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Papers

Research in a Technology-Driven Environment.....	7
<i>Constantinos J. Stefanou</i>	<i>7</i>
How can external auditors utilize ChatGPT?.....	8
<i>Benita Gullkvist</i>	<i>8</i>
Cloud ERP Adoption in Organizations	9
<i>Amalia Stafyla, Argyro Kontou and Ioannis Nanos</i>	<i>9</i>
Using a LLM to Detect Management Fraud.....	10
<i>Georgia Boskou, Evrikleia Chatzipetrou, Eleftherios Tiakas, Efstathios Kirkos and Charalambos Spathis.....</i>	<i>10</i>
Bankruptcy Prediction using Machine Learning Techniques. Evidence from the European Banking Sector	11
<i>Apostolos Dasilas and Anna Rigani</i>	<i>11</i>
Tax accounting of unused net operating losses in periods of financial distress	12
<i>Evangelos T. Chytis.....</i>	<i>12</i>
The importance of culture for fostering innovation in organizations.....	13
<i>Athanasios Vasilopoulos and Christos Tsitsakis.....</i>	<i>13</i>
Implementation of a chatbot and evaluation of its use in an academic institution.....	19
<i>Ioannis Nanos, Christos Mellos, Amalia Stafyla.....</i>	<i>19</i>
The relationship between ESG-related reputational risk exposure and firm performance and the moderating insurance-like effect of ESG reporting	21
<i>Benita Gullkvist</i>	<i>21</i>
Addressing Missing Economic and Financial Data: Methods, Best Practices and Challenges	23
<i>Eleftherios Tiakas , Georgia Boskou, Evrikleia Chatzipetrou, Efstathios Kirkos.....</i>	<i>23</i>
Exploring Membership Programs in Ride Hailing Platforms.....	35
<i>Haozhao Zhang, Huseyin Cavusoglu and Srinivasan Raghunathan</i>	<i>35</i>
The association between female Directors' presence on the Board of Directors and Long-Term Leverage on Greek Listed Firms	36
<i>Anastasios Chatzis, Georgios L. Thanasas, Agathi Koulidou</i>	<i>36</i>
Enhancing Sustainable Development through Artificial Intelligence: Insights from Expert Interviews.....	51
<i>Henrik Lindseth, Jostein Rygg, Leif Skiftenes Flak, Eli Hustad.....</i>	<i>51</i>
Proposals on the reformation of personal income taxation in Greece.....	74
<i>Efstathia Koutroubi.....</i>	<i>74</i>
The impact of disclosure timeliness and cybersecurity risk management assurance on investors' judgments and decisions.....	94
<i>Patricia Navarro, Steve G. Sutton.....</i>	<i>94</i>
Sustainability Reporting Standards: Evidence from the Athens Stock Exchange	100
<i>Glykeria-Maria Papanikolaou, Evrikleia Chatzipetrou, Eleftherios Tiakas, Georgia Boskou.....</i>	<i>100</i>
The impact of executives' financial background on corporate innovation.....	103
<i>Minghui Yang, Michail Fygiouris, Epameinondas Katsikas, Chris Grose, Dimitrios Koufopoulos.....</i>	<i>103</i>
Legal issues about the implementation of smart contracts	125
<i>Kalliopi Kalampouka</i>	<i>125</i>
Deciphering the Use of Disclosure Tone through AI-based Decision Aids: Do Reliance and Experience Moderate AI Relevance in Investor Decision Making?.....	134
<i>Anis Triki, Vicky Arnold, Steve G. Sutton</i>	<i>134</i>

An Analysis of the Impact of ESG on Corporate Financial Performance.....	140
<i>Jiaxuan Wang, Michail Fygiouris, Epameinondas Katsikas, Chris Grose, Dimitrios Koufopoulos.....</i>	
Performance Impacts of Accounting/Finance Transformation – the Mediating Role of Analytics Systems Quality	163
<i>Maria-Luise Ossimitz and Bernhard Wieder</i>	
Guests’ perceptions on eco-tourism: The case of hotels in Greece	178
<i>Emmanouela - Angelika Achdjian, Angelos - Stavros Stavropoulos, Stella Zounta, Dionysia Panagopoulou, Evangelos Chytis.....</i>	
SCOR Model: A literature review	192
<i>Margarita I. Zarogianni, Costas Assimakopoulos, Ioannis Nanos</i>	

Research in a Technology-Driven Environment

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In the current rapidly evolving technology-driven environments, technological advancements, such as AI and industry 4.0 digital transformation tools, have become increasingly important in shaping the paradigms of research across diverse fields. This paper explores the transformative impact of advanced technologies on research methodologies, data analysis, and interdisciplinary collaboration. Technological advancements in artificial intelligence, big data analytics, and digital communication tools have significantly enhanced the efficiency and scope of research. These innovations facilitate the collection, processing, and interpretation of vast and complex datasets, enabling researchers to uncover insights with unprecedented precision and speed. AI-driven research facilitates automated hypothesis generation, predictive modeling, and real-time data analysis, significantly accelerating the research cycle.

Moreover, technology has facilitated access to research tools and information, fostering global collaborations and accelerating the dissemination of knowledge. In this context, digital platforms and virtual environments have become crucial in supporting remote research activities, enabling continuous scientific inquiry even in the face of geographical and logistical constraints.

However, the integration of technology into research also presents challenges. Ethical considerations, data privacy, and the digital divide are critical issues that need to be addressed to ensure equitable and responsible research practices. Furthermore, the rapid pace of technological change necessitates continuous adaptation and skill development among researchers to fully harness the potential of these tools.

In conclusion, the confluence of technology and research is revolutionizing the way knowledge is generated and applied. As we navigate this dynamic environment, it is essential to balance the opportunities and challenges to foster a robust and inclusive research ecosystem that leverages technology for the advancement of society.

Keywords: AI Research, technology-driven environment, ethical practices

How can external auditors utilize ChatGPT?

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Generative artificial intelligence (Gen AI) and large language models (LLMs), such as ChatGPT, Bing, Perplexity etcetera, have received considerable attention lately. The technology uses a combination of unsupervised pre-training and supervised fine-tuning to provide human-like responses to queries. The responses largely resemble those of a human expert. Worldwide, the general public, researchers and professionals have tested and adopted these tools, and numerous potential uses have emerged in various fields. For example, in education, Wood et al. provided evidence that ChatGPT performs better than the student average for 15.8 percent of assessments.

This study explores the usefulness, reliability and limitations of ChatPGT (by OpenAI) as a potential tool for external auditors. The study builds on prior research, conducted interviews with auditing professionals and empirical findings when exploring the use of ChatFPT for various audit tasks. The simulation testing explores ChatGPT's ability to summarize, search and analyze information in financial statements and sustainability reports of listed companies included in the Europe Stoxx 600 index for the year 2023 or 2022 (depending on data access). By posing questions and comparing ChatGPT's answers with responses derived from a manual examination of the corresponding information in the report, the efficiency, reliability and limitations of ChatGPT for audit work is evaluated.

The yet preliminary findings indicate some use potential, if limitations are considered. In brief, ChatGPT seems to manage narratives and text better than graphs and tables, thus performing queries on text and related analysis more reliably than on tabulated information. ChatGPT is efficient and can easily, quickly and accurately summarize long text sections, something that is considered useful in audit work. It is also noted that ChatGPT's capacity to perform has increased over the last year, when these tests have been conducted.

Keywords: generative artificial intelligence, Gen AI, ChatGPT, audit tasks, automation

Cloud ERP Adoption in Organizations

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The adoption of Cloud Enterprise Resource Planning (ERP) systems has emerged as a transformative trend for organizations seeking to enhance operational efficiency, agility, and scalability. This abstract examines the critical factors driving the adoption of cloud-based ERP solutions, their benefits, challenges, and the impact on organizational performance and strategy.

Cloud ERP systems offer a significant departure from traditional on-premises ERP solutions by leveraging cloud computing technology to provide real-time, scalable, and cost-effective business process management tools. This transition enables organizations to streamline operations, reduce IT overhead, and enhance data accessibility and collaboration across departments. Key drivers of cloud ERP adoption include the need for flexibility in resource management, rapid scalability to meet evolving business demands, and the capability to support remote and hybrid work environments.

The benefits of cloud ERP systems are multifaceted. They provide enhanced data integration and real-time analytics, empowering organizations with actionable insights to drive strategic decision-making. The subscription-based pricing models associated with cloud ERP also reduce the upfront capital expenditures and allow for more predictable IT spending, making these systems particularly attractive to small and medium-sized enterprises (SMEs). Furthermore, cloud ERP solutions typically offer improved security and compliance capabilities, with vendors often providing robust measures to protect sensitive business data and ensure regulatory compliance.

However, the adoption of cloud ERP systems is not without challenges. Organizations must navigate issues such as data migration complexities, integration with existing legacy systems, and concerns over data security and vendor lock-in. Additionally, the shift to a cloud-based model requires cultural and operational changes within organizations, including staff training and change management efforts to ensure smooth implementation and adoption.

In conclusion, cloud ERP systems represent a pivotal advancement in enterprise resource management, offering significant opportunities for operational improvement and strategic growth. To fully capitalize on these benefits, organizations must carefully consider the associated challenges and develop comprehensive strategies for successful adoption and integration.

Keywords: Cloud ERP, digital transformation, ERP adoption

Using a LLM to Detect Management Fraud

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Recently, Large Language Models (LLMs) have attracted significant attention due to their versatility in executing a broad spectrum of tasks, including natural language understanding, sentiment analysis, translation, summarization, and more. Within the realm of auditing, recent studies indicate that LLMs can be effectively utilized for financial ratio analysis, journal entry testing, verification of internal accounting records, among other pertinent tasks. This study delves into the capability of LLMs to identify management fraud by scrutinizing text segments extracted from annual reports. Specifically, it examines the letters from CEOs to shareholders to identify and leverage language patterns and characteristics that help differentiate fraudulent cases from legitimate ones. By applying advanced prompt engineering techniques such as instruction learning and few-shot learning, we enhance the model's existing knowledge base and improve its predictive accuracy. Although the findings demonstrate the potential of LLMs in detecting management fraud, they reveal limitations when compared to traditional text mining techniques previously employed in similar studies.

Keywords: management fraud detection, auditing, large language models, prompt engineering, machine learning

Bankruptcy Prediction using Machine Learning Techniques. Evidence from the European Banking Sector

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Traditionally, bankruptcy prediction relied on conventional financial ratios and quantitative analysis, which often failed to capture the intricacies and nonlinear relationships inherent in complex financial data. However, the rapid advancements in artificial intelligence (AI) and machine learning (ML) techniques have opened new avenues for bankruptcy prediction, providing more sophisticated tools to analyze vast amounts of data, uncover hidden patterns, and improve the accuracy of predictions (Lombardo et al. 2022; Yang et al. 2021).

The application of AI and ML algorithms for bankruptcy prediction has garnered significant academic attention. These new techniques offer the potential to uncover non-obvious relationships between financial variables, detect subtle indicators of financial distress, and enhance the predictive power of bankruptcy models. By leveraging the power of computational models, researchers and practitioners aim to develop robust and reliable bankruptcy prediction models that can assist decision-makers in identifying companies at risk of insolvency and guide appropriate intervention strategies (Mishraz et al., 2021; Yang et al., 2021; Nyitrai and Virág, 2019; Rainarli, 2019). Despite the growing interest and advancements in bankruptcy prediction using AI and ML, several challenges have emerged. One of the primary challenges is the availability and quality of data (Aljawazneh et al., 2021). Financial data is often complex, heterogeneous, and prone to errors, necessitating meticulous careful preprocessing and feature engineering to derive meaningful insights. Additionally, the dynamic nature of financial markets demands the development of models that can adapt to changing economic conditions (Safi et al., 2022). Another significant challenge is the interpretability and explainability of AI and ML models. Finally, the diverse regulatory framework of the European banking sector poses another challenge for accurately predicting bankruptcies.

Employing AI and ML techniques this paper aims to conduct bankruptcy prediction using data from the EU banking sector. In particular, this study uses data from 4,750 active banks and 1,569 inactive banks from EU countries for the period 2013-2021. The study employs a range of ML methods, such as decision trees, neural networks, support vector machines, and ensemble learners (boosting and bagging). The results reveal that the ensemble model trained with the Adaboost algorithm using the oversampling method SMOTE, achieves an area under the ROC curve (AUC) value of 90.9%.

Keywords: Machine learning, bankruptcy prediction, banking sector

Tax accounting of unused net operating losses in periods of financial distress

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For the European Securities and Markets Authority (ESMA), treating positions with deferred tax assets during a financial crisis is of high priority. Attention is being drawn to the recoverability of deferred tax assets arising from the carryforward of unused tax losses (DTAs_TLC) and the focus is on improving the information provided. This study examines whether the recognition and tax disclosure of DTAs_TLC in times of financial distress meets the requirements of international accounting standards and what impact institutional and external factors may have. In this context, the role of external auditors and specific company characteristics are also examined. Using a hand-picked panel data set of the largest companies listed on the Athens Stock Exchange before and during the economic crisis in Greece, the results indicate that DTAs_TLC do not comply with the guidelines set by International Accounting Standards (IAS/IFRS). The extent and quality of tax disclosures and the engagement of large audit firms seem to increase the likelihood of the occurrence of DTA_TLCs positions in the financial statements.

Keywords: deferred tax assets, tax loss carryforward, audit quality, disclosure quality

The importance of culture for fostering innovation

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Abstract

Culture can play an important role in the success of an organization. From the shared values, and the type of communication channels to the recognition that a company gives to their employees everything matters. However, studies also suggest that fostering an environment that can take into consideration characteristics like open communication and the team structure can help to achieve innovation in the company. Thus, our main goal with this short paper is to analyze through studies and the latest literature, the impact organizational culture has on innovation. In addition, we are going to examine the characteristics of currently available tools that can measure the culture of innovation.

Keywords: Innovation, Culture, Tools, Organizations

1 Introduction

The pressure that competition among companies can bring, the new global market standards, and the importance of keeping up with innovative technology and sustainability are just a few challenges that many businesses need to tackle in order to be profitable, innovative and operate without major problems.

One, out of many, ways that companies can encounter these challenges, is to have the right organizational culture within the company. This not only can help significantly but also can bring a lot of innovative capabilities. Besides, to be an innovative company, you do not necessarily focus only on products/services, you also need to develop a culture that will be able to foster innovation, and this is what a lot of innovative companies actually do (Zhang et al., 2023).

However, we need to keep in mind that there are times when innovation through culture can be difficult. That can be for example when there is a company structure that is mostly centralized and eventually employees in these situations tend to be less involved and committed.

Consequently, our main goal with this paper is to examine, through the literature, and studies, how culture can play a significant role in the innovation of an organization and what are the characteristics that the team needs to have in order to be able to be innovative. One more important aspect is that through the paper, we will try to name the currently available tools that can measure the culture of innovation in organizations.

In conclusion, the following chapters are organized as follows.

- The first chapter was an introduction to the paper and the importance of having a culture that can help a company to tackle problems and to bring innovation.

- The second chapter is a brief literature review about the importance of culture in the organizations and the impact that has in innovation, while there is also a discussion on the definition of both culture and innovation.
- The third chapter is about the important characteristics that culture needs to have for fostering innovation within an organization.
- The fourth chapter is about the currently available tools that can be used in order to measure the culture of innovation within an organization.
- The fifth chapter is a discussion of the key findings from our paper.
- The sixth, and final chapter, is the conclusion of our paper including the limitations and the proposal for future research.

2 Brief literature review

2.1 Organizational Culture

As we mentioned, organizational culture plays a significant role in the success of an organization, but what is culture? Defining “Culture” can be difficult since there is not one definitive definition. Culture can be the norms, the values, and how an organization can support people and innovation (Stock & Zacharias, 2011).

As the organizational culture plays an important role in refining and improving a company’s upcoming prospects, according to Schein (2004) organizational culture focuses on people and its main purpose is to support organizations and companies by having the right climate and practices.

Also, but not limited to, McCarthy (2013) mentions that organizational culture is a more socially constructed and holistic matter that it can be tough to change. To continue, organizational culture can be separated into four types which will be briefly presented below.

