply of certain goods or the performance of a certain service; and b) these two contracts form, from an objective point of view, a commercial unit; a commercial unit is deemed to exist where the supplier of goods or the service provider himself finances the credit for the consumer or, if it is financed by a third party, where the creditor uses the services of the supplier of goods or the service provider in connection with the marketing, conclusion or preparation of the credit agreement or where the goods in question or the provision of a particular service are expressly specified in the credit agreement;
21.	Early repayment	means the full or partial discharge of the consumer's obligations under a credit agreement before the date agreed in the credit agreement;

22.	Debt counseling services	means personalised assistance of a technical, legal or psychological nature provided by independent professional operators who, in particular, are not creditors or credit intermediaries, as defined in this Directive, nor credit purchasers or credit servicers, as defined in points (6) and (8) of Article 3 of Directive (EU) 2021/2167 of the European Parliament and of the Council (27), for the benefit of consumers who are experiencing or are likely to experience difficulties in meeting their financial commitments.

(Source: Directive EU 2023/2225)

Article 2, point (1) of the Directive, specifies that the scope of Directive (EU) 2023/2225 of the European Parliament and of the Council of 18 October 2023 on credit agreements for consumers and repealing Directive 2008/48/EC applies to credit agreements.

The exceptions are found in Article 2, point (2) of Directive (EU) 2023/2225 of the European Parliament and of the Council. This point basically presents the areas in which this Directive does not apply (Table 2).

Table 2 – *Areas in which Directive does NOT apply*

No.	**Areas in which Directive (EU) 2023/2225 of the European Parliament and of the Council of 18 October 2023 does NOT apply**
1.	credit agreements secured either by a mortgage or by another comparable security commonly used in a Member State having as its object immovable property or by a right over immovable property
2	credit agreements whose purpose is to acquire or retain ownership rights over land or an existing or planned building, including premises intended for commercial, economic or professional activities;
3	credit agreements which have as their object a credit with a total value exceeding EUR 100,000
4	credit agreements granted by employers to their employees on an ancillary basis, either interest-free or offered with an effective annual interest rate lower than that charged on the market and which are not offered to the general public;
5	credit agreements concluded with investment firms, as defined in point (1) of Article 4(1) of Directive 2014/65/EU of the European Parliament and of the Council([25]), or with credit institutions, as defined in point (1) of Article 4(1) of Regulation (EU) No 575/2013, the purpose of which is to enable an investor to carry out a transaction in relation to one or more of the financial instruments listed in Section C of Annex I to Directive 2014/65/EU, where the investment firm or credit institution granting the credit is involved in that transaction;
6	credit agreements that are the result of a decision issued by a court or another authority established according to law;
7	rental or leasing contracts where the obligation or option to purchase the object of the contract is not provided for either in the contract itself or in a separate contract;
8.	payment deferral under the following conditions: - a supplier of goods or a service provider grants the consumer time to pay for the goods or services made available by that supplier or service provider; - the purchase price does not include interest and does not involve any other costs but only limited costs borne by the consumer, in accordance with national law, for making late payment - payment to be made in full within 50 days of the supply of goods or the provision of services.
9	as regards the deferral of payment offered by suppliers of goods or service providers which are not micro, small or medium-sized enterprises as defined in Recommendation 2003/361/EC, where such suppliers or service providers offer information society services within the meaning of Article 1(1)(b) of Directive (EU) 2015/1535 of the European Parliament and of the Council (26) which consist in the conclusion of distance contracts with consumers for the sale of goods or the provision of services within the meaning of point 7 of Article 2 of Directive 2011/83/EU, the exclusion from the scope of this Directive shall apply only where the following conditions are met:

	- a third party does not offer or purchase credits; - payment must be made in full within 14 days of delivery of the goods or services; - the purchase price does not include interest and does not involve any other costs but only limited costs borne by the consumer, in accordance with national law, for making late payments;
10.	credit agreements regarding the postponement, free of charge, of the payment of an existing debt;
11.	credit agreements whereby the consumer is required to place an asset at the creditor's disposal as security, and in which the consumer's liability is strictly limited to the pledged asset;
12.	credit agreements relating to loans granted to a restricted public on the basis of a legal provision of general interest, at interest rates relating to the credit lower than those normally practiced on the market or without interest or under conditions that are more advantageous for the consumer than those normally practiced on the market;
13.	credit agreements already in existence on 20 November 2026; however, Articles 23 and 24, the second sentence of Article 25(1), Article 25(2) and Articles 28 and 39 shall apply to all open-ended credit agreements existing on 20 November 2026.