Firstly, there is Clan Culture. This type of culture mostly refers to a type of organizational culture that aims to promote a collaborative environment among the people of a business (Boatman, 2024).

Secondly, there is the culture of adhocracy. Essentially, an organization that has this kind of culture can face problems such as hindering the exchange of knowledge as it relies more on individual initiative and decision-making (Khurohani, 2013; Gaál et al., 2010).

Thirdly, is the Market culture which places more emphasis on employee outcomes. The main purpose of this type of culture is to set measurable goals, which is also an important motivator and can bring significant changes to the employees (Gaál et al., 2010).

Finally, there is the Hierarchy culture. The main difference of this type is that it provides formal and structured procedures to members of the organization (Ali et al., 2016).

2.2 Innovation

Although there is not one single definition for innovation, the Oslo manual tried to define innovation as the: *“implementations of products or production and delivery processes with new or significantly improved characteristics”*. The third edition of the Oslo Manual extends the definition to include new organizational methods in business practices, workplace organization, or external relations implementation” (OECD, 2005 pp. 46).

Another more general attempt made by Baregheh, Rowley & Sambrook (2009) is that innovation can be a multi-step process. In this process, organizations can transform ideas into new and improved products, services, etc. in order to successfully advance and be able to compete.

Innovation plays an important role in the profitability and prosperity of a company. A few examples of why innovation is very important to companies are because it will be easier to be

competitive, may have an important advantage, be more profitable and have the highest market share.

Innovation can also be planned through the business model of a company. This can dynamically help businesses to use innovation in order to develop products and services that can bring competitive advantage and more (Medina and Guerrero, 2017).

2.3 Culture of Innovation

The Culture of Innovation is about the process that a company follows in which its members share some characteristics like a common set of values, behaviors, attitudes, and beliefs. All these shared characteristics can play an important role in order to help or/and creating innovative products or services within the organization (Ali & Park, 2016).

Furthermore, innovative culture can be shaped through the work group dynamics, having in mind the importance of the engagement in people, the creativity, and the way that this can be implemented (Comas, 2022).

To build a culture of innovation is not an easy task. This is mostly because in order to support innovation inside an organization, it needs the people to have the proper culture that inspires them to innovate (Halim et al., 2015). Lastly, talent management can also support innovation culture within a company.

In the next chapter, we will discuss in more detail, the necessary characteristics that companies must have, in order to achieve a culture of innovation.

3 Some of the characteristics of innovation culture within an organization

Identifying and building the essential characteristics within a company in order to support an innovative culture is very important. Papers and studies have identified the necessary characteristics that an organization must have in order to build a culture of innovation among employees.

According to the paper by Kalvani (2011), the key contribution to the creation of a culture that contains innovation is the open collaboration between the employees, and trust, combined with autonomy of movement and experimentation.

Two more papers, of Liker & Hoseus (2008) & Wei et al. (2013) contribute with some important characteristics that a culture within an organization can have in order to be innovative. In the first paper, an important role plays in the existence of motivation and development within the company. Through this way, the employees manage to contribute significantly to the success of the company. Equally, for the second paper, important parts of culture in order to be innovative, are the right incentives, the right and effective decision-making, and the effectiveness.

Furthermore, Tidd & Bessant (2009) supported that some important aspects like trust and transparency in the workplace, support from senior management, and a proper approach to conflict resolution are just some of the characteristics that their study found to shape a culture of innovation in an organization.

Last but not least, Valencia and Hernández (2018), suggested that some of the necessary attributes that are going towards a more inclusive and innovative culture within an organization can be the respect among the group, the acceptance of diversity the curiosity and the respect. Thus, in order to conclude, these papers suggest a plethora of characteristics like trust, teamwork, proper approach to conflict resolution, etc., that need to be in an organization in order to build a culture towards innovations.

4 A sample of available tools that can measure the culture of innovation

A very important aspect of a culture of innovation is the available tools that can help a company measure and identify it. The most commonly used tools to measure the impact of culture on innovation are through qualitative approaches such as questionnaires, surveys, and data analysis. There are some specific instruments that are able to measure the culture of innovation

within a company (Danks et al, 2017).

Below, we will have the chance to name some important tools that were constructed in order to measure the culture of innovation.

To begin with, one tool is the Open Innovation Climate Measure from Wikhamn and Wikhamn (2011). This tool was used in a multinational automotive company, and the main aspect was to process and measure the open innovation principles in practice. Another tool is the Innovation Quotient Survey from Rao and Weintraub (2013). This tool was field tested for more than 2 years and its purpose was to measure mostly the values, climate, resources, and behavior within an organization.

One more tool is the FOCUS questionnaire from Van Muijen et al. (1999). The main purpose of this tool was to measure culture through some characteristics such as innovation and flexibility, among different countries. The sample of this questionnaire was more than 4000 employees of 61 organizations.

Furthermore, the Value Innovation Potential Assessment Tool (VIPAT) from Aiman-Smith et al. (2005) tried to develop another tool that can measure the potential of a team in having an innovative mindset.

Lastly, there is the Radiography of Innovation Culture-Multidimensional Questionnaire (RIC-MQ) from the work of Muñoz-van Den Eynde et al. (2015). This tool aims to study the culture of innovation in companies having the viewpoint of the individuals and the people that are involved in the process and the development of innovation.

In conclusion, as discussed in this chapter, there are many tools that can be used in order to measure the culture of innovation inside an organization even though these tools are measuring different aspects of culture of innovation.

5 Conclusion

Having discussed the important characteristics of an organizational culture that can foster innovation in organizations, it becomes clear that building an environment that can help employees and managers to achieve an innovative culture can be challenging.

If we consider the lack of resources whether these are financial or not, and the structure of the organization, and some other key elements like having or trained employees with all these necessary skills that can help to build a more coherent environment that innovation can thrive, can be very challenging. That is the reason that companies understand that there is a lot of work that needs to be done in order to implement an innovative culture.

Inside the core culture of an organization, there are some characteristics that research suggests that can help towards innovation. Among these characteristics are open communication, team collaboration, and open-minded sessions. These are only a few examples that contribute to bringing to life a culture of innovation.

Moreover, through the tools that were presented, we understand that not all of them are focusing on the same parameters. There are tools that are more focused on some specific characteristics while others are trying to “see” the bigger picture.

In conclusion, organizational culture plays an important role in a company. As a matter of fact, the right culture within an organization can make employees think and act in ways that can support innovation.

5.1 Limits of the research & Further research

The current paper tries to analyze through studies and the literature and available data - reports, the impact that organizational culture has on innovation as well as the current available tools and characteristics that can measure the culture of innovation.

However, there are two limitations to our research. Firstly, there may be more tools that an organization can use to measure the innovation culture that is currently presented. Secondly, our research is focused on the characteristics that a company can have in order to achieve an innovation culture without mentioning other factors like the technology that is used inside the

organizations etc.

Our recommendation for a future research, is to focus more on the available tools that can measure the culture of innovation and also to implement more on field studies in order to determine the impact on companies.

To conclude, we believe that there is a need for further research on how successful and innovative companies can utilize and strengthen the company culture in order to achieve more innovation within the organization.

References

- Aiman-Smith, L. *et al.* (2005) 'Assessing your organization's potential for value innovation,' *Research Technology Management*, 48(2), pp. 37–42. <https://doi.org/10.1080/08956308.2005.11657303>.
- Ali, H. *et al.* (2016) 'Hierarchical Culture and Knowledge Management Processes: Evidence from Pakistan,' *International Journal for Innovative Research in Multidisciplinary Field*, 2(10). <https://www.ijirmf.com/wp-content/uploads/2016/11/201610007.pdf>.
- Ali, M. and Park, K. (2016) 'The mediating role of an innovative culture in the relationship between absorptive capacity and technical and non-technical innovation,' *Journal of Business Research*, 69(5), pp. 1669–1675. <https://doi.org/10.1016/j.jbusres.2015.10.036>.
- Baregheh, A., Rowley, J. and Sambrook, S. (2009) 'Towards a multidisciplinary definition of innovation,' *Management Decision*, 47(8), pp. 1323–1339. <https://doi.org/10.1108/00251740910984578>.
- Comas, S.H. (2022) 'The culture of innovation,' Social Science Research Network [Preprint]. <https://doi.org/10.2139/ssrn.4112343>.
- Danks, S., Rao, J. and Allen, J. (2017) 'Measuring Culture of Innovation: A Validation Study of the Innovation Quotient Instrument (Part One),' *Performance Improvement Quarterly*, 29(4), pp. 427–454. <https://doi.org/10.1002/piq.21236>.
- Gaál, Z. *et al.* (2010) *Clan, Adhocracy, Market, Hierarchy? Investigating Organizational Culture Types and Knowledge Sharing in Bulgaria, Hungary and Serbia*. https://www.researchgate.net/publication/258333507_Clan_Adhocracy_Market_Hierarchy_Investigating_Organizational_Culture_Types_and_Knowledge_Sharing_in_Bulgaria_Hungary_and_Serbia.
- Halim, H.A. *et al.* (2015) 'Towards an innovation Culture: Enhancing Innovative performance of Malaysian SMEs,' *Academic Journal of Interdisciplinary Studies* [Preprint]. <https://doi.org/10.5901/ajis.2015.v4n2p85>.
- Kalyani, M. (2011) 'Innovative Culture: an intervention strategy for sustainable growth in changing scenario,' *International Journal of Business Administration*, 2(4). <https://doi.org/10.5430/ijba.v2n4p84>.
- Khurosani, A. (2013) 'Adhocracy culture support and leader's working creativity,' *International Journal of Social Science and Humanity (Online)*, pp. 411–415. <https://doi.org/10.7763/ijssh.2013.v3.272>.
- Liker, J. and Hoseus, M. (2008) *Toyota Culture: The heart and soul of the Toyota Way*. 1st edn. McGraw Hill. <https://www.amazon.com/Toyota-Culture-Heart-Soul-Way/dp/0071492178>.
- McCarthy, E. (2013) 'The dynamics of culture, innovation and organisational change: a nano-psychology future perspective of the psycho-social and cultural underpinnings of

- Medina, S.A.P. and Guerrero, N.A. (2017) 'Innovation and competitiveness: organizational culture and business model,' *Dimensión Empresarial/DimensiÓN Empresarial*, 15(2).
<https://doi.org/10.15665/rde.v15i2.1023>.
- Muñoz-van Den Eynde, A. et al. (2015) 'Measuring Innovation Culture: Development and validation of a multidimensional questionnaire,' *Advances in Research*, 4(2), pp. 122–141.
<https://doi.org/10.9734/air/2015/15533>.
- OECD (2005) *Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data*. 3rd edn. OECD and Eurostat.
<https://ec.europa.eu/eurostat/documents/3859598/5889925/OSLO-EN.PDF>.
- Rao, J. and Weintraub, J. (2013) *How innovative is your company's culture?*
<https://sloanreview.mit.edu/article/how-innovative-is-your-companys-culture/>.
- Schein, E. H. (2004). *Organizational culture and leadership* (3rd ed.). San Francisco, CA: Jossey-Bass.
- Stock, R. and Zacharias, N. (2011) 'Patterns and performance outcomes of innovation orientation,' *Journal of the Academy of Marketing Science* [Preprint].
<https://www.econbiz.de/Record/patterns-and-performance-outcomes-of-innovation-orientation-stock-homburg-ruth/10010218002>.
- Tidd, J. and Bessant, J.R. (2020) *Managing innovation: Integrating Technological, Market and Organizational Change*. John Wiley & Sons.
- Van Muijen, J.J. et al. (1999) 'Organizational Culture: the Focus questionnaire,' *European Journal of Work and Organizational Psychology*, 8(4), pp. 551–568.
<https://doi.org/10.1080/135943299398168>.
- Valencia, J.C.N. and Hernández, G.C. (2018) 'Model of culture for innovation,' in IntechOpen eBooks. <https://doi.org/10.5772/intechopen.81002>.
- Wei, Y. et al. (2012) 'The impact of innovative culture on individual employees: The moderating role of market information sharing,' *Journal of Product Innovation Management*, 30(5), pp. 1027–1041. <https://doi.org/10.1111/j.1540-5885.2012.01000.x>.
- Wikhamn, B.R. and Wikhamn, W. (2011) 'Open Innovation Climate Measure: The introduction of a validated scale,' *Creativity and Innovation Management*, 20(4), pp. 284–295.
<https://doi.org/10.1111/j.1467-8691.2011.00611.x>.
- Zhang, W. et al. (2023) 'Understanding how organizational culture affects innovation Performance: A Management Context Perspective,' *Sustainability (Basel)*, 15(8), p. 6644.
<https://doi.org/10.3390/su15086644>.

Implementation of a chatbot and evaluation of its use in an academic institution

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Abstract

Chatbots are computer programs of certain purpose and knowledge field, designed to simulate the communication and interaction with human users mainly through the internet. Ease of design and development, 24-hour availability, simultaneous interaction with multiple users, ability to access knowledge through other chatbots, no dependency in specific platforms and no need of installation are only a few of the advantages related to the use of chatbots today. This is the reason why chatbots have been integrated in many service and educational sectors, with a significant and growing number of reported case studies suggesting successful implementation of chatbots in academic institutions. Operating in the website of an academic institution, a chatbot can provide immediate and constant information both to prospective and enrolled students, such as information about the schools- departments, the undergraduate and postgraduate programs offered, the curriculum of each program, the admission requirements, the time-schedule for lessons and exams, the contact details of administrative and academic staff, the working hours of the library and any frequently asked question that could emerge.

In this paper, after a literature review on chatbot developments in the educational sector, we describe the implementation of a chatbot in a clone-demo website of a Master's Degree program in a Greek University. The platform that was selected for chatbot's development was Tidio, due to the various operating features offered, to the free version that was available and to the fact that it could be easily integrated into the content management system (CMS) that the website was built (WordPress).

After the implementation, customization and launch of the chatbot we proceeded in the evaluation of its use, by performing an online survey among selected groups of undergraduate students (who are generally interested in the Masters' program), enrolled-registered students (who study in the specific program) and other-externals visitors (that might be interested in the Master's program). The objectives of our research were: i) to identify the frequency of chatbots use in general, ii) to evaluate the chatbot that was implemented for the specific Master's degree, in terms of perceived usefulness, ease of use, ease of learning to use and overall user satisfaction, iii) to identify the intention to use chatbot, not only in the official website of the Master's program, but also in other websites as well.

The findings of our research showed that users are not frequently using chatbots in the websites they visit. As far as the specific chatbot is concerned, users showed moderate overall satisfaction and a significant percent of agreement for its usefulness, ease of use and ease of learning. Also, users agree that the use of a chatbot in the official Master's program website would be a good idea, that they would use it in that case and that they would also recommend it to other people. Finally, users expressed the intention of using a chatbot in their next visit on a website.

Limitations of our study initially refer to the technical aspects of chatbot implementation. More specifically, we used a specific platform and the free-of-charge version, therefore it was not possible to further customize the chatbot and utilize all of its characteristics. There were also limitations concerning our research, mainly referring to the small sample size and the fact that the chatbot was implemented in a clone-demo version of the official website, something that may have affected users' interaction and responses.

However and with all the above limitations, the outcomes of our study can have practical implications for academic institutions that consider implementing a chatbot in their websites. Future efforts in this area may include the implementation of a chatbot in another platform, with more customization capabilities and/or the integration of further functions, such as natural language processing (NLP) to enrich the operating scope of the chatbot and the management of its interactions.

Keywords: Chatbot, Higher Education, ICT, Use, Evaluation

The relationship between ESG-related reputational risk exposure and firm performance and the moderating insurance-like effect of ESG reporting

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Reputational risk is a key strategic risk, which is potentially embedded in every kind of environmental, social, and governance (ESG) risk (Bonime-Blanc, 2017). Media reports, such as the British Petroleum's oil spill in the Gulf of Mexico and Volkswagen's diesel emissions scandal, are only two high profile examples showing how easily a firm's good reputation can be damaged. Thus, corporate reputational risk is viewed as a key business challenge, which has the potential consequences of a major strategic crisis (Deloitte, 2014).