(Source: Directive (EU) 2023/2225)

We note that, with respect to the areas covered by this directive and the areas in which it does not apply, Directive (EU) 2023/2225 makes several clarifications in points: 3,4,5,6,7 and 8 of Article 2, as follows:

In point (3), the directive applies to credit agreements with a total value exceeding EUR 100,000, subject to the following:

1. the loans are not secured by a mortgage;

2. the loans are not secured by another security:

- comparable currently used in a Member State having as its object immovable property;

- by a right over immovable property, if the respective credit agreements are concluded for the purpose of renovation of residential immovable property.

Article 2, point (4) specifies that the type of credit in the form of exceeding the credit limit applies only to the following articles:

(a) articles 1, 2, 3, 17, 19, 25, 31, 35 and 36 and Articles 39-50;

(b) article 18, unless Member States decide otherwise.

Point (5) of Article 2 specifies that Member States may exempt from the application of this Directive credit agreement in the form of debit cards with deferred payment:

(a) which are provided by a credit institution or a payment institution;

(b) the terms of which stipulate that the credit must be repaid within 40 days;

(c) which is interest-free and only incur limited costs related to the provision of the payment service.

Point (6) provides that Member States: may provide that only Articles 1, 2, 3, 7, 8, 11, 19 and 20, points (a) to (h) and (l) of the first subparagraph of Article 21(1), Article 21(3), Articles 23 and 25 and Articles 28 to 50 shall apply to credit agreements which are concluded by an organization the membership of which is limited to persons residing or working in a given area or to employees and retired employees of a given employer, or to persons who fulfil other requirements laid down in national law which constitute the basis for the existence of a common link between the members, and which cumulatively fulfils the following conditions:

(a) it is established for the mutual benefit of its members;

(b) it makes a profit solely for the benefit of its members;

(c) it fulfils a social role provided for by national law;

(d) it receives and manages only the savings of its members and provides credit facilities only to them;

(e) it grants credit at an annual percentage rate of interest lower than that normally charged on the market or within the limits of a ceiling provided for by national law.

Member States may also:

1. to exclude from the scope of this Directive credit agreements concluded by an organization

referred to in the first subparagraph where the total value of all existing credit agreements concluded by that organization is insignificant in relation to the total value of all existing credit agreements concluded in the Member State in which that organization is established and where the total value of all credit agreements concluded by all such organizations in that Member State does not exceed 1 % of the total value of all existing credit agreements concluded in that Member State.

2. to review annually whether the conditions for the application of any such exclusion referred to in the second subparagraph are still met and to withdraw the exclusion where it considers that those conditions are no longer met.

Point (7) provides that Member States may provide that only Articles 1, 2, 3, 7, 8, 11, 19 and 20, points (a) to (h) and points (l) and (r) of the first subparagraph of Article 21(1), Article 21(3) and Articles 23 and 25, Articles 28 to 38 and Articles 40 to 50 shall apply to credit agreements between the creditor and the consumer as regards deferred payment or repayment methods, where the consumer has already breached or is likely to breach his payment obligations under the initial credit agreement and where the following conditions are met:

(a) the agreement between the parties to the contract is likely to preclude the possibility of bringing legal proceedings in relation to the consumer's failure to comply with payment obligations;

(b) by concluding that agreement, the consumer would not be subject to less favorable contractual terms than those in the initial credit agreement.

Point (8) provides that Member States may provide that Article 8(3)(d), (e) and (f), Article 10(5), Article 11(4) and Article 21(3) shall not apply to one or more of the following categories of credit agreements:

(a) credit agreements having as their object a credit with a total amount of less than EUR 200;

(b) credit agreements under which the credit is granted free of interest and without any other charge;

(c) credit agreements under which the credit is to be repaid within three months and for which only insignificant charges are payable.

The impact of the Credit Agreements Directive will be positive in that the parties involved are aware of:

1. the meaning of the definitions by the parties involved in a credit agreement;

2. areas where the Directive does not apply;

3. the clarifications that the Member States may make in the field of credit agreements, summarized in Tables 1 and Table 2.

4. the elements specified by the Directive for each stage of lending;

5. Financial education.

Conclusions

Directive (EU) 2023/2225 of the European Parliament and of the Council of 18 October 2023 on credit agreements for consumers and repealing Directive 2008/48/EC:

1. applies to credit agreements;

2. establishes a common framework for harmonization of: a) certain aspects of the legislative acts; b) administrative acts concerning consumer credit agreements of the Member States;

3. applies to credit agreements;

4. there are areas in which the Directive does not apply;

5. The Directive makes specific clarifications for certain situations;

6. The Directive was drawn up on the basis of: a) a proposal from the European Commission; b) the proposal from the European Commission was made after the draft legislative act had been transmitted to the national parliaments; c) the Treaty on the Functioning of the European Union, in particular Article 114; d) the opinion of the European Economic and Social Committee;

7. The Directive makes provisions regarding the conversion of amounts expressed in euro into national currency

– for the purposes of this Directive, Member States which convert amounts expressed in euro into their national currency shall initially use in such conversion the exchange rate prevailing on 19 November 2023;

– Member States may round off the amounts resulting from the conversion referred to in paragraph 1 provided that the rounding does not exceed EUR 10;

8.The Directive was adopted in Strasbourg;

9. The Directive entered into force on the twentieth day following its publication in the Official Journal of the European Union;

10.It is addressed to the Member States;

11. It was published in OJ L, Strasbourg, on 18 October 2023;

12.The new aspects adopted by the Directive relate to: clarifying the meaning of some terms and defining them, in terms of object, scope, definitions;

13.provides for minimum measures for creditors:

- rules of professional conduct and requirements for staff, rules of professional conduct when granting consumer credit, requirements for staff knowledge and competence;
- financial education and support for consumers facing financial difficulties: financial education, arrears and restructuring measures due to financial difficulties, debt counselling services, lenders and credit intermediaries;
- access to activity, registration and supervision of institutions that are neither credit institutions nor payment institutions;
- specific obligations for credit intermediaries;
- assignment of rights and dispute resolution, the transfer of rights; extrajudicial settlement of disputes;
- competent authorities, competent authorities;

14.concrete measures to protect credit consumers:

- provides for the obligation to provide free information to consumers;
- provides for non-discrimination;
- pre-contractual information concerns: personalized offers; adequate explanations; general information; advertising and marketing; standard information to be included in the advertising of credit agreements;
- practices: grouping practices, bonding practices; implied consent; advisory services; unsolicited lending;
- evaluation: obligation to assess the consumer's creditworthiness;
- the form and content of credit agreements: form of the credit agreement; information included in the credit agreement;
- changes to the credit agreement and the interest rate related to the credit: information regarding changes to the credit agreement; changes to the interest rate on the credit;
- "overdraft" facilities and exceeding the credit limit: overdraft facilities; exceeding the credit limit;
- withdrawal, termination and early repayment, right of withdrawal; linked credit agreements; open-ended credit agreements; early repayment;
- effective annual interest rate and measures to limit rates and costs, calculation of the annual percentage rate of charge; measures to limit the interest rates on the loan, the annual percentage rate of charge or the total cost of the loan to the consumer;
- final provisions embodied in: level of harmonization; mandatory nature of this Directive; penalties; exercise of the delegation of powers; review and monitoring; repeal and transitional provisions; transposition; entry into force; addressees.

We appreciate that the transposition of Directive (EU) 2023/2225 of the European Parliament and of the Council of 18 October 2023 on consumer credit agreements and repealing Directive 2008/48/EC into the national legislation of the Member States of the European Union will allow:

1. harmonization of national legislation of the Community states with Community norms

2. use of artificial intelligence in credit contracts at all stages thereof, namely at the stage: pre-contractual; getting to know the client; establishing the client's creditworthiness; developing the loan repayment schedule; building the smart contract; monitoring clients; monitoring risks at the client level; developing periodic reports for litigious clients.

3. the use of artificial intelligence for the compliance of the application of regulations on credit contracts at the national level of the Member States;

4. the use of artificial intelligence for the compliance of the application of regulations on credit contracts at the European level.

The novel aspects brought by the European Directive represent the concrete and lasting support for sustainability and durability offered by the European Commission and the European Economic and Social Committee for the parties involved in credit contracts, harmonizing national legislation with the requirements of European norms.

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"The choice about how gets deployed AI is ours."

Oren Etzioni

Research Analysis in Financial Risk Management

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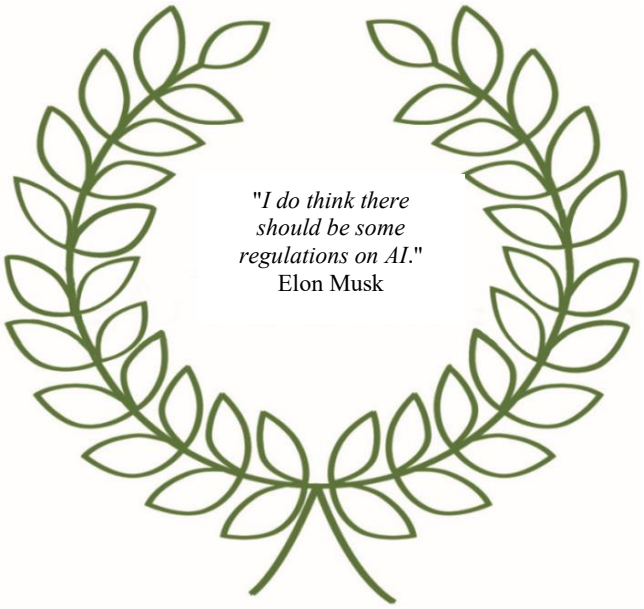
Abstract