Contemporary researchers argue that firms may use sustainability reporting as a risk management strategy (Christensen, 2016), and that ESG reporting can provide some protection to a company's reputation and influence stakeholders' reactions to reputation adverse events (Minor and Morgan, 2011). Research has both supported the notion that ESG reporting is a means to manage companies' corporate reputation (e.g. Michelon, 2011; Arora and Lodhia, 2017) and not supported the idea that ESG reporting may "brandish a firm's reputation in a time of crisis" (Linthicum et al., 2010).

This study examines the association between the level of ESG related reputational risks and firm (financial) performance and explores whether companies through voluntary ESG actions (ESG reporting) can mitigate ESG related reputational risks and maintain a good firm performance. We use financial and ESG data for a large sample of U.S. public companies from 2012 to 2016 in combination with archival data on reputation risk exposure. Our results indicate that higher level of ESG reporting mitigates the negative effect of an increase in the level of reputation risk exposure on financial performance, providing empirical evidence of insurance-like effects of sustainability reporting. Further, our results suggest that ESG risk origin appears to matter, i.e., environmentally, socially or governance related reputational risk exposures do not have equally significant effect on the corporate financial performance.

Keywords: reputational risk, ESG risk exposure, ESG reporting, financial performance.

References

- Arora, M. P., Lodhia, S., 2017. The BP Gulf of Mexico oil spill: Exploring the link between social and environmental disclosures and reputation risk management. *Journal of Cleaner Production* 140, 1287–1297
- Bonime-Blanc, A. 2017. *The Reputation Risk Handbook: Surviving and Thriving in the Age of Hyper-Transparency*. Routledge.
- Christensen, D.M., 2016. Corporate accountability reporting and high-profile misconduct. *The Accounting Review* 91(2), 377–399.
- Deloitte, 2014. Global risk survey. Available at: https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Governance-Risk-Compliance/gx_grc_Reputation@Risk%20survey%20report_FINAL.pdf
- Linthicum, C., Reitenga, A., Sanchez, J., 2010. Social responsibility and corporate reputation: the case of the Arthur Andersen Enron audit failure. *Journal of Accounting and Public Policy* 29(2), 160–176.
- Michelon, G., 2011. Sustainability disclosure and reputation: a comparative study. *Corporate Reputation Review* 14(2), 79–96.
- Minor, D., Morgan, J., 2011. CSR as reputation insurance: primum non nocere. *California Management Review* 53(3), 40–59.

Addressing Missing Economic and Financial Data: Methods, Best Practices and Challenges

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Abstract

A common issue that economic and financial analysts face is the problem of missing data in the economic or financial data they manage, which may lead to the distortion of their results and their analysis in general. Moreover, the missing values problem has the effect of reducing the reliability, validity and accuracy of the resulting models, and bias the decisions that are taken. This paper presents an overview of existing methods for handling incomplete economic or financial data, best practices and the challenges that emerge.

Keywords: economic data, financial data, missing data, missing values

Introduction

Economic and financial data are very important on which various models are tested and applied, extensive research is based and important decisions are made. However, there are often gaps and omissions in their records. A number of reasons are responsible for that: for example, in financial data time series that are regularly updated (such as in stock markets), it may happen that, due to technical reasons, their recordings may stop responding. Furthermore, in financial data reports some information may be omitted either unintentionally or on purpose. Moreover, there are cases where it may be impossible to calculate some economic factors, as is the case of GDP, which, in several countries, has not been measured and recorded in the World Bank Data for some years.

Addressing the missing economic and financial data has many important applications. For example, in the analyses of financial time series (stock prices, trading volumes, etc.), the handling of missing data produces more accurate predictions, limits the possible risks and provides better investment opportunities. In

labor market analysis, missing data often appear on employment status, incomes, education levels and other relevant variables. The effective handling of missing data can provide better insights into labor market trends, workforce participation and income inequality. In studies of development economics, the addressing of missing data on factors influencing economic growth can provide more comprehensive analyses of development outcomes.

The selection of the method for addressing the missing data definitely affects the quality of results. Many data analysts use very simple solutions to handle the missing data and avoid using more complex strategies, which could provide even better results. Some of these common simple strategies are:

- I. Delete each row/record from the dataset that contains at least one missing value.
- II. Replace the missing values with specific constant values.
- III. In case of missing values in numerical data, replace with the mean or median.
- IV. In case of missing values in categorical data, replace with the category that appears the most.
- V. Replace the missing values using information from other fields/attributes/columns of the same row/record.

However, important problems may arise by following these strategies. In strategy (I), a large number of rows/records may need to be removed, which could lead to a significant loss of data. In strategy (II), the constant values must be defined by a domain expert and the results will be biased in case there is a significant number of replacements. The same problem of bias also holds for strategies (III) and (IV). In strategy (V), the rules for replacements must be defined by domain experts and the derived rules may not replace all cases of missing values.

Therefore, data analysts must follow more advanced strategies. They can either use specific algorithms for addressing the missing data, or they can use prediction models (or even more advanced methods) to predict the missing data.

In the following sections, an overview of such existing methods is provided and practical rules for their application, as well as important derived challenges, are presented.

Types of Missing Data

An important study of the types of missing data was proposed by Rubin (1976). There are three main missing data mechanisms (Little and Rubin, 1987,2002,2019; Schafer and Graham, 2002):

- *Missing Completely at Random (MCAR)*: When missingness occurs randomly and it is unrelated to any observed or unobserved data values of the variables (fields / attributes / columns).
- *Missing at Random (MAR)*: When missingness is partly depended on the observed data values of the variables but it is unrelated to any of the values of the variables that are missing.
- *Missing Not at Random (MNAR)*: When missingness is related to the missing data itself, even after considering the data of the observed variables.

An example for MCAR is when some data in stock markets is not recorded due to a temporary power failure, thus the reason for the missing data is completely unrelated to the contents of the dataset. In the case of MAR, some personal data (like weight, age, etc.) asked in certain surveys are more likely to be completed by men and less likely by women, thus the missing values are related to gender (which is recorded). Finally, an MNAR case can be observed in people's financial data, where higher income people may not reveal their incomes and other relevant data, thus there is a correlation of the missing values and the actual income.

The case of MCAR is often addressed by removing the rows/records that contain missing values, as the results will remain unbiased, which, however, is dependent on the percentage of the rows/records that would be deleted. For the case of MAR, it is much safer to apply prediction models for the missing data based on the complete observed data. The case of MNAR is the most challenging, since the prediction data model must not be based on the observed data.

There is also a type of missing data named *Structurally Missing Data*, where the data is missing for a certain reason. For example, in case there is a field for the employment status of a person (employment or unemployment) and other fields are related to the employment case, it is expected to have missing values in those fields for the unemployment cases. However, this kind of missingness is trivial and is usually addressed by the deletions of the unrelated rows/records.

Baseline Methods and Best Practices

According to Allison (2002), Enders (2001, 2010), Graham (2009), Marsh (1998), Newman (2003, 2009, 2014), Schafer and Graham (2002), Cooper et al. (2009), Dong and Peng (2013), there are five baseline methods for addressing missing data:

Listwise Deletion [LD]: all rows/records from the dataset that contain at least one missing value are deleted, and the analysis is conducted with the rest.

Pairwise Deletion [PD]: summary estimates (means, correlations, etc.) are calculated from all the available data (completed rows/records) relevant to each estimate, and the analysis is conducted based on these estimates.

Single Imputation [SI] (with ad hoc techniques): each missing value is filled by using a simple calculation (mean, median, etc. of completed rows/records), or by using an algorithm (regression imputation, hot deck imputation), and the analysis is conducted with the derived full completed dataset. In the regression imputation (Song and Shepperd, 2007), the missing values are replaced by predictions based on a regression model created from the completed rows/records (this technique is preferred by many researchers). In hot-deck imputation, the missing values are matched with other values in the dataset, which are based on key variables that have complete values (Andridge and Little, 2010).

Maximum Likelihood [ML]: parameters of interest are estimated from the incomplete dataset (by using Full Information Maximum Likelihood [FIML] or other similar algorithms) or summary estimates are calculated (by using Expectation- Maximization [EM] or other similar algorithms), and the analysis is conducted based on these estimates. The FIML algorithm takes into account all the observed data (including missing data) and estimates the parameters of a model by maximizing the likelihood function of the observed data. The pure EM algorithm is an iterative algorithm until convergence, where in each iteration there are two phases: expectation and maximization. In expectation phase, the missing values are estimated from the observed data, and in maximization phase the current estimated values are used to maximize the probability of all the data (Cooper et al., 2009; Dong and Peng, 2013; Lin and Tsai, 2020).

Multiple Imputation [MI]: the missing values are imputed multiple times, in order to create $S \geq 40$ sample datasets, and the analysis is conducted to each one. The results of all S imputed datasets are combined to derive the final imputation result. Several statistical models for multiple imputation have been proposed, as for example in (Cooper et al., 2009; Dong and Peng, 2013).

Some major issues that must be considered for practical application of these methods are the following:

- According to the type of missingness, in the most challenging case of MNAR, all these methods produce bias. In the case of MAR, the LD, PD methods produce bias, and quite often the SI method as well. In the case of MCAR, the SI often produce bias.
- According to standard errors, LD method produces large standard errors, PD and SI methods produce inaccurate standard errors, ML and MI methods produce accurate standard errors.
- ML and MI methods provide improved results, as more variables are added to the imputation model, but the number of variables should be less than 100.

Newman mentions that, although statisticians suggest these rules, researchers in management (and in other domains) systematically ignored them. This sometimes can be harmful, depending on the amount of missing data, the pattern of missing data, and whether the data are missing in a weakly or strongly systematic fashion. Therefore, it provides a pragmatic decision tree, followed by five practical guidelines for help (Newman, 2014):

1. Use all the available data, do not use listwise deletion (LD).
2. Do not use single imputation (SI).
3. In case the dataset has missing data in more than one field / attribute / column of a group of fields on its rows / records, and the level of missingness exceeds 10%, maximum likelihood (ML) and multiple imputation (MI) techniques should be used under a strategy that includes auxiliary variables and any hypothesized interaction terms as part of the imputation/estimation model.
4. In case the dataset has missing data only in some field of a group of fields on its records, do not discard the whole group.
5. In case the dataset has missing data in an entire group of fields on its records, and the recorded data for this group are below 30%, simple missing data sensitivity analyses should be conducted.

Advanced Methods

In the previous decades, more advanced statistical methods have been proposed as a solution for the problem of missing values. However, the revolution of Machine Learning and Deep Learning inspired researchers to further extend the application of methods and algorithms addressing the missing data.

A. Advanced Statistical Methods

Multiple Imputation with bootstrapping

Honaker et al. (2011) proposed a multiple imputation method by applying the EMB (expectation-maximization with bootstrapping) algorithm. This algorithm uses the familiar EM algorithm on multiple bootstrapped samples of the original incomplete data to draw values of the complete-data parameters. The imputed values are drawn from each set of bootstrapped parameters, and the missing values are replaced with these draws. Furthermore, in this study a software program was presented with the name “Amelia II” that provides a simple user interface, in order to create and manage the imputation model, to generate the imputed datasets, and to check fitness scores.

Principal Component Analysis (PCA)-based methods

Audigier et al. (2016) proposed another multiple imputation method by using a Bayesian Principal Component Analysis (PCA) approach. The Bayesian treatment of the PCA model is used to reflect the uncertainty of the parameters from one imputation to the next. This approach allows researchers to isolate the relevant information and decreases the variability of the estimator for the missing values. A comparative survey for PCA methods which address missing values is presented in (Dray and Josse, 2015).

There are also several other advanced statistical methods and specialized algorithms that have been proposed for addressing the missing data. A comprehensive review is presented in (Armina et al., 2017).

B. Machine Learning-Based Imputation Methods

The machine learning-based imputation methods predict the missing values by using supervised or unsupervised learning. The estimation of missing data is based on information of non-missing values and all available data. Some of the most used methods are the following:

K-NN Classification: The K-Nearest Neighbor algorithm is applied, in order to classify the nearest neighbors of the missing values. It uses these neighbors for imputation. Although several different distance measures have been studied on K-NN, the

Euclidean distance is the most widely used one. Many variations of the k-NN approach have been proposed. A good reference is in (Emmanuel et al., 2021).

Support Vector Machines: This algorithm uses a labelled training sample and tries to discover optimal separating hyperplanes, so that the distances from the hyperplanes to the nearest data points get maximized. According to the returned weights of the applied hyperplanes, the missing values are addressed (Stewart et al., 2018). This algorithm is extensively used and many variations have also been proposed (Emmanuel et al., 2021).

Decision Trees: Tree structures are created with algorithms to illustrate all possible outcomes. For each variable/field/column/attribute that contains missing values, a decision tree is created, and it is used accordingly for imputation (Twala, 2009). The most used algorithms for building the decision trees are ID3, C4.5, CART. However, many variations have also been studied and applied (Emmanuel et al., 2021).

Clustering Methods: The K-means clustering algorithm is applied in two phases. In the first phase the clusters are created, while in the second phase the derived clusters are used for addressing the missing values (Gajawada and Toshniwal, 2012). Hierarchical clustering and other clustering algorithms have also been used for imputation (Emmanuel et al., 2021).

Ensemble methods: Multiple models are created and combined, in order to produce more improved results (Zhang and Ma, 2012; Emmanuel et al., 2021).

C. Deep Learning-Based Imputation Methods

The recent exponential growth of AI methods and deep learning approaches also touched on the problem of missing data imputation. Some of the most used deep learning models to handle the missing data are the following:

Generative Adversarial Imputation Networks (GAIN):

The deep learning procedure of these networks consider the imputer as a generator, while the discriminator tries to discriminate whether each component of an input is imputed or not. Moreover, there is a hint mechanism to adjust the difficulty of discrimination for the MCAR case (Yoon, et al., 2018). An important variation, which is better for higher missing data, is the misGAN algorithm (Li et al., 2019). It uses generative adversarial networks to generate fake complete data, by using fake masks indicating which component is missing. In the training procedure of the generators, a discriminator tries to discriminate between fake missing data and real missing data. Another variation for highly missing data is the GAMIN algorithm (Yoon and Sull, 2020), which is based on generative adversarial networks but for multiple

imputation. Two other variations, GAIN with one-hot encodings and GAIN with embeddings, were also studied in (Sun et al., 2023).

Variational Auto-Encoder (VAE) based methods:

A variational auto-encoder has an artificial neural-network architecture, which is a generative model with a prior and noise distribution. Camino et al. (2019) trained traditional VAE's with random noise insertions on the positions with missing values. Several other algorithms that are based on variational auto-encoders (VAE) were also proposed for imputation (McCoy et al., 2018; Qiu et al., 2020). Two other variations, VAE with one-hot encodings and VAE with embeddings, were also studied in (Sun et al., 2023). Moreover, Ipsen et al. (2022) proposes the supervised missing data importance-weighted autoencoder (supMIWAE) algorithm, where it marginalizes missing values in a joint model of covariates and outcomes. It uses a deep latent variable model that can be learned jointly with the discriminative model.

Multiple Imputation using Denoising Autoencoders (MIDA):

Gondara and Wang (2018), Lu et al. (2020), Wang et al. (2021) propose a family of Multiple Imputation using Denoising Autoencoders (MIDA) algorithms, which extend a class of neural networks by intentionally using denoising autoencoders to corrupt the input data (in order to prevent the networks from learning the identity functions) and create a useful low-dimensional representation of the input data.

Convolutional Neural Networks based methods:

Khan et al. (2022) proposes an imputation method that uses a convolutional neural network to impute the missing values. The training is based on kernels where their weights are determined by learning from the available data.

Other methods:

Lin et al. (2022) study two supervised deep neural networks for missing value imputation, the Multi-Layer Perceptron (MLP) and the Deep Belief Networks (DBN). More specialized methods are presented in the book of Leke & Marwala (2019).