The financial health of a business is crucial for its continued operation and growth. The purpose of the study is to realize a descriptive and evaluative research of leadership in financial risk management. To achieve a meticulous understanding of current research trends, this paper employed a bibliometric approach, so, to gain insights into leadership in financial risk management, Scopus and VOS viewer were employed to analyze relevant articles. The study has limits as the trends are presented following the bibliometric analysis, this paper can represent a starting point for the following researches in the field.

Keywords: leadership, financial risk management, financial crisis

Introduction

Leadership is an important factor with a high impact in job performance and organizational power to adapt to new challenges (Bass et al., 2003). Financial performance has been a key metric for evaluating corporate success, reflecting a company's ability to generate revenue from its assets. It provides a snapshot of a company's financial health at the end of each fiscal year (Van Wijk, 2018). Risk-taking policies within companies ultimately depend on management. So that, studies on the relationship between corporate governance mechanisms and default the risk has multiplied in recent years (José García et al. 2022). As Wollen (2013) sustain, financial industry suffered severe damage because of organizations that were unprepared to navigate the intricate landscape of investment risk.



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The Financial dimension of a business is very important, as it contributes significantly to maintaining the company's continued existence and sustainability (Hasbu et al., 2024). Despite its importance, financial education is not a priority for many university students, leading to a lack of financial awareness and personal leadership skills (Del Rosario Arambulo-Dolorier et al., 2024). Yankovskaya et al. (2022) propose a new, alternative approach to financial risk management during economic crises that is based on corporate social responsibility (CSR) and long-term, large-scale investments in social and environmental innovations. The authors argue that this new approach is more effective than the existing approach, which focuses on short-term, small-scale investments in technological innovations, as it can better support both economic growth and sustainable development.

Tao and Hutchinson (2013) examine the role of compensation and risk committees in managing and monitoring the risk behavior of Australian financial firms in the period leading up to the global financial crisis. They demonstrate the importance of having qualified and experienced committee members, as well as the benefits of having directors serve on both the risk and compensation committees. As main findings, the composition of the risk and compensation committees can significantly impact a company's risk level. When the same directors serve on both committees, it can lead to a better alignment between the company's risk exposure and the incentives provided to executives. This can reduce information asymmetry and improve overall firm performance.

Iglesias-Casal et al. (2020) examines the impact of securitization on the financial stability and systematic/systemic risk of European banks from 2000 to 2017. It finds that securitization led to an increase in the systematic risk of originating banks in the pre-crisis period, due to an increase in both systemic risk (correlation with the market) and idiosyncratic risk. However, this effect was not observed during and after the crisis period. Nurmagambetova et al. (2013) explores the importance of risk management in financial institutions, especially during unstable economic times. The financial crisis of 2008 highlighted the need for better risk assessment. Financial institutions can thrive when they manage risks effectively, ensuring they are reasonable, controllable, and within their financial capabilities.

The theme of the research is investigating leadership in financial risk management role through a bibliometric analysis. This paper aims to explore the development of research surrounding the question: "What are the trends in research on leadership in financial risk management over the past 46 years?

Materials and Methods

The aim of this study is to conduct a descriptive and evaluative research of leadership in financial risk management. This examination is based on papers sourced from Scopus international database. To have a comprehensive understanding of leadership in financial risk management, this study: explores how research about financial risk management leadership is distributed in Scopus publications, analyze the leadership in financial risk management research within the Scopus database and examines the trends in leadership approaches within financial risk management as reflected in published research (Table 1).

To achieve a meticulous understanding of current research trends, this paper employed a bibliometric approach, so, to gain insights into leadership in financial risk management, Scopus and VOSviewer were employed to analyze relevant articles. A search string was developed consisting of five main keywords: 1) leadership, 2) management, 3) financial, 4) risk, 5) crisis, focused on articles published between 1978 and 2024 period. After filtering, 4.604 articles were obtained. Next, English documents were selected and the number of the documents decreased to 4.435.

Table 1 – *Bibliometric analysis process: inclusion and exclusion criteria*

Stage	Details	
Stage 1	**Source**	Scopus database
	Indexation	All
	Date	16.08.2024
	Search Period	1 January 1978 – 16 August 2024
	Searched keywords	(TITLE-ABS-KEY (leadership OR management) AND TITLE-ABS-KEY (financial) AND TITLE-ABS-KEY (risk) AND TITLE-ABS-KEY (crisis) AND (LIMIT-TO (LANGUAGE , "English"))
	Initial result	4.604 documents
Refining stages		
Stage 2	**Language**	English = 4.435 documents
	Final result	4.435 documents

Results and Discussions

The results of this bibliometric analysis are presented below. Figure 1 presents a graph highlighting co-occurring keywords within the analyzed research on leadership in financial risk management. From the 4.435 articles identified in the analyzed period, over 218 keywords are concentrated in 3 clusters, with 12159 links.

The red cluster presents the keywords: "financial crisis", "risk management", "crisis management", "artificial intelligence", "banking", "stock market", "data mining", "financial stability" and "empirical analysis". Financial crises and risk management go hand in hand, both pointing to the critical importance of understanding and managing economic events. Also, it can be seen a connection between the artificial intelligence and the way organizations approach and manage financial risks and crises.

The green one is based on the keyword: "human" and creates interconnections between the following topics: "article", "review", "health policy", "methodology" etc. these keywords suggest a focus on health research that analyzes or evaluates policies, strategies, or interventions related to leadership and the financial crisis.

Lastly, the blue cluster appears focused on the concept of "risk factor" and revolves around the key words "female", "pandemics", "male", "adult", "socioeconomics", "mental health". It emphasizes the role of risk factors for leadership in financial crisis.

By examining these clusters, we can gain a deep and multifaceted understanding of leadership in financial risk management, considering environmental, economic, social, and organizational factors.

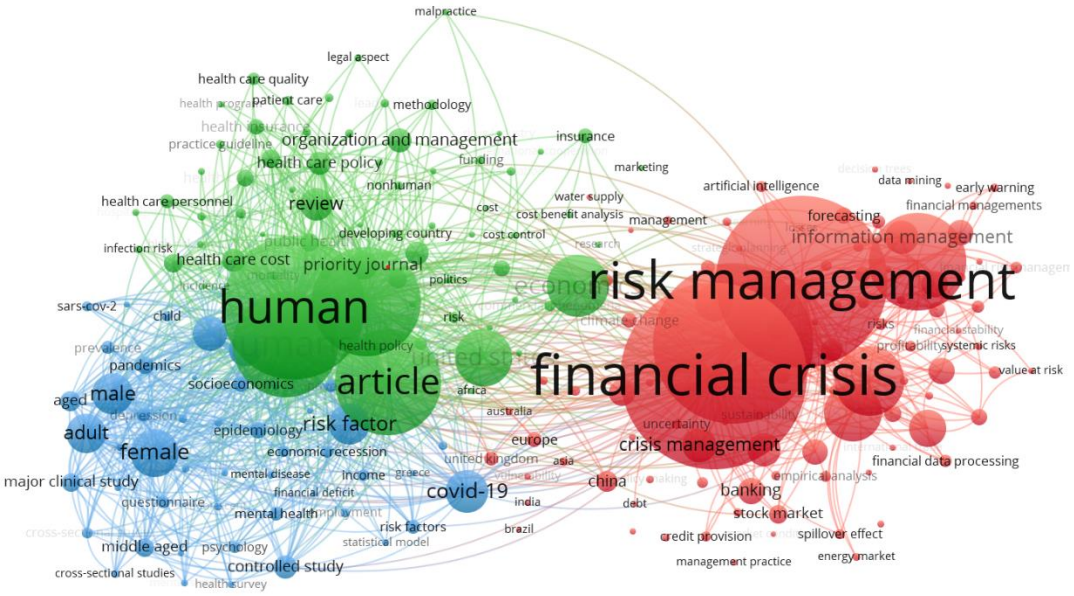

Figure 1 – *Keyword co-occurrence graph*

Regarding the evolution of papers published by year, it can be observed a increase in the volume of published articles throughout the analysed period, showing a growing academic focus on leadership in financial risk management. The observed peak in article numbers for 2022 can be attributed to the interest in leadership in this field (Figure 2).