Applications on Economic Data and Challenges

Many of the presented and other existing methods have not been yet applied for addressing specific economic and financial datasets that contain missing values, which could be a great challenge for future researchers. However, there are some seminal works, which we present:

- Bryzgalova et al. (2022) study baseline and advanced statistical algorithms for missing financial data. More specifically, the complex patterns of missing observations of firm fundamentals are studied, and a novel imputation method is proposed which exploits both time-series and cross-sectional dependency of data to impute the missing values.
- Freyberger et al. (2022) proposes a statistical methodology for addressing missing data in cross-sectional asset pricing studies. This approach uses conditional mean imputations and weighted least squares to derive estimates. Moreover, the proposed estimator is mapped to a Generalized Method of Moments (GMM) framework to validate its efficiency.
- Michalowsky et al. (2020) study the impact of missing data in economic evaluations, such as health utilities and costs, by using statistical multiple imputation methods (item imputation and aggregate imputation).
- John et al. (2019) proposes five PCA approaches for imputation of missing data in economic and financial time series. More specifically, the studied methods are: Singular Value Decomposition Imputation (svdPCA), Bayesian imputation (bPCA), Probabilistic imputation (pPCA), Non-Linear Iterative Partial Least squares imputation (nipalsPCA) and Local Least Square imputation (llsPCA).
- Wubetie (2017) study several statistical and clustering methods for missing socio-economic yearly time series data. More specifically, the missing values are imputed by using regression estimates, Lagrange polynomial interpolation, linear interpolation, linear spline interpolation, PCA, factor analysis, hierarchical clustering, and K-means clustering.
- Takahashi and Ito (2013) study several statistical multiple imputation methods for addressing the missing data in official economic statistics. More specifically, the studied multiple imputation methods are Markov Chain Monte Carlo (MCMC), Fully Conditional Specification (FCS), and Expectation-Maximization with Bootstrapping (EMB).
- Humphreys, B. R. (2013) study baseline and alternative statistical models to deal with the problem of missing values in economic and especially microeconomic data.

Conclusion

The missing data problem is an important issue in economic and financial data. Addressing it with a simple strategy often produces significant biases in analyses. Moreover, when important decisions are taken, based on such biased analyses, they may end up being wrong. In this paper, we conducted an overview of the existing methods for addressing missing data, which has led us to the conclusion that they have not been systematically applied to economic and financial datasets. We noticed that most of the methods that have been applied are mainly statistical methods. Therefore, the challenge for future researchers is to systematically apply the presented methods to economic and financial data, especially the advanced methods of machine learning and deep learning that do not seem to have been applied yet.

References

- Allison, P. D. (2002). *Missing data*. Thousand Oaks, CA: Sage
- Andridge, R. R., & Little, R. J. (2010). A review of hot deck imputation for survey non-response. *International statistical review*, 78(1), 40-64.
- Armina, R., Zain, A. M., Ali, N. A., & Sallehuddin, R. (2017, September). A review on missing value estimation using imputation algorithm. In *Journal of Physics: Conference Series* (Vol. 892, No. 1, p. 012004). IOP Publishing.
- Audigier, V., Husson, F., & Josse, J. (2016). Multiple imputation for continuous variables using a Bayesian principal component analysis. *Journal of statistical computation and simulation*, 86(11), 2140-2156.
- Bryzgalova, S., Lerner, S., Lettau, M., & Pelger, M. (2022). *Missing financial data*. Available at SSRN, 4106794.
- Camino, R. D., Hammerschmidt, C. A., & State, R. (2019). Improving missing data imputation with deep generative models. *arXiv preprint arXiv:1902.10666*.
- Cooper, H., Hedges, L. V., & Valentine, J. C. (2009). The handbook of research synthesis and meta-analysis 2nd edition. In *The Hand. of Res. Synthesis and Meta-Analysis*, 2nd Ed. (pp. 1-615). Russell Sage Foundation.
- Dong, Y., & Peng, C. Y. J. (2013). *Principled missing data methods for researchers*. SpringerPlus, 2, 1-17.
- Dray, S., & Josse, J. (2015). Principal component analysis with missing values: a comparative survey of methods. *Plant Ecology*, 216, 657-667.
- Emmanuel, T., Maupong, T., Mpoeleng, D. et al. (2021). A survey on missing data in machine learning. *Journal of Big Data* 8, 140 (2021).
- Enders, C. K. (2001). A primer on maximum likelihood algorithms for use with missing data. *Structural Equation Modeling*, 8, 128-141.
- Enders, C. K. (2010). *Applied missing data analysis*. New York, NY: Guilford.

- Freyberger, J., Höppner, B., Neuhierl, A., & Weber, M. (2022). Missing data in asset pricing panels (No. w30761). National Bureau of Economic Research.
- Gajawada, S., & Toshniwal, D. (2012). Missing value imputation method based on clustering and nearest neighbours. *International Journal of Future Computer and Communication*, 1(2), 206-208.
- Gondara, L., & Wang, K., (2018), MIDA: Multiple imputation using denoising autoencoders, *Pacific-Asia Conference on Knowledge Discovery and Data Mining*, 260–272
- Graham, J. W. (2009). Missing data analysis: Making it work in the real world. *Annual Review of Psychology*, 60, 549-576.
- Honaker, J., King, G., & Blackwell, M. (2011). Amelia II: A program for missing data. *Journal of statistical software*, 45, 1-47.
- Humphreys, B. R. (2013). Dealing with zeros in economic data. *University of Alberta, Department of Economics*, 1, 1-27.
- Ipsen, N. B., Mattei, P. A., & Frellsen, J. (2022). How to deal with missing data in supervised deep learning?. In *10th International Conference on Learning Representations*.
- John, C., Ekpenyong, E. J., & Nworu, C. C. (2019). Imputation of missing values in economic and financial time series data using five principal component analysis approaches. *CBNJournalof Applied Statistics (JAS)*, 10(1), 3.
- Khan, H., Wang, X., & Liu, H. (2022). Handling missing data through deep convolutional neural network. *Information Sciences*, 595, 278-293.
- Leke, C. A., & Marwala, T. (2019). Deep learning and missing data in engineering systems (p. 179). Berlin, Germany: Springer International Publishing.
- Li, S. C. X., Jiang, B., & Marlin, B. (2019). Misgan: Learning from incomplete data with generative adversarial networks. *arXiv preprint arXiv:1902.09599*.
- Lin, W. C., & Tsai, C. F. (2020). Missing value imputation: a review and analysis of the literature (2006–2017). *Artificial Intelligence Review*, 53, 1487-1509.
- Little, R. J. A., & Rubin, D. B. (1987). *Statistical analysis with missing data*. John Wiley & Sons.
- Little, R. J. A., & Rubin, D. B. (2002). *Statistical analysis with missing data* (2nd ed.). John Wiley & Sons.
- Little, R. J. A., & Rubin, D. B. (2019). *Statistical analysis with missing data* (3rd ed.). John Wiley & Sons.
- Lu, H.-m., Perrone, G., & Unpingco, J., (2020), Multiple imputation with denoising autoencoder using metamorphic truth and imputation feedback, *arXiv preprint arXiv:2002.08338*.
- Marsh, H. W. (1998). Pairwise deletion for missing data in structural equation models: Nonpositive definite matrices, parameter estimates, goodness of fit, and adjusted sample sizes. *Structural Equation Modeling*, 5, 22-36.
- McCoy, J. T., Kroon, S., & Auret, L. (2018). Variational autoencoders for missing data imputation with application to a simulated milling circuit. *IFAC-PapersOnLine*, 51(21), 141-146.
- Michalowsky, B., Hoffmann, W., Kennedy, K., & Xie, F. (2020). Is the whole larger than the sum of its parts? Impact of missing data imputation in economic evaluation conducted

alongside randomized controlled trials. *The European Journal of Health Economics*, 21(5), 717-728.

Newman, D. A. (2003). Longitudinal modeling with randomly and systematically missing data: A simulation of ad hoc, maximum likelihood, and multiple imputation techniques. *Organizational Research Methods*, 6, 328-362.

Newman, D. A. (2009). Missing data techniques and low response rates: The role of systematic nonresponse parameters. In C. E. Lance & R. J. Vandenberg (Eds.), *Statistical and methodological myths and urban legends: Doctrine, verity, and fable in the organizational and social sciences* (pp. 7-36). New York, NY: Routledge.

Newman, D. A. (2014). Missing data: Five practical guidelines. *Organizational Research Methods*, 17(4), 372-411.

Qiu, Y. L., Zheng, H., & Gevaert, O. (2020). Genomic data imputation with variational auto-encoders. *GigaScience*, 9(8), gaa082.

Rubin, D. B. (1976). Inference and missing data. *Biometrika*, 63(3), 581-592.

Schafer, J. L., & Graham, J.W. (2002). Missing data: Our view of the state of the art. *Psychological Methods*, 7, 147-177.

Song, Q., & Shepperd, M. (2007). Missing data imputation techniques. *International journal of business intelligence and data mining*, 2(3), 261-291.

Stewart, T. G., Zeng, D., & Wu, M. C. (2018). Constructing support vector machines with missing data. *Wiley Interdisciplinary Reviews: Computational Statistics*, 10(4), 1430.

Sun, Y., Li, J., Xu, Y., Zhang, T., & Wang, X. (2023). Deep learning versus conventional methods for missing data imputation: A review and comparative study. *Expert Systems with Applications*, 120201.

Takahashi, M., & Ito, T. (2013, August). Multiple imputation of missing values in economic surveys: Comparison of competing algorithms. In *Proceedings of The 59th World Statistics Congress of the International Statistical Institute (ISI)* (pp. 3240-3245).

Twala, B. (2009). An empirical comparison of techniques for handling incomplete data using decision trees. *Applied Artificial Intelligence*, 23(5), 373-405.

Wang, Z., Akande, O., Poulos, J., & Li, F. (2021). Are deep learning models superior for missing data imputation in large surveys? Evidence from an empirical comparison. *arXiv preprint arXiv:2103.09316*.

Wubetie, H. T. (2017). Missing data management and statistical measurement of socio-economic status: application of big data. *Journal of Big Data*, 4(1), 47.

Yoon, J., Jordon, J., & Schaar, M. (2018, July). Gain: Missing data imputation using generative adversarial nets. In *International conference on machine learning* (pp. 5689-5698). PMLR.

Yoon, S., & Sull, S. (2020). GAMIN: Generative adversarial multiple imputation network for highly missing data. In *Proceedings of the IEEE/CVF conference on computer vision and pattern recognition* (pp. 8456-8464).

Zhang, C., & Ma, Y. (Eds.). (2012). *Ensemble machine learning: methods and applications*. Springer Science & Business Media.

Exploring Membership Programs in RideHailing Platforms

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Abstract

Membership plans, wherein consumers pay an upfront fee to access products or services for free during membership period, are ubiquitous across industries. Sellers' motivations for offering such plans in both physical good and information good markets have been extensively researched. In this study, we examine the incentives of a ride-hailing platform operating under the sharing economy model to introduce such a membership plan. Unlike traditional markets where sellers operate with a captive supply to meet the demand at a fixed marginal cost, a ride-hailing platform relies on drivers who independently schedule their services, resulting in fluctuating driver availability and a variable marginal cost. The platform dynamically adjusts rider price and driver wage after observing rider demand and driver supply. We show that it is optimal for the platform to introduce the membership plan only when the ratio of the expected supply potential to the expected demand potential during the membership period is above a threshold. The platform's profit gain from the membership plan stems solely from the revenue generated from the membership fee because the membership plan reduces the platform's operating profit during the membership period. Variability in rider demand and driver supply exert opposing effects on the platform's incentive to introduce the membership plan; an increase in supply variability diminishes the platform's incentive while an increase in demand variability enhances it. This stands in sharp contrast to traditional markets, where supply variability is absent and demand variability does not impact a seller's decision regarding the membership plan, suggesting that the self-scheduled nature of supply and its variability cause demand variability to play a prominent role in the platform's decision. If implemented, the membership plan benefits the platform, drivers, and society at large, albeit at the expense of riders.

Keywords: sharing economy, membership programs, ride-hailing platforms, dynamic pricing

The association between female Directors' presence on the Board of Directors and Long-Term Leverage on Greek Listed Firms

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Abstract

To accurately evaluate a company's performance, it is important to consider not only financial indicators but also social and economic aspects. This change is due to harmonized laws across countries, prompting stakeholders to consider broader criteria. Research shows that directors' personal characteristics can influence their opinions and affect the adoption of relevant corporate policies. Gender diversity of boardrooms play a significant role in this since women are more riskaverse than men, and therefore they tend to engage in more moderated corporate policies. Our research focuses on panel data concerning Greek listed firms from 2014 to 2018. After conducting a thorough analysis, we discovered that having women in boardrooms significantly reduces the probability of firms engaging in higher levels of long-term leverage. To conduct our research, we used descriptive statistics, pairwise correlation matrix, and probit regression model. Additionally, we used a diverse set of control variables that we categorized into three groups during our analysis.

Keywords: Corporate Governance, Gender Diversity, Long-Term Leverage, Cost of Debt, Female Directors

1. Introduction

In recent decades, there has been a growing recognition of the need to evaluate not only the financial performance but also the social and economic aspects in assessing a firm's value (Setó-Pamies, 2015). The shift in perspective has been necessitated by the harmonization of legislation across different countries. As a result, stakeholders are now expected to consider broader criteria beyond just financial indicators (Ferrero-Ferrero, Fernández-Izquierdo, & Muñoz-Torres, 2015; Jitmaneeroj, 2016). Scholars such as Kahloul, Sbai, and Grira (2022) argue that the creation of corporate value stems from the ability of managerial executives to make informed decisions that consider multiple dimensions and shape the firm's strategic direction.

The discussion on board gender diversity is closely linked to the global movement towards gender equality and women's empowerment. The United Nations' Agenda 2030 emphasizes the importance of gender equality in various sectors, including business and corporate governance. As a response to this agenda, countries worldwide have been adopting measures to promote the participation of women at the highest levels of decision-making in corporations (Yadav and Prashar, 2022). Notably, European countries such as Norway, France, Italy, and Belgium have introduced gender quotas, mandating a minimum representation of women on corporate boards, often set at 40% (Mehmood, De Luca, & Quach, 2023).

Consequently, numerous countries have implemented affirmative reforms aimed at increasing the representation of women on boards. These reforms, driven by corporate governance codes, include both mandatory measures, such as gender-based board membership quotas, and voluntary initiatives, such as targets for female board representation (Lee, 2015). These reforms seek to enhance board diversity and foster inclusive decision-making processes, ultimately aiming to improve corporate performance.

In the context of Greek listed companies on the Athens Stock Exchange, this research aims to examine the impact of adopting the practices outlined in the corporate governance code regarding gender diversity on boards. Specifically, it aims to investigate whether the increased representation of women on boards has a negative effect on the long-term leverage of these companies. By doing so, this study contributes to the broader academic discourse on corporate governance, gender diversity, and firms' long-term leverage.

Our analysis pertains to the 100 Greek companies listed on the Athens Stock Exchange (Athex) from 2014-2018. During our analysis, we use descriptive statistics, pairwise correlation matrix, and probit regression model. Our research states that the presence of women in the boardrooms significantly reduces the likelihood of firms engaging in higher levels of long-term leverage. In our study, we categorized the control variables vector into three groups of covariates based on their impact on long-term leverage. These categories include boardroom-specific, firm-specific, and auditor-specific variables. Boardroom-specific variables refer to the characteristics of the Directors in the Board of Directors that affect their decision-making process (García & Herrero, 2021). Firm-specific variables, on the other hand, control for firm characteristics that influence the complexity and difficulty of decision-making, such as the firm's size. Finally, we control for auditor-specific characteristics, such as the characteristics of the audit firm.

This study makes several contributions to the existing literature. Firstly, there are only a few studies that explore the effects of gender diversity on long-term leverage. Our results provide insights into the factors that influence directors' decisions on long-term leverage, particularly how gender

affects risk preferences. Secondly, our study focuses on gender diversity in Greek listed firms and aims to shed light on potential misunderstandings about how diversity impacts leverage in developing countries. Finally, by utilizing a diverse set of control variables, we aim to provide a comprehensive analysis of the factors that determine gender diversity in the boardroom. This approach ensures that our findings are robust and insightful, enabling us to offer valuable recommendations for achieving greater gender balance in corporate leadership.