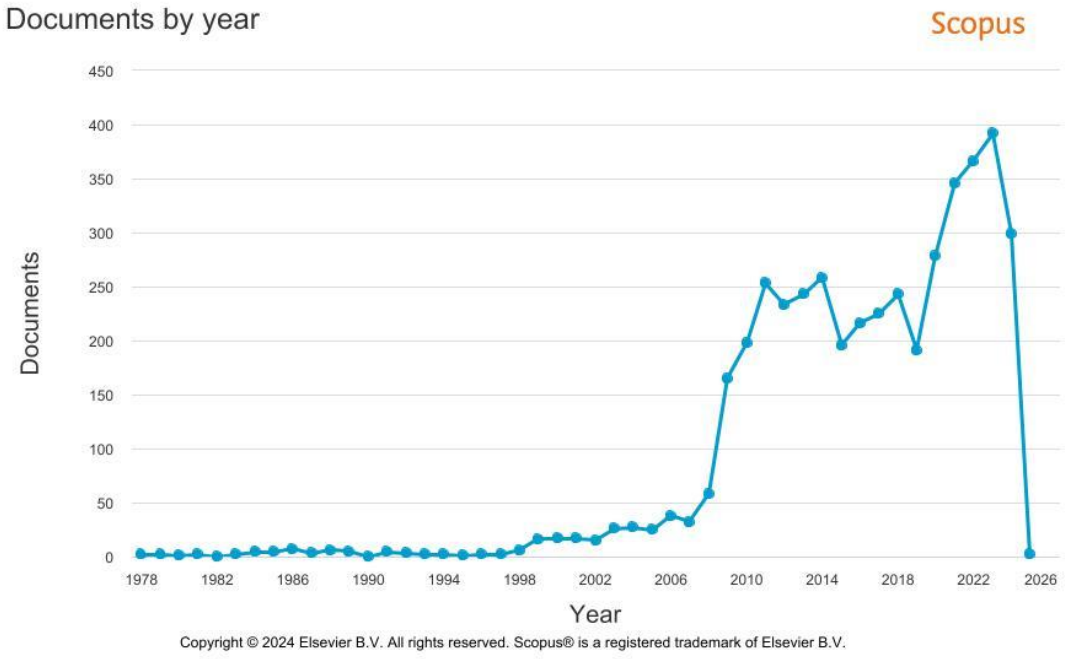

Figure 2 – *The evolution of papers published by year*

This output presents the geographical distribution of research regarding leadership in financial risk management, highlighted by nine clusters, with 915 links from where it can be noticed a strong alignment of values, culture, and perspectives.

Whereas particular countries, like the United States, China, Russian Federation and France, have a notably higher publication rate, this doesn't reduce worldwide interest about this subject. Central attention to leadership in financial risk management across various nations highlights the importance of research partnerships, where a global academic effort is focused on achieving an effective leadership in this domain (Figure 3).

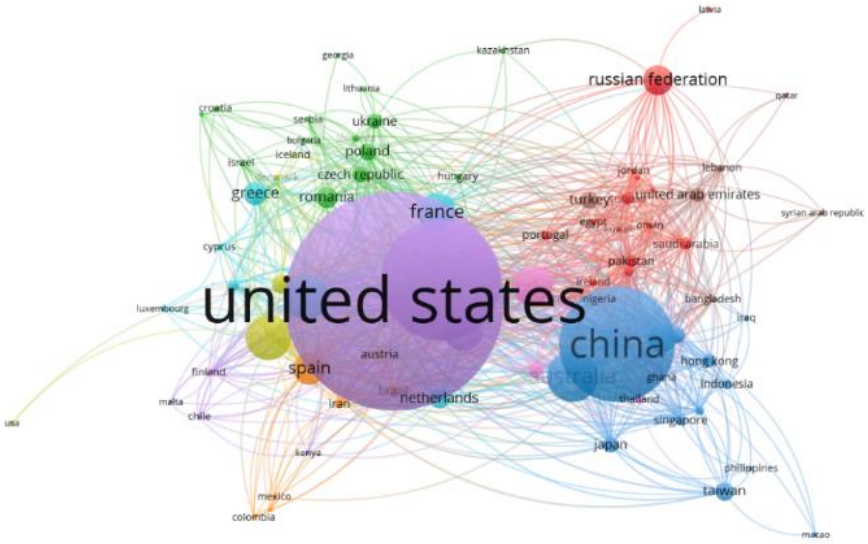

Figure 3 – *Countries with highest publication output*

In Figure 4 we can see the documents per year by source, where is presented top 10 journals which disseminates the authors' knowledge of research in the financial field. All of them have registred the most published works in the last 20 years, which may suggest an acceleration of the pace of research.

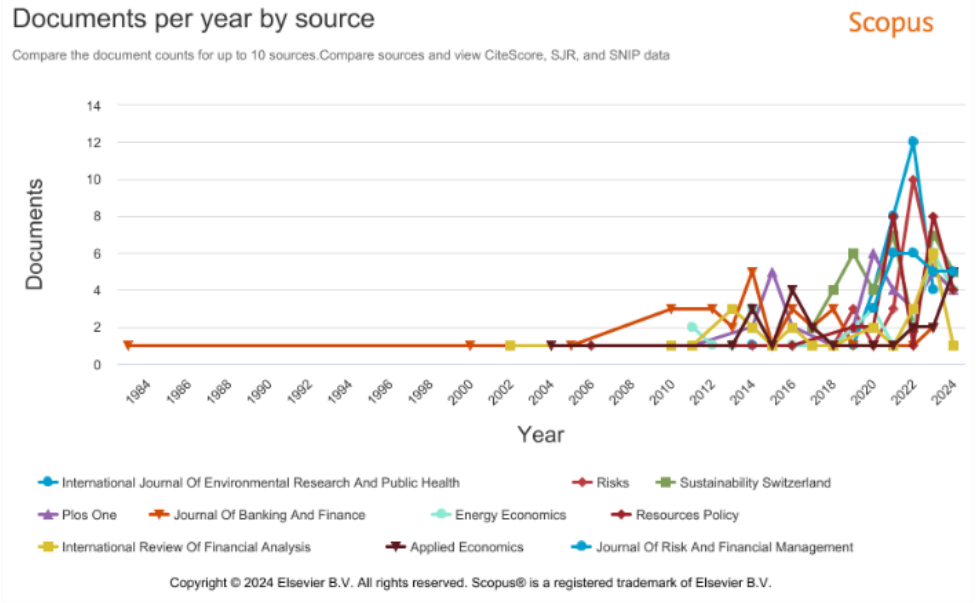

Figure 4 – *Documents per year by source*

Figure 5 present valuable insights into the most important authors driving research on leadership in financial risk management. The links between the authors in the field who collaborated are presented, being highlighted five clusters, with 29 links, from which it appears that there are collaborations in the field, for a long-term development.

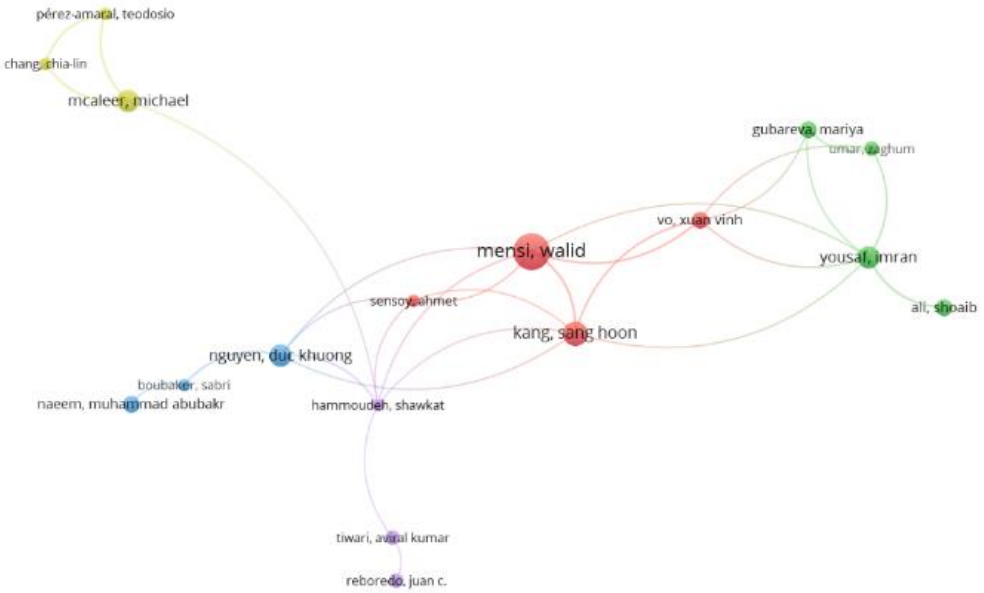

Figure 5 – *Top authors making notable contributions on leadership in financial risk management*

Analyzing the number of publications, we can see that articles (66,1%) are the largest category of publications, suggesting that most research is presented in article format, and conference papers (11,1%) are the second most popular category, indicating that conferences play an important role in disseminating research. Articles are more accessible and faster to publish than other types of publications, which may explain why articles are the most popular category. So, analyzing these numbers gives us insight into publishing preferences and practices in that field (Figure 6).