The study is organized as follows: in section 2, we develop our hypothesis development where we analyze the effect of gender diversity in Corporate Governance (section 2.1) and how gender influences the boardrooms' decisions regarding debt structure (section 2.2). In section 3, we present our data and research method. More specifically, in section 3.1, we present our sample selection process; in section 3.2, the measurement of female presence in the boardrooms; in section 3.3, the measurement of long-term leverage; and in section 3.4, we demonstrate our research model. In section 4, we present our results, which concern the presentation of descriptives (section 4.1), the pairwise correlation matrix (section 4.2), and the outcomes of the probit-regression method. Finally, in Section 5, we present our conclusions.

2. Hypothesis Development

2.1 Gender Diversity in Corporate Governance

Research has been conducted to examine how nonfinancial factors impact company performance. This line of inquiry is aligned with stakeholder theory, which posits that corporate outcomes are influenced by economic, managerial, social, psychological, and behavioral practice (McGuinness, Vieito, & Wang, 2017). Specifically, investigations have centered on the implications of board diversity, including gender diversity, for corporate performance. Moreover, the implementation of corporate governance principles has driven the adoption of board gender diversity by companies, leading to the inclusion of women in boardrooms and fostering interest in examining corporate performance in relation to gender dynamic (Gabaldon, de Anca, Mateos de Cabo, & Gimeno, 2016; Shahab, Ntim, Chengang, Ullah, & Fosu, 2018; Shahab, Ntim, Ullah, Yugang, & Ye, 2020).

Scholars have explored the potential benefits associated with board gender diversity. For instance, Adams and Funk (2012) argue that women directors can facilitate more inclusive and comprehensive discussions among board members, leading to the consideration of a broader range of ideas, perspectives, and risks. They suggest that this inclusive decision-making process may contribute to the adoption of innovative and competitive business strategies. Similarly, de Cabo, Gimeno, and Escot (2011) find that gender diverse boards tend to be more attentive to non-financial outcomes, such as corporate social responsibility and environmental sustainability, demonstrating a holistic approach to decision-making.

In summary, the recent years have seen a notable evolution in Corporate Governance practices, including the adoption of board gender diversity measures in Greece. The discussion surrounding gender diversity in boardrooms is intertwined with the global movement towards gender equality and women's empowerment. Research suggests that increasing gender diversity on corporate boards can positively impact decision-making processes, corporate performance, and the overall effectiveness of corporate governance.

2.2 Gender Diversity in Boardroom and Long-term leverage

Previous research has highlighted how the personal characteristics of directors could influence their opinions, which in turn affects the adoption of relevant corporate policies. Prior studies have consistently demonstrated that women tend to exhibit higher levels of risk aversion compared to their male counterparts (Adams & Ferreira, 2009; Gupta, Mortal, Chakrabarty, Guo, & Turban, 2020; Lanis, Richardson, & Taylor, 2017; Reddy & Jadhav, 2019). This information is crucial to consider when making important decisions that involve risk, particularly in fields such as finance and investment (Rao & Tilt, 2016). Prior studies have proved that the presence of female directors on corporate boards reduces the likelihood of managers engaging in opportunistic behavior and information asymmetry (Usman, Farooq, Zhang, Makki, & Khan, 2019). Female directors on boards are likely to exhibit a lower cost of equity, as they rely on less risky financing decisions (Aljughaiman, Albarrak, Cao, & Trinh, 2022).

The minimization of the likelihood of female directors engaging in opportunistic behavior affects creditors' opinions about the firm. Due to this trait, female directors have less potential for loan default and a lower cost of debt (Usman et al., 2019). Moreover, it is also proved that these results are stronger in government-owned firms, when there are gender-diverse boards (Usman et al., 2019). Another significant trait that influences the behavior of female Directors, and therefore the decision-making process in boardrooms, is that female directors are more sensitive to Corporate Social Responsibility (CSR) policies (Rao & Tilt, 2016). Firms led by female executives benefit from higher credit ratings, compensating for refinancing risk associated with shorter-term debt due to their greater ethical sensitivities (Datta, Doan, & Toscano, 2021).

Another aspect that is widely discussed in prior studies is the critical mass theory. According to this theory, there is a critical point which means a specific number of women in the boardroom that permits women to have impacted opinions in the boardroom (Torchia, Calabrò, & Huse, 2011). This contradicts tokenism theory, which suggests that having one or two women in the boardroom may not provide enough influence to impact the final decision making. For example, Engel, Lewis, Cardon, and Hentschel (2023) support that there is an underrepresentation of women in entrepreneurship, and especially start-ups. However, various studies have researched the appropriate threshold of women in the boardroom to ensure their voices are heard (Garcia-Blandon, Maria, & Diego, 2022; Pandey, Biswas, Ali, & Mansi, 2020), and also regarding debt-structure decisions. Aljughaiman et al. (2022) argue that a critical mass of around 28% of women in decision-making processes is necessary to achieve lower levels of debt financing.

Despite the critical mass theory, several studies have found that the presence of women on the Board of Directors is negatively correlated with the cost of debt (Pandey et al., 2020; Garcia-Blandon et al., 2022). Furthermore, there is a negative correlation between the cost of debt and the interaction between board gender diversity and firm size (Kamil & Appiah, 2022). Following these assumptions, we developed the hypothesis development presented below:

H₁: Female directors' presence in the boardrooms is negatively associated with long-term leverage.

3. Data and research method

3.1 Sample

Our analysis concerns the Greek listed firms which are trading in the Athens Stock Exchange known as Athex. The number of listed firms in Athex, during 2014-2018, is 209 and represents

893 firm-year observations (HCMC, 2018). We excluded from our sample 74 listed firms, which represent 218¹ firm-year observations, due to their deletion from Athex during 2014-2018. These listed firms were excluded from our sample because they were not listed in all the five years of our sample period, resulting in making our dataset cross-sectional. Furthermore, we subtracted from listed firms with missing model variables. In this vein, we avoid a potential omitted variable problem in case we had a firm year observation with missing values on our model variables. Finally, we excluded Banks and Financial Institutions, since they disclose their financial statements in a different way than the remaining sample. According to IFRS 7, banks do not distinguish short-term from long-term debt in the disclosed financial statements. This creates difficulty in calculating our dependent variable which concerns long-term debt (IFRS 7). Therefore, we excluded banks and financial institutions from our sample. Our final sample is comprised of 100 firms that represent 500 firm-year observations, which makes them panel data (Table 1)

3.2 Measuring Female presence in the boardroom

We measure women's presence in the boardroom by counting the number of female directors in the Board of Directors. We downloaded the financial statements of the listed firms from the Athex website, and we counted the number of female directors in each firm from 2014 to 2018. We preferred to keep the number of female directors in our analysis instead of using a dummy variable. In this vein, we do not exclude the effect of more than one woman in the decisions of the boardroom. According to prior literature, the number of women plays a significant role in the decision-making of the board of directors (Torchia et al., 2011).

3.3 Measuring long term debt

In our analysis we separate our firms in our sample into high and low level leverage. We measure long term debt ratio as the total amount of long term debt scaled by total assets (García & Herrero, 2021). Our main dependent variable is a dummy variable equal to 1 if the long term debt ratio is higher than its median, and 0 otherwise. In this case we are able to differentiate the firms that have more long term leverage and observe whether there is higher or lower number of women in these firms.

3.4 Research model

Model (1) represents the model analysis regarding the effect of female presence in the Board of Directors (*Fem*) on long term debt (*High Leverage*):

$$\begin{aligned} \text{High Leverage}_{it} = & \beta_0 + \beta_1 \text{Fem}_{it} + \beta_2 \text{BoDInd}_{it} + \beta_3 \text{BoD}_{it} + \beta_4 \text{CEODual}_{it} + \beta_5 \text{Size}_{it} \\ & + \beta_6 \text{Cash}_{it} + \beta_7 \text{ROA}_{it} + \beta_8 \text{WC}_{it} + \beta_9 \text{BIG4}_{it} + \text{Year}_{\text{indicators}} \\ & + \varepsilon_t (1) \end{aligned}$$

High leverage is our dependent variable, and it is defined as an indicator variable equal to 1 if the long-term debt ratio is higher than its mean value and 0 otherwise. *Fem* is our main independent variable and measures the presence of women on the Board of Directors. Specifically, it is the number of female directors participating in the Board of Directors. We also control for year indicators by including year-fixed effects. All variables are described in the Appendix.

We divided the control variables vector into three categories of covariates, which we identified in prior studies as impacting long-term leverage. The categories concern boardroom, firm, and auditor-specific variables.

Firstly, boardroom-specific variables concern the characteristics of the Directors in Board of Directors that affect the nature of their decision-making procedure (García & Herrero, 2021). Specifically, we control for boardroom independence which considers the percentage of Independent and non-executive Directors in the Board of Directors (*BoDInd*). This control variable measures the percentage of Directors that are independent of the firms' functions, meaning that they are not executive members such as managers but influence the boardroom's decision-making (Rebeiz, 2018). Moreover, we use *BoD* control for the size of the boardroom, meaning the number of Directors participating in the Board of Directors (García & Herrero, 2021). We also consider CEO duality a significant variable that determines the boardroom decision making. The influence of whether the CEO is also the president of the Board of Directors on decision-making is an issue that has concerned prior studies (Baliga, Moyer, & Rao, 1996; Elsayed, 2007; Krause, Semadeni, & Cannella Jr, 2014).

Secondly, we control for firm-specific characteristics that influence the complexity and difficulty of decision-making, such as the firm's leverage structure. Following the model of García and Herrero (2021), we control for firm size (*Size*), profitability (*ROA*), liquidity (*Cash*), and working capital (*WC*).

Finally, we control for an auditor-specific characteristic, which is *BIG4*. This variable is an indicator variable equal to 1 if the audit firm is KPMG, PwC, Deloitte, or EY, and 0 otherwise. In this part, we have to point out that we use control variables following prior literature (García & Herrero, 2021) that affect the decision-making process of the Directors in the boardroom. The percentage of long-term debt might bring a firm in a risky position, and this is the main reason why several boardroom-, firm- and auditor-characteristics might affect this percentage (Gul & Goodwin, 2010).

4. Results

4.1 Descriptives

Table 2 represents the descriptive statistics of our sample. Specifically, the first part concerns the boardrooms without female Directors, while the second part the Boardrooms with female Directors. This division aims to analyze the differences between boardrooms with and without female Directors. We observe a statistically significant difference at 10% of our main independent variable. This indicates that the boardrooms with female Directors have less long-term debt compared to the boardrooms that consist of male Directors. This indicates that female directors follow less risky policies regarding leverage structure compared to male Directors. The leverage structure is important to the policies followed by Directors as they are more exposed to their lenders. Therefore, lenders are stakeholders with significant power (Gul & Goodwin, 2010).

Moreover, we observe a statistically significant difference in the size of the boardroom between the firms with and without female Directors, where the boardrooms without female Directors have

more participants. Another variable that is statistically different in means, is *CEODual*, where it is higher in the Boardrooms with female Directors. (Table 2)

4.2 Correlation matrix

Table 3 represents the correlation matrix results from pairwise correlation. We observe that femaledirectors' presence in the boardroom (*Fem*) is negatively associated with higher levels of long-term debt and is statistically significant at 10%. This indicates that the women's presence in the boardroom minimizes the level of firms' long-term leverage. Moreover, we observe a statistically significant association between our dependent variable and a certain number of our control variables, such as *BoD*, *CEODual*, *Size*, *Cash*, *ROA* and *WC*. There are no issues with multicollinearity as the mean-variance inflation factor is within the permitted threshold. Additionally, the variance inflation factor for each variable in model (1) is less than 10. (Table 3)

Results

The results of the probit regression are presented in Table 4. In this regression, the dependent variable is High Leverage. The analysis indicates a statistically significant relationship between *Fem* and High Leverage, where $p < 0.01$. The coefficient is negative and equals -0.169, implying that the presence of women in the boardrooms minimizes the likelihood of the firm engaging in higher levels of long-term leverage. Moreover, we observe, at the boardroom-specific control vector, that when the president and the CEO are the same person (*CEODual*), the long-term debt is positively affected, and the relation is statistically significant at 1%. According to Kuo, Wang, and Lin (2015), analyzing the association between CEO duality and debt supported that "*CEOs with dual positions can cause debt-agency problems, or if they have more power to control the firm's risk, this can increase the firm's debt capacity*". Regarding firm characteristics, we observe that the coefficients in all of them are statistically significant at 1%. This is logical since the variables *Size*, *Cash*, *ROA*, and *WC* are directly connected to long-term leverage through the Financial Statement of Income and Balance Sheet.

5. Conclusions

Further elaborating on the research findings, the analysis of the collected data highlights the impact of women on Greek listed firms. The correlation coefficients, which indicate the strength and direction of the relationship between variables, consistently demonstrate strong values across all examined indicators and years. This implies that the presence of women in top management positions directly influences debt structure, financial performance, and operational effectiveness of the firms.

These findings emphasize the importance of considering other factors and decision-making processes within the board of directors that contribute to a company's leverage, profitability, and efficiency. The study suggests that collective decision-making, which involves the active participation and collaboration of all board members, plays a more significant role in shaping the company's overall performance.

However, it is worth noting that this research focused specifically on the relationship between women and long-term leverage. Future studies could delve deeper into the factors that contribute

to the relationship between gender diversity and company performance, considering additional variables such as board composition, leadership styles, industry dynamics, and external factors.

Moreover, the suggestion to conduct a similar investigation focusing on the male gender and its correlation with company profitability and efficiency aims to provide a comparative perspective. By analyzing both genders' influence on performance indicators, a more comprehensive understanding of the gender-related dynamics within corporate governance can be achieved. This would contribute to the ongoing discourse on gender diversity in leadership positions and shed light on the broader implications of collective decision-making in corporate settings.

Overall, this study contributes to the existing body of knowledge on corporate governance and gender diversity by highlighting the direct association between women and long-term leverage. It underscores the significance of collective decision-making and encourages further research to explore the underlying mechanisms that shape the relationship between gender diversity and corporate leverage.

Table 1: Sample selection procedure

Selection procedure	Firms	Firm year observations
Listed firms in the Athens Stock Exchange (Athex) from 2014 to 2018	209	893
Less: Listed firms deleted from Athex during 2014-2018	74	218
Less: Listed firms with missing data	27	135
Less: Banks and Financial Institutions	8	40
Final sample	100	500

This table presents the sample selection procedure of our analysis. The information, regarding the listed firms and those deleted during 2014-2018, was derived from Hellenic Capital Market Commission website (see 3.1 Sample).

Table 2: Descriptive Statistics

This table presents the descriptive statistics of the model variables separated into the firms with and without female Directors in their Boardroom. Variables' definitions are in Appendix. The asterisks *, ** and *** indicate the p-values of 10%, 5% and 1%, respectively. All numbers are rounded to the third decimal place. All variables were winsorized at 1 and 99%.

VARIABLES	Boardrooms without female Directors (N=237)					Boardrooms with female Directors (N=263)					t-statistic
	mean	St. Dev	25th	Median	75th	mean	St. Dev	25th	Median	75th	
High Leverage	0.553	0.498	0	1	1	0.464	0.500	0	0	1	0.089*
BoDInd	0.652	0.162	0.545	0.667	0.800	0.608	0.145	0.500	0.571	0.714	0.045**
BoD	7.966	2.526	6	7	9	7.620	1.898	7	7	9	0.346
CEODual	0.388	0.488	0	0	1	0.494	0.501	0	0	1	-0.106*
Size	18.18	1.659	16.87	18.07	19.27	18.24	1.528	17.18	17.71	18.86	-0.058
Cash	0.061	0.077	0.009	0.027	0.085	0.069	0.091	0.006	0.033	0.090	-0.008
ROA	-0.003	0.088	-0.030	0.007	0.037	-0.003	0.072	-0.023	0.003	0.035	-0.000
WC	0.061	0.525	-0.104	0.087	0.323	0.105	0.437	-0.116	0.142	0.377	-0.044
BIG4	0.224	0.418	0	0	0	0.210	0.408	0	0	0	0.014

Table 3: Correlation matrix

This table presents the correlation matrix of model (1) using pairwise correlation. T-statistics are represented in parentheses. The variables' definitions are in the Appendix. All numbers are rounded to the third decimal place. All variables were winorized at 1 and 99%.

	High Leverage	Fem	BoDInd	BoD	CEODual	Size	Cash	ROA	WC	BIG4
High Leverage	1									
Fem	-0.076 0.089	1								
BoDInd	-0.033 0.467	-0.212 0.000	1							
BoD	0.097 0.031	-0.055 0.223	0.053 0.235	1						
CEODual	0.134 0.003	0.146 0.001	-0.045 0.316	-0.203 0.000	1					
Size	0.218 0.000	-0.013 0.771	0.041 0.363	0.610 0.000	0.031 0.495	1				
Cash	-0.183 0.000	-0.036 0.428	0.021 0.636	0.151 0.001	0.007 0.879	0.221 0.000	1			
ROA	-0.094 0.036	0.029 0.512	-0.087 0.052	0.147 0.001	0.086 0.055	0.314 0.000	0.369 0.000	1		
WC	-0.080 0.075	0.034 0.449	-0.124 0.006	0.018 0.690	0.022 0.631	0.077 0.085	0.514 0.000	0.572 0.000	1	
BIG4	0.022 0.627	-0.098 0.029	0.193 0.000	0.432 0.000	-0.096 0.032	0.509 0.000	0.273 0.000	0.064 0.154	-0.009 0.846	1

Table 4: OLS regression results

This table presents the OLS analysis of *High Leverage* with female directors' presence in the Board of Directors (Fem) for the entire sample. Standard errors are clustered at firm level, with t-statistics presented in parentheses. The asterisks *, ** and *** indicate the p-values of 10%, 5% and 1%, respectively. Variables' definitions are in Appendix. All numbers are rounded to the third decimal place. All variables were winsorized at 1 and 99%.

VARIABLES	High Leverage
Fem	-0.169*** (0.063)
BoDInd	-0.396 (0.413)
BoD	0.010 (0.036)
CEODual	0.47 3*** (0.130)
Size	0.341*** (0.059)
Cash	-4.640*** (0.937)
ROA	-4.063*** (1.021)
WC	0.451*** (0.172)
BIG4	-0.241 (0.177)
Year Effects	Included
Constant	-5.911*** (0.987)
Observations	500
Pseudo R-squared	0.171
Mean VIF	1.56

Appendix Dependent

Variable

High Leverage An indicator equal to 1 if the long term debt ratio is higher than its median, and 0 otherwise. Long-term debt ratios is long term debt scaled by total assets.

Main Independent Variable

Fem Number of female directors participating in the Board of Directors.

Control Variables

Boardroom-specific control variables

BoDInd Number of Independent Directors in the Board of Directors scaled by the total number of all the Directors participating in the Board of Directors.

BoD Total number of all the Directors participating in the Board of Directors

CEODual An indicator variable equal to 1 if the CEO and the president of the Board of Directors are the same person, and 0 otherwise.

Firm-specific control variables

Size Natural logarithm of total assets.

Cash Cash and cash equivalents scaled by total

assets.ROA Pre-tax income scaled by total assets.

WC Working Capital

References

- Adams, R. B., & Ferreira, D. (2009). Women in the Boardroom and Their Impact on Governance and Performance. *Journal of Financial Economics*, 94(2), 291-309. doi:<https://doi.org/10.1016/j.jfineco.2008.10.007>
- Adams, R. B., & Funk, P. (2012). Beyond the Glass Ceiling: Does Gender Matter? *Management Science*, 58(2), 219-235. doi:10.1287/mnsc.1110.1452
- Aljughaiman, A. A., Albarrak, M., Cao, N. D., & Trinh, V. Q. (2022). Cost of Equity, Debt Financing Policy, and the Role of Female Directors. *Cogent Economics & Finance*, 10(1), 2109274.
- Baliga, B. R., Moyer, R. C., & Rao, R. S. (1996). Ceo Duality and Firm Performance: What's the Fuss? *Strategic management journal*, 17(1), 41-53.
- Datta, S., Doan, T., & Toscano, F. (2021). Top Executive Gender, Board Gender Diversity, and Financing Decisions: Evidence from Debt Structure Choice. *Journal of Banking & Finance*, 125, 106070. doi:<https://doi.org/10.1016/j.jbankfin.2021.106070>
- de Cabo, R. M., Gimeno, R., & Escot, L. (2011). Disentangling Discrimination on Spanish Boards of Directors. *Corporate governance: an international review*, 19(1), 77-95. doi:<https://doi.org/10.1111/j.1467-8683.2010.00837.x>
- Elsayed, K. (2007). Does Ceo Duality Really Affect Corporate Performance? *Corporate governance: an international review*, 15(6), 1203-1214.
- Engel, Y., Lewis, T., Cardon, M. S., & Hentschel, T. (2023). Signaling Diversity Debt: Startup Gender Composition and the Gender Gap in Joiners' Interest. *Academy of Management Journal*, 66(5), 1469-1500.
- Ferrero-Ferrero, I., Fernández-Izquierdo, M. Á., & Muñoz-Torres, M. J. (2015). Integrating Sustainability into Corporate Governance: An Empirical Study on Board Diversity. *Corporate Social Responsibility and Environmental Management*, 22(4), 193-207. doi:<https://doi.org/10.1002/csr.1333>
- Gabaldon, P., de Anca, C., Mateos de Cabo, R., & Gimeno, R. (2016). Searching for Women on Boards: An Analysis from the Supply and Demand Perspective. *Corporate governance: an international review*, 24(3), 371-385. doi:<https://doi.org/10.1111/corg.12141>
- Garcia-Blandon, J., Maria, A.-B. J., & Diego, R. (2022). Female Directors and the Firm's Cost of Debt: Evidence from a Quasi-Natural Experiment. *European Management Journal*.
- García, C. J., & Herrero, B. (2021). Female Directors, Capital Structure, and Financial Distress. *Journal of Business Research*, 136, 592-601. doi:<https://doi.org/10.1016/j.jbusres.2021.07.061>
- Gul, F. A., & Goodwin, J. (2010). Short-Term Debt Maturity Structures, Credit Ratings, and the Pricing of Audit Services. *The Accounting Review*, 85(3), 877-909.
- Gupta, V. K., Mortal, S., Chakrabarty, B., Guo, X., & Turban, D. B. (2020). Cfo Gender and Financial Statement Irregularities. *Academy of Management Journal*, 63(3), 802-831.
- HCMC. (2018). Annual Report 2018. *Hellenic Capital Market Commission, March 2019*. IFRS 7. Financial Instruments: Disclosure. retrieved from <https://www.ifrs.org/issued-standards/list-of-standards/ifrs-7-financial-instruments-disclosures/#about>.
- Jitmaneeroj, B. (2016). Reform Priorities for Corporate Sustainability. *Management Decision*, 54(6), 1497-1521. doi:10.1108/MD-11-2015-0505

- Kahloul, I., Sbai, H., & Grira, J. (2022). Does Corporate Social Responsibility Reporting Improve Financial Performance? The Moderating Role of Board Diversity and Gender Composition. *The Quarterly Review of Economics and Finance*, 84, 305-314. doi:<https://doi.org/10.1016/j.qref.2022.03.001>
- Kamil, R., & Appiah, K. O. (2022). Board Gender Diversity and Cost of Debt: Do Firm Size and Industry Type Matter? *Gender in Management: An International Journal*, 37(1), 19-38.
- Krause, R., Semadeni, M., & Cannella Jr, A. A. (2014). Ceo Duality: A Review and Research Agenda. *Journal of Management*, 40(1), 256-286.
- Kuo, H. C., Wang, L. H., & Lin, D. (2015). Ceo Traits, Corporate Performance, and Financial Leverage. *International Journal of Economics and Finance*, 7(1), 68-86.
- Lanis, R., Richardson, G., & Taylor, G. (2017). Board of Director Gender and Corporate Tax Aggressiveness: An Empirical Analysis. *Journal of business ethics*, 144, 577-596.
- Lee, L., Marshall, R., Rallis, D., & Moscardi, M. (2015). Global Trends in Gender Diversity on Corporate Boards. (Retrieved from: <https://www.msci.com/documents/10199/04b6f646-d638-4878-9c61-4eb91748a82b>).
- McGuinness, P. B., Vieito, J. P., & Wang, M. (2017). The Role of Board Gender and Foreign Ownership in the Csr Performance of Chinese Listed Firms. *Journal of Corporate Finance*, 42, 75-99. doi:<https://doi.org/10.1016/j.jcorpfin.2016.11.001>
- Mehmood, A., De Luca, F., & Quach, H. (2023). Investigating How Board Gender Diversity Affects Environmental, Social and Governance Performance: Evidence from the Utilities Sector. *Utilities Policy*, 83, 101588. doi:<https://doi.org/10.1016/j.jup.2023.101588>
- Pandey, R., Biswas, P. K., Ali, M. J., & Mansi, M. (2020). Female Directors on the Board and Cost of Debt: Evidence from Australia. *Accounting & Finance*, 60(4), 4031-4060.
- Rao, K., & Tilt, C. (2016). Board Composition and Corporate Social Responsibility: The Role of Diversity, Gender, Strategy and Decision Making. *Journal of business ethics*, 138, 327-347.
- Rebeiz, K. S. (2018). Relationship between Boardroom Independence and Corporate Performance: Reflections and Perspectives. *European Management Journal*, 36(1), 83-90. doi:<https://doi.org/10.1016/j.emj.2017.01.008>
- Reddy, S., & Jadhav, A. M. (2019). Gender Diversity in Boardrooms—a Literature Review. *Cogent Economics & Finance*, 7(1), 1644703.
- Setó-Pamies, D. (2015). The Relationship between Women Directors and Corporate Social Responsibility. *Corporate Social Responsibility and Environmental Management*, 22(6), 334-345. doi:<https://doi.org/10.1002/csr.1349>
- Shahab, Y., Ntim, C. G., Chengang, Y., Ullah, F., & Fosu, S. (2018). Environmental Policy, Environmental Performance, and Financial Distress in China: Do Top Management Team Characteristics Matter? *Business Strategy and the Environment*, 27(8), 1635-1652. doi:<https://doi.org/10.1002/bse.2229>
- Shahab, Y., Ntim, C. G., Ullah, F., Yugang, C., & Ye, Z. (2020). Ceo Power and Stock Price Crash Risk in China: Do Female Directors' Critical Mass and Ownership Structure Matter? *International Review of Financial Analysis*, 68, 101457. doi:<https://doi.org/10.1016/j.irfa.2020.101457>

Torchia, M., Calabrò, A., & Huse, M. (2011). Women Directors on Corporate Boards: From Tokenism to Critical Mass. *Journal of business ethics*, 102, 299-317.

Usman, M., Farooq, M. U., Zhang, J., Makki, M. A. M., & Khan, M. K. (2019). Female Directors and the Cost of Debt: Does Gender Diversity in the Boardroom Matter to Lenders? *Managerial Auditing Journal*, 34(4), 374-392.

Enhancing Sustainable Development through Artificial Intelligence: Insights from Expert Interviews

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Abstract

Recently, sustainability has gained increased attention as a pivotal concept in business, amplified by the latest climate report from the United Nations (UN), indicating a critical juncture in meeting climate goals. Concurrently, there is growing interest in exploring the intersection of sustainable development and artificial intelligence (AI), driven by advancements in algorithms, processing power, and data availability. This emerging field seeks to investigate the potential of AI to facilitate sustainability, an area that has yet to be extensively explored. Utilizing the sustainability goals from UN as a benchmark, the study has explored (1) sustainability practices and strategies in Norwegian businesses, (2) the adoption effort of AI within these businesses, and (3) how AI can act as a catalyst for sustainable development in line with the sustainability goals of UN. Employing a qualitative approach, we conducted eleven expert interviews in ten companies operating in the IT industry. Overall, the study suggests that AI can positively influence sustainability and underscores the need for future research to identify critical success factors for AI adoption while mitigating potential negative impacts of AI on sustainable development.

Keywords

Sustainability, artificial intelligence, sustainable development goals, information systems

1. Introduction

In recent years, sustainability has ascended as a pivotal concept in both business practices and IS research (Dyllick and Muff 2016; Pappas et al. 2023; Seidel et al. 2017). This heightened

focus on sustainability aligns with the urgent findings of the latest climate report by the United Nations (UN) on climate change (IPCC 2024), indicating a critical phase in our pursuit of climate objectives. Concurrently, the ongoing digitalization of society has paid attention to green innovation (Song et al. 2019). Within the IT industry, where technology is paramount, the integration of sustainable development with technological innovation is crucial. Investments in green technologies not only align with sustainability goals but also present avenues for stimulating development and innovation (Zhang et al. 2020).

On another front, advancements in algorithms have enabled artificial intelligence (AI) systems to process and analyze complex data more efficiently, leading to more accurate predictions and insights (Ågerfalk et al. 2022). AI is defined as machines mimicking human cognitive tasks, driving digital transformation (Benbya et al. 2020; Duan et al. 2019). Additionally, the proliferation of large and diverse datasets, facilitated by the digital transformation and the Internet of Things (IoT), has provided AI with the raw material needed to learn, adapt, and improve its performance across various applications, ranging from healthcare and finance to manufacturing and beyond (Hansen and Bøgh 2021; Kumar et al. 2020). These collective advancements have significantly accelerated the evolution and adoption of AI across industries, shaping its role as a transformative force in the contemporary digital era (Jan et al. 2023). However, while AI offers innovative solutions, questions arise about its societal and environmental impact.

This study investigates the nexus between sustainable development and AI to explore the potential of AI as an enabler for sustainable development. This phenomenon remains relatively underexplored in extant research, indicating a knowledge gap (e.g., Nishant et al. 2020).

The study aims to address this gap by examining enterprises, and by utilizing the UN Sustainable Development Goals (SDGs) as a benchmark to assess the sustainable potential of AI. With the research question *"What are the relationships between sustainable development and artificial intelligence?"* the study seeks to elucidate (1) sustainable management practices in Norwegian enterprises and the strategies employed, (2) the degree of AI integration within these enterprises, and (3) how AI can serve as a catalyst for sustainable development in alignment with the SDGs recommended by UN.

To answer the research question, a qualitative study of expert interviews was conducted. The data collection took part in spring 2022, comprising eleven interviews with representatives from ten different IT-oriented enterprises (Lindseth and Rygg 2022). Informants included experts knowledgeable about sustainability efforts and AI within their respective organizations. Through insights gained from these enterprises, connections between sustainable development and AI in practice were identified.

The reminding paper is structured as follows. In Section 2, we introduce the background, central concepts, and previous research relevant to this study. Section 3 provides an overview of our methodology and the companies involved in the research. In Section 4, we present our findings, which are then discussed in Section 5. Finally, in Section 6, we draw conclusions regarding the potential impact of AI as a catalyst for sustainable development in companies.

2. Background and previous research

In this section, we elucidate the foundational context that underpins our research, providing an overview of the pivotal concepts of sustainability and AI. Furthermore, we explain their centrality within IS research.

2.1 The concept of sustainability and the role of IT/IS

In recent years, sustainability, and sustainable development within the realm of digitization have garnered significant attention among IS researchers. Notably, Chen et al. (2008) explored the motivations of organizations towards sustainability, focusing on their inclination towards eco-friendly practices. This study aimed to understand how IS could facilitate three key ecological sustainability milestones: eco-efficiency, eco-equity, and eco-effectiveness. Similarly, Watson et al. (2010) investigated the potential of IS for contributions to sustainable development by influencing diverse environmental objectives.

Despite the focus on sustainability for a decade in IS research, its focus remains nascent and evolving, prompting calls for continued investigation (Watson et al. 2021). This growing emphasis on sustainability is corroborated by global concerns, such as the recent climate report by UN labeling the current climate situation as a "code red" for humanity. Consequently, businesses, both large and small, are increasingly integrating sustainability into their strategic frameworks, signaling a proactive shift towards greener practices (Krogstie 2023).

Our research aims to delve deeper into this evolving landscape by empirically examining how organizations manage sustainability both internally and externally, particularly within the IS context. A key focus is on exploring how innovative technologies, such as AI, can augment sustainability efforts.

The Triple Bottom Line (TBL) is a framework that evaluates the performance of an organization based on three pillars: social, environmental, and economic (Elkington 1997). This aligns with the sustainability triangle, which encompasses three primary dimensions: environmental, economic, and social (Vinuesa et al. 2020). While the term sustainability may evoke environmental concerns, it encompasses more than just climate, such as the 2-degree goal from the Paris Agreement (UN 2016), which is crucial for solidarity in cooperation to achieve climate goals. Each of the different fundamental aspects of sustainability has its own goals and sub-goals.

Each dimension, while distinct, plays a pivotal role in sustainable development. Environmental sustainability emphasizes reducing carbon footprints (Chege and Wang 2020; Feroz et al. 2021), economic sustainability underscores stable economic growth (Fernandes et al. 2021), and social sustainability focuses on upholding fundamental human rights and addressing issues like the digital divide (Flak and Hofmann 2020; Vassilakopoulou and Hustad 2023). Together, these dimensions form the cornerstone of sustainable development, emphasizing the importance of balancing profit, people, and the planet to foster a sustainable society. In this context, various indicator sets have been proposed to help businesses assess their sustainability efforts and mitigate greenwashing risks (Baldi and Pandimiglio 2022).

The SDGs by UN present a comprehensive roadmap to address poverty, human rights, and climate change by 2030, encompassing 17 main goals and 169 sub-goals. These SDGs are pivotal in harmonizing the social, economic, and environmental facets of sustainability. In our study, the SDGs serve as a foundational framework to evaluate sustainable development practices, determining whether IS initiatives align with these global objectives. This involves analyzing organizational activities and measures vis-à-vis specific SDGs to assess alignment and efficacy.

A few previous studies have explored the intersection between AI and the SDGs, offering diverse perspectives on the *potential* impact of AI (Corbett and Mellouli 2017; Truby 2020; Vinuesa et al. 2020; Watson et al. 2021). By synthesizing insights from these studies, we aim to delineate the role of AI in supporting sustainable development by doing empirical research, mapping its contributions across the 17 SDGs. This endeavor seeks to identify instances where AI has been observed to facilitate or impact these global sustainability objectives.

2.2 The concept of AI and a brief overview of AI in IS research

AI is fundamentally reshaping the landscapes of both business and education, introducing innovative approaches and tools that enhance efficiency, decision-making, and learning experiences (Halagatti et al. 2023; Tan 2023; Venkateswaran et al. 2024).

Within the business sector, AI-powered technologies such as machine learning (ML) algorithms, natural language processing (NLP), robotic process automation (RPA), and advanced generative AI models are revolutionizing traditional practices in areas like strategic planning and resource allocation (Davenport and Ronanki 2018; Fui-Hoon Nah et al. 2023). Machine learning algorithms sift through vast datasets to discern patterns, generating actionable insights that facilitate data-driven decision-making (Maass et al. 2018). Concurrently, NLP tools like chatbots and sentiment analysis tools elevate customer engagement by enhancing interactions and sentiment tracking, thereby enabling customer satisfaction (Vassilakopoulou et al. 2023). Additionally, RPA streamlines routine tasks, amplifying operational efficiency and releasing human resources to concentrate on strategic innovation (Lacity et al. 2021).

Overall, AI represents an innovative technology capable of identifying complex tasks and solving problems more rapidly and efficiently than traditional analog and even other digital methods. Consequently, AI has substantial potential to become a cornerstone in digital transformation, offering opportunities and advantages across various sectors (Truby 2020). Yet, the integration of AI is not without ethical dilemmas and challenges (Mikalef et al. 2022). While AI holds promise for alleviating poverty and supporting sustainable development through data-driven insights, it also holds risks. Truby (2020) underscores the potential for misuse, especially in developing countries where AI could exacerbate financial crimes and corruption. To utilize the potential of AI in a responsible way and with sustainable intentions, it is crucial that regulatory frameworks should guide its deployment to prevent misuse and cause unintended harm (Akbarighatar et al. 2023).

2.3 Summary – the intersection between AI and sustainability

In the scope of this study, we place special emphasis on exploring the intersection between AI capabilities and the principles of sustainability. We aim to understand the potential of the unique attributes of AI in driving sustainable development forward. Specifically, we seek answers to questions such as: How can the inherent features of AI act as catalysts in sustainable initiatives? Additionally, we delve into the potential challenges that might emerge when integrating AI into sustainable practices.

Given the increasing global awareness of environmental issues and the urgent need for action, our research is grounded in our contemporary context. We attempt to shed light on the transformative potential of smart technologies such as AI in fostering not just environmental sustainability but also societal and economic welfare. In doing so, our study aims to provide valuable insights into how these advanced technologies can be effectively harnessed to address the challenges in obtaining sustainable business practices.

3. Research method and context

We employed a qualitative approach, utilizing expert interviews (Meuser and Nagel 2009) to gather insights into how Norwegian companies utilize and manage AI in relation to sustainability. We utilized an interpretive approach which helped us to understand the knowledge of the reality and beliefs of the participants in their social context (Orlikowski and Baroudi 1991). The selection of participants was based on their experience with sustainability work and/or utilization of AI technologies. We aimed to identify, explore, and comprehend how participants experienced AI and sustainability, as well as the interplay between them. Participants were selected through three methods: purposive sampling, self-selection, and snowball sampling (Miles et al. 2018). We strategically selected interviewees from businesses meeting the following criteria: (1) Being involved in technology/IT-driven operations (2) being engaged in sustainability work, (3) having experience with AI (limited or comprehensive), and (4) working in a company that possesses a large amount of data (big data focus). In total we interviewed eleven participants from ten companies, and each interview lasted between 45 minutes to an hour. Table 1 depicts an overview of the interviewees and their companies.

Table 1. Overview of the companies (anonymized with codes) participating in the study.

#	Code	Industry	Description
1	Alpha	Autonomi	A small business focusing on artificial intelligence operations across various devices. The company aims to integrate AI into devices to streamline workplaces, reduce workplace injuries, and significantly cut down consumption across devices
2	Bravo	Technology	A large enterprise driving high-tech advancements globally. This company has been instrumental in enhancing capabilities of individuals and organizations, standing as a key force in international technological development
3	Charlie	Consulting	A prominent Norwegian IT firm offering digital workplaces, cloud services, data centers, and data-driven innovation. They prioritize IT security and are among the leading advocates for sustainability in the

			Norwegian IT sector, working towards a future aligned with forward-thinking, responsibility, and curiosity.
4	Delta	Consulting	A major company leading digital consultancy in Norway. They assist both private and public entities in taking digital leadership, aiming to create value for their clients and society while striving for a better and more sustainable future
5	Echo 2 interviews	Transportation	A significant player responsible for a substantial portion of central transportation in Norway, with an in-house IT department serving both civilian and military sectors. They are a driving force in environmental efforts within transportation, actively working to reduce overall greenhouse gas emissions in Norwegian transport
6	Foxtrot	Consulting	A large Scandinavian consulting firm serving clients across various sectors, providing a range of development and advisory services, including AI within their portfolio
7	Golf	Energy	A major company well-established in the energy sector in Norway. They stand as a leading player in sustainability initiatives within their region, actively collaborating with partners to ensure optimal energy yield and network expansion
8	Hotel	Technology	A medium-sized company with regional branches, operating as a cooperative. They handle operational tasks related to technology and networking, ensuring robust infrastructure and hardware in municipalities.
9	India	Public organization	A large Norwegian public entity handling critical societal tasks. While developing their strategies, they are also subject to state-driven conditions. With a focus on people and societal impact, they are technology-oriented, boasting their own IT department and CIO.
10	Juliet	Consulting	Consulting A large international consulting firm with several Norwegian branches. Operating across various business areas and sectors, they are a global leader in digitalization and are actively advancing in the development and implementation of AI projects

Through dialogues with participants, we discerned the nuances of AI adoption and its impact on these enterprises. Our aim was to understand sustainable AI usage, identify potential implications, and relate these to the SDGs of the UN, which so far has a scarcity of empirical evidence in extant research (Denicolai et al. 2021). Therefore, we linked the narratives from the participants to the SDGs from UN. Our interpretive approach (Walsham 2006) allowed us to delve into detailed scenarios and cases, examining the interconnectedness of AI and sustainability, and develop rich descriptions (Walsham 1995).

We gained insights into the topic we explored, recognizing that perceptions could vary from one interview to another, providing us with common patterns and themes as well as idiosyncratic meanings that were interpreted (Dubé and Robey 1999).

We primarily employed the "emergent coding" method to define our codes and themes (Saldaña 2021, p. 7). This approach involved reviewing transcripts and identifying themes progressively throughout the process, leading to an increasing number of groups and themes. Concurrently, we integrated "structured coding" where predefined themes (Kvale and

Brinkmann 2009), such as AI and sustainability goals served as the foundation for our interpretation, focusing on the impact of AI on sustainability goals. This hybrid approach facilitated a structured review, followed by a more open "emergent" approach, allowing for the addition of new themes and codes based on the patterns identified.

Revision was an integral part of our inductive emergent coding. Given the development of new themes and categories, revisiting the interviews and codes was essential. This iterative process led to the discovery of new codes aligning with the themes, resulting in a more comprehensive revised analysis. After the initial "first cycle coding", it was crucial to re-examine the data to ensure alignment between the intended portrayal and the actual codes and categories (Sarker et al. 2001). This led to a "second cycle coding," refining the codes further. Concurrently, we utilized analytic memos (Corbin 2007), resembling lab notebooks and/or research blogs, to record pertinent comments related to the research, interviews, and codes (Saldaña, 2021, p. 58). In Quirkos (described below), memos functioned as annotations or thought bubbles alongside the codes, aiding in organizing the codes with notes throughout the process and adhering closely to the codes-to-theory model.

We utilized the Quirkos analytical tool to explore and assess categories and relationships among various themes (Turner 2016). During the coding process, distinct categories emerged, including projects, services, strategies, initiatives, indicators, technologies, challenges, and competitive advantages. To discern the prevalence of sustainability within the businesses, we employed the overview feature in Quirkos to analyze the aforementioned categories and examine the distribution of codes related to sustainability. Quirkos offers an overlap function that enables the identification of codes in interviews containing multiple themes. This allowed us to compare instances in transcripts that encompass both AI and one or more additional themes, such as a sustainability goal. Through this, we gained an overview of the number of codes containing both AI and a specific theme, and subsequently determined the number of interviews encompassed within this collection.

4. Results

4.1 The role of sustainability within the enterprises

In our interviews, we explored the emphasis companies dedicated to sustainable development to understand the relationship between sustainability and AI. We examined how firms engage with sustainability through their strategies and initiatives. The analysis revealed that companies are actively pursuing sustainability, which we summarize based on expert interviews in this subsection.

Companies vary in their sustainability focus, distinguishing between *internal* and *external* sustainability. Notably, consultancy firms often emphasize external impact, assisting clients in adopting sustainable practices through their own suggestions or strategic guidance. Some firms concentrate on supporting clients with sustainability similarly to their internal sustainability efforts. However, tracking external sustainability initiatives is often easier than monitoring internal practices. This allows consultancies to spotlight their sustainable practices, aiding clients towards sustainability.

"...as a consultancy company, we often lack full control over our resources. Yet, being sustainable and ethical requires us to engage with clients and encourage their sustainability."
Juliet

We interpret a desire to influence clients towards sustainability as a consistent focus among consultancy firms. Differences lie in the extent to which firms drive clients towards sustainable choices and establish sustainable strategies. Approaches to clients vary, focusing on assisting clients with their objectives rather than prescribing sustainability strategies. Juliet's expertise indicates that clients frequently prioritize sustainability, with consultancies striving to facilitate and guide these decisions.

While Juliet describes clients as already inclined towards sustainability, Delta suggests that many clients lack clarity on sustainable solutions. Delta emphasizes the need to educate clients on achieving sustainability, particularly since few possess the necessary technological expertise. Their external sustainability focus includes promoting existing solutions, such as AI projects aimed at sustainable goals. Another perspective on external sustainability involves assisting clients with sustainability reporting, as described by Foxtrot. Foxtrot aids clients in reporting their sustainability efforts rather than driving sustainable practices.

Customer focus reflects approaches to internal and external sustainability. Consultancies show interconnectivity between internal sustainability practices and an overarching sustainability strategy. Initially, consultants fulfill internal sustainability desires, followed by clients adopting or mirroring these practices. Clients are influenced by the external sustainability focus of consultancies, leading to a holistic sustainability strategy both internally and externally.

There is a variation among firms regarding the extent and maturity of sustainability strategies and actions. Some focus on services to gain sustainability efforts, while others have comprehensive organizational strategies. Responses varied in alignment with UN sustainability goals: some integrate them into their overarching strategy, while others are in the process. Table 2 presents quotes from participants, highlighting firms where the SDGs are a significant part of their strategy (three first rows) and those with alternative sustainability measures (last two rows).

Table 2. Focus on sustainability and the SDGs from UN as a part of the strategy.

Company	Alignment with SDGs from UN
Alpha	"We have highlighted 5-6 of them."
Charlie	"We aim for all but focus on 6 where we can make the most impact."
Delta	"Goals: 11, 15, 13, 8, & 4."
Hotel	"No mention of sustainability goals in our strategy, although our owners do."
India	"Part of our IT ambitions, but unsure of our current sustainability focus."

Table 2 provides excerpts from interviews,

To reveal how the enterprises have approached sustainability, we aim to assess the prevalence of SDGs within them. The following chart in Figure 1 indicates the frequency of SDGs mentioned in interviews, shedding light on their importance and focus within the sample.

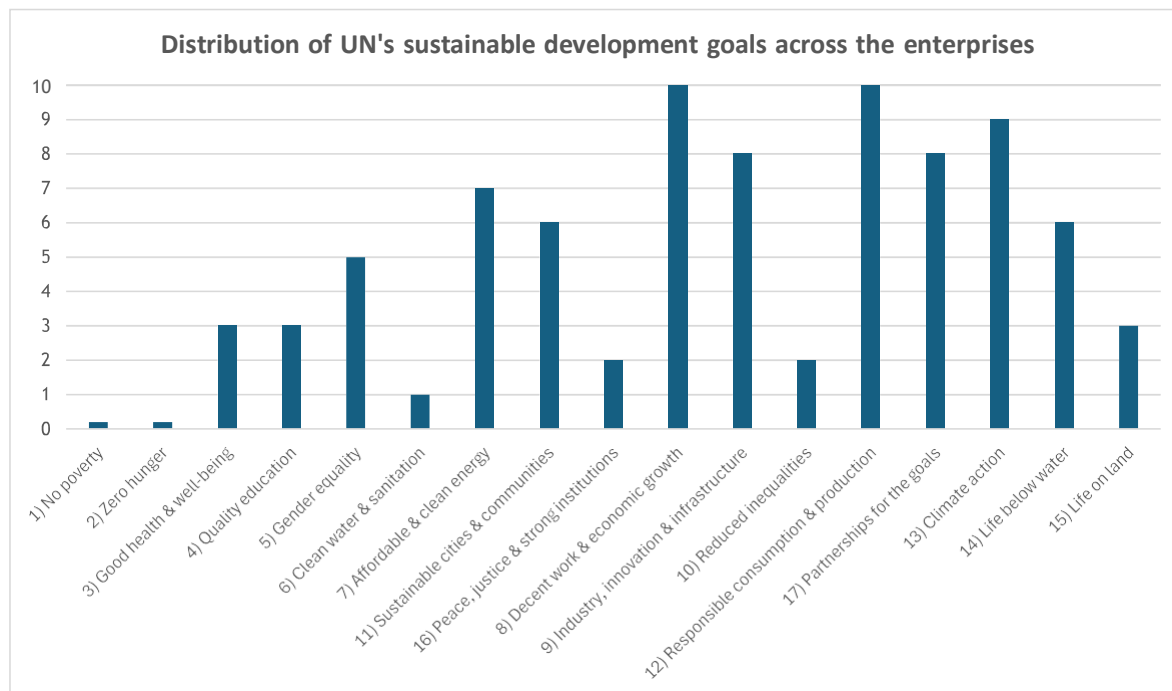


Figure 1. Distribution of the focus of SDGs across the enterprises in this study

The graph categorizes SDGs into societal (1-7, 11, 16), economic (8, 9, 10, 12, 17), and environmental (13-15) dimensions. Bars represent the number of firms that include the SDG in their strategy or mention projects aligning with their sub-goals (totaling 169). While firms may discuss some SDGs explicitly, others are implied in their discussions, as depicted in Figure 1.

SDGs 8 and 12 are most frequently cited across interviews. SDG 8 resonates with the Norwegian business ethos of ethical employment and environmental responsibility. However, the chart merely reflects mentions, not emphasis. Further research is needed for conclusive insights.

	Social									Economic					Environment		
SDG	1	2	3	4	5	6	7	11	16	8	9	10	12	17	13	14	15
Number of codes in the results	0	0	8	6	13	3	31	17	2	32	36	2	50	16	44	15	6

Table 3. Overview of the number of statements related to the three sustainability dimensions in the empirical data material.

Findings suggest that not just the number of mentions but the frequency of each SDG indicates specific corporate focuses. Table 3 details the prevalence of SDGs, revealing an emphasis on economic and environmental sustainability among businesses.

The table highlights differences among the three sustainability dimensions. Analysis of the interviews indicates that societal sustainability goals are less frequently mentioned in businesses compared to economic and environmental ones. An exception is goal 7, which stands out as it directly relates to technology and AI operations. This goal aims to "Ensure

access to affordable, reliable, sustainable, and modern energy for all" (UN 2024). This emphasizes the central role of energy management in AI implementation. Companies suggest that AI usage increases energy demands, underscoring the need for sustainable energy consumption in technology. Technologies like AI must operate sustainably to ensure energy consumption is neutral, promoting increased productivity.

4.2 The role of AI within the enterprises

This section delves into the role of AI in businesses to contextualize it with sustainability. Several of the companies report projects based on or incorporating AI technology. We highlight AI projects from Charlie, Echo, and Foxtrot to depict the diverse applications of AI, ranging from healthcare, sales, and transportation to disaster alerts and energy management.

Charlie shares an AI project enhancing elderly care, using AI and ML to assist dementia patients, monitor their sleep, and provide independent living solutions, allowing seniors to stay at home rather than moving to care facilities.

Echo employs technology for tasks previously human-monitored, such as creating virtual fences around airplanes using cameras to trigger alarms if boundaries are breached, enhancing security and efficiency.

Echo also combines AI with other technologies to innovate. They use AI weather models to predict track conditions, impacting chemical emissions, and employ predictive models for passenger arrival times, optimizing staff readiness and reducing passenger stress.

Analytical applications are common across companies using AI. Both Echo and Foxtrot discuss data analytics and predictive modeling. Foxtrot emphasizes big data analytics to identify patterns and establish data platforms for system development and IoT integration.

While Foxtrot is advancing in business intelligence and big data analytics, machine learning is less prevalent. Similarly, most companies investigated show some AI use but often at early stages or smaller scales. Foxtrot also applies AI to optimize energy supply, enhancing existing capacities based on real-time factors and demand.

Foxtrot's expert mentions a central data lake in Bergen integrating water supply monitoring with energy, climate, and environmental factors, leading to predictive analytics in what they term "smart-water management."

Based on findings, companies vary in AI implementation stages. Some have concrete AI projects, while others are still in planning phases. Table 4 summarizes the AI adoption status across the companies.

Tabell 4. Overview of the AI adoption within the enterprises

AI implementation / how far have the companies progressed?		
Idea / no AI	Pilot / starting with AI	Implemented / using AI
Echo	Alpha Foxtrot Hotel India	Bravo Charlie Delta Golf Juliet

4.3 Achieving the sustainability goals by utilizing AI

Companies emphasize aligning AI implementation with sustainability, treating AI as part of a broader digital transformation strategy. Without clear understanding and the purpose behind AI implementation, desired results will not be achieved. This is evident in companies where focus is placed on preparatory work and creating a conducive environment for AI adoption.

Delta highlights the need for a digital transformation to enable technologies like AI to make industries more efficient. Proper AI adoption involves integrating AI into sustainability efforts, ensuring people involved understand its purpose and utility. Poor follow-up and training can lead to AI project failures, even if the algorithms are sound.

Juliet emphasizes that the effectiveness of AI largely depends on a strong focus on end-users and stakeholders, underscoring the importance of educating them about its implications. While current AI projects show increased engagement and understanding compared to previous years, there remains substantial learning to be gathered from these initiatives.

Experts stress the need to design technology in alignment with sustainability objectives. Echo underscores the relevance of AI in response to increasing digitization in society and its pivotal role in sustainability endeavors. The efficiency inherent in AI can streamline various business functions, leading to cost reductions and enhanced operational uptime. This operational efficiency resonates with sustainability goals by curtailing wasteful practices, spanning energy consumption to resource management.

Echo expresses concern that, for a society to be sustainable, businesses must maintain profitability. AI must substantiate its economic outlay by delivering positive returns while also furthering sustainability objectives. Achieving a harmonious balance between economic viability and sustainability proves essential for successful AI adoption, a response echoed in expert discussions and the literature on IS. Without aligning intent and problem-solving strategies from the outset, AI initiatives risk failing across societal, economic, and environmental dimensions.

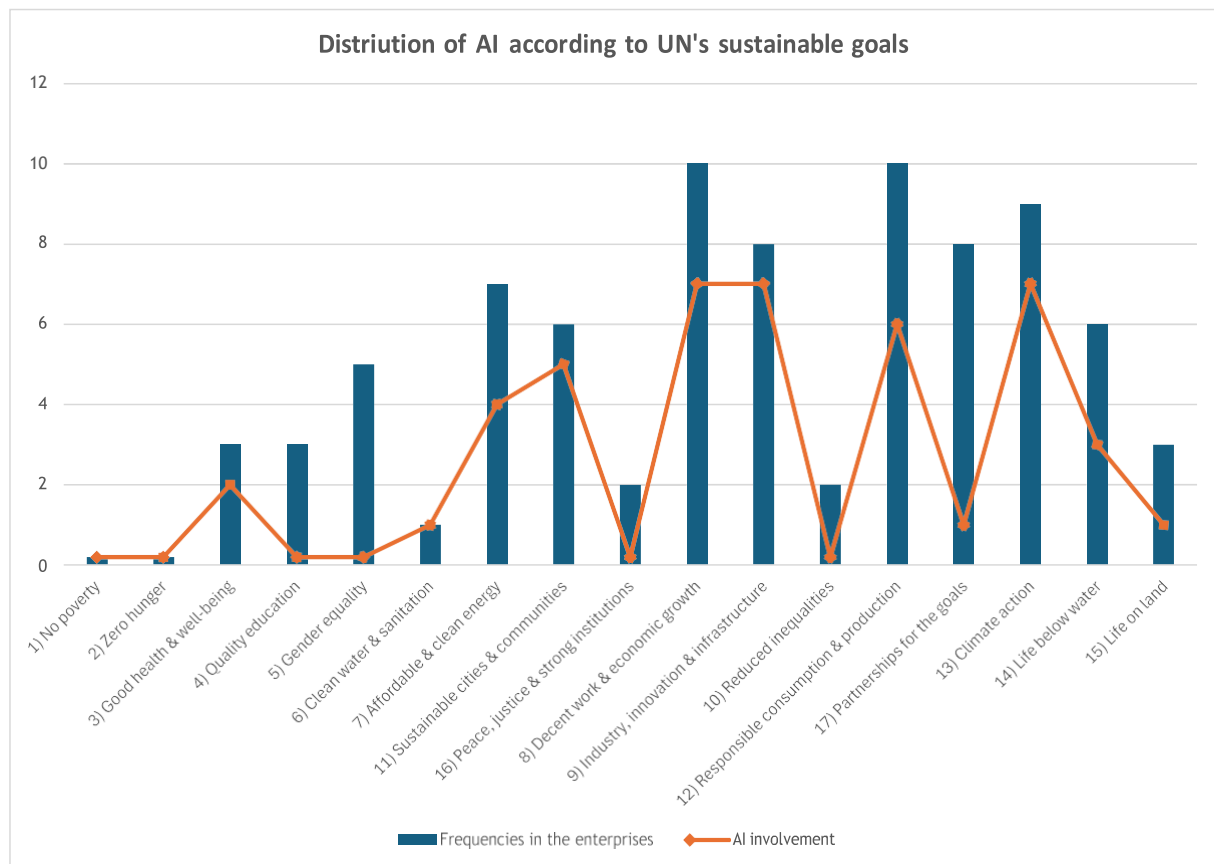


Figure 2. Distribution of AI according to the SDGs from UN.

The graph, based on Figure 2, depicts the frequency of sustainability goals within companies, with an overlapping line showing the potential impact of AI on these goals. This graph derives from codes gathered from all transcripts. The overlapping line titled "AI involvement" indicates the number of companies where AI intersects with specific sustainability goals. It interprets the extent to which AI influences these goals within companies. The graph highlights five prominent peaks corresponding to the sustainability goals: 11) Sustainable cities and communities, 8) Decent work and economic growth, 9) Industry, innovation, and infrastructure, 12) Responsible consumption and production, and 13) Climate action. The frequency indicates how many companies currently use or are working on AI initiatives to achieve parts of these sustainability goals.

4.4 The influence on the different SDGs

In the following, we will delve deeper into the potential of AI to act as a catalyst for sustainable development, presenting how AI aligns with various sustainability goals across businesses.

4.4.1 SDG 8: Decent Work and Economic Growth

SDG 8 aims to create high-quality jobs for all. According to the UN, achieving decent work and economic growth involves integrating youth into the workforce, ensuring predictable and safe workplaces, boosting female employment, reducing informal and illicit labor, and promoting sustainable economic growth, full employment, and decent work for all (UN 2024).

All companies recognize the importance of SDG 8, indicating a commitment to employee welfare and fostering a positive workplace environment. In examining AI as a catalyst for achieving sustainability goals, it is crucial to consider the impact of AI on jobs within these companies.

The main debate around AI and SDG 8 revolves around its potential to create, alter, or eliminate jobs. For companies, AI implementation primarily leads to efficiency gains, which can reduce workloads and possibly render some jobs redundant.

"Major industry leaders are fully embracing AI because it significantly reduces workloads and enhances efficiency." - Charlie

While digitalization, including AI implementation, brings transformative changes, it is intriguing to note the dual role of AI: not only potentially eliminating jobs but also creating new ones. Experts highlight that automation may shift job roles and required skills, emphasizing the need for companies to support their employees through these transitions.

"There will be a shift in skill requirements. Companies have a responsibility to facilitate this transition for their employees." - Echo

Despite potential job changes, experts stress the ongoing need for employee skills and adaptability. AI can not only modify job roles but also entirely eliminate them, prompting questions about the alignment of AI with SDG 8 for decent and safe work environments.

"With effective algorithms or machine learning, jobs can disappear. Organizations must ensure stability and support for at-risk employees." - Hotel

Beyond changing job roles, the economic benefits of AI also play a crucial role. A notable advantage is the potential of AI to directly create safer job environments by replacing humans in hazardous operations.

"Economically, AI can significantly reduce onboard crew costs, estimated at around 50% per ship, and also mitigate risks by removing personnel from dangerous tasks." - Alpha

In summary, successful AI implementation requires inclusive involvement. Companies identify human factors as the main uncertainty in AI adoption, emphasizing the importance of communication and employee support. While AI can both alter and create jobs, digitalization, based on interviews, tends to create more jobs than it eliminates, serving as an accelerator towards achieving SDG 8. Additionally, the potential of AI to create safer work environments is particularly relevant for industries like manufacturing and transportation, highlighting the role of AI in promoting secure job environments.

4.4.2 SDG 9: Industry, Innovation, and Infrastructure

Sustainability Goal 9 frequently connects with AI based on our interviews. The UN states: *"Infrastructure is the backbone for societal function. Investments in transport, water systems, energy, and information technology are essential for sustainable development"* (UN 2024). To achieve this goal, there is a need for increased focus on technology and science, explaining the strong link between AI and this sustainability goal.

While most companies do not prioritize this goal, it resonates deeply with AI, as highlighted by industry participants. One expert suggests that the potential of AI is most significant in achieving SDG 9:

"... it is sustainability goal 9. I believe that is where it hits the most. We need to connect technology and utilize data smarter to optimize resources." - Golf

Golf emphasizes the role of AI in creating smarter businesses. For AI to integrate with existing technologies and data, businesses need robust infrastructure and high data quality. SDG 9 encapsulates IT as part of sustainable industrialization and innovation, making it an area where AI naturally fits. Experts underscore the potential of AI in innovating with data. This potential is evident in areas such as infrastructure and transportation, where AI can play a pivotal role. Foxtrot, for instance, has leveraged AI to optimize public transport:

"In Rogaland [west region in Norway], we optimized public transportation using AI, ensuring that transit modes operate at regular intervals." - Foxtrot

Foxtrot detailed AI-driven efforts to enhance public transport through autonomy, predictions, and optimization. The capabilities of AI hold promise for sustainable solutions, a response echoed by an expert from Echo. AI can help build efficient transport systems, supporting SDG 11.2, which emphasizes safe, accessible, and sustainable transport systems.

4.4.3 SDG 11: Sustainable Cities and Communities

In Norwegian business, AI is frequently highlighted as a contributor to SDG 11, which aims to make cities and communities inclusive, safe, resilient, and sustainable (UN 2024). AI aids businesses in making sustainable choices, especially supporting sub-goals 11.2 and 11.5. For instance, Golf uses AI to optimize energy production and predict future population and industrial growth, guiding sustainable community development. AI-driven machine learning evaluates if and how communities should expand, exemplified by power grids.

Foxtrot employs AI as predictive tools for decision-making related to water usage, identifying anomalies and leaks for better water resource management. Additionally, AI aids in disaster management, predicting potential dangers like dam leaks and floods, thereby reducing damage, costs, and human losses.

Charlie sees AI as a catalyst for sustainable IoT solutions. They use AI-driven machine learning to process IoT data for smart building predictions, aiding in decision-making to support home care and reduce strain on healthcare systems. While primarily aligning with health-focused SDG 3, the application of AI also positively impacts SDG 8 and 11, promoting decent work conditions and innovating urban areas where healthcare services and the elderly reside.

4.4.4 SDG 12: Responsible Consumption and Production

AI is frequently mentioned in relation to its impact on SDG 12. The use of AI promotes smarter choices, leading to efficient and sustainable operations. It can help reduce waste, such as one-third of food produced but not consumed (UN 2024). Experts often discussed this goal, indicating a significant link between AI and SDG 12.

AI aids sustainability by enhancing efficiency in daily operations and production. Juliet highlighted the positive impact of AI on sustainability by improving supply chain efficiency, potentially reducing emissions by up to 5%.

Energy consumption is crucial in AI usage. Experts distinguish between on-premise solutions and cloud services, with cloud services often seen as essential to fully harness the potential of AI. A study by Bravo revealed that public cloud solutions were more effective in data centers in 79-93% of cases due to operational efficiency and cost benefits. However, the increased consumption of data centers also raises concerns about energy usage.

To harness the potential of AI sustainably, there is a need to address its energy consumption, linking to SDG 7. Juliet suggested incorporating AI to manage its own computing power to balance energy consumption.

Cloud services and energy consumption by data centers were also discussed by Bravo. The expert compared it to personal consumption, advocating for replacing old technology with efficient ones or turning off unused systems to reduce energy consumption. However, opinions varied on the cost-effectiveness of cloud solutions.

Delta highlighted sustainable development through AI by reusing data and methods. For instance, recognizing animals like cats and dogs can be used to recognize humans, optimizing data usage.

Companies emphasize the role of AI in promoting responsible consumption, such