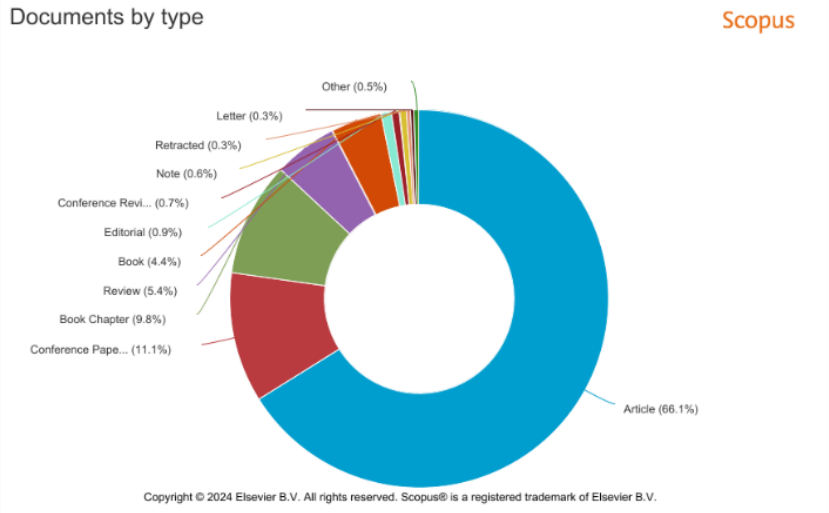

Figure 6 – *Documents by type*

The dominance of economics, business, and social sciences suggests a focus on understanding and managing the complexities of the modern world (Figure 7). The emergence of computer science, medicine, engineering, and environmental science indicates a growing emphasis on technological innovation, healthcare, and sustainability. For a good operation, all these areas need a correct financial management, with efficient risk management.

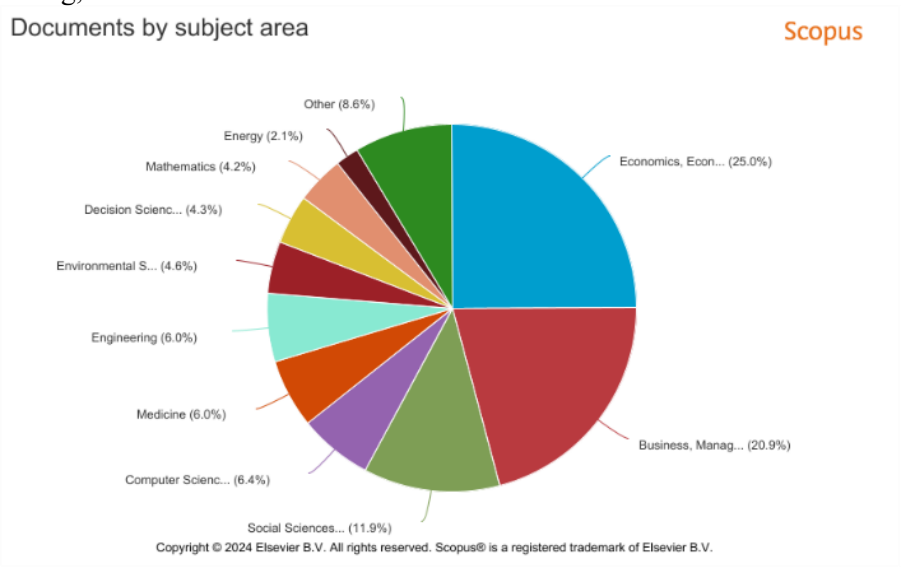

Figure 7 – *Documents by subject area*

Conclusions

In conclusion, the paper presented the most important aspects of a bibliometric analysis. By examining the keyword clusters, we have a deep and multifaceted understanding of leadership in financial risk management, considering environmental, economic, social, and organizational factors. About the evolution of papers published by year, it can be observed a increase in the volume of published articles throughout the analysed period, showing a growing academic focus on leadership in financial risk management. Regarding the countries with the highest publication output, it is presented a geographical distribution of leadership in financial risk management research, from where it can be noticed a strong alignment of values, culture, and perspectives.

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The study has limits as the trends are presented following the bibliometric analysis, this paper can represent a starting point for the following researches in this subject.

Acknowledgments: *This paper was co-financed by The Bucharest University of Economic Studies during the PhD program.*

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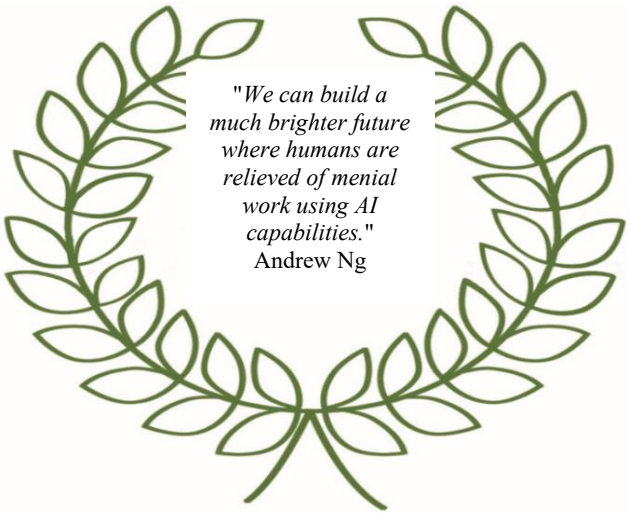

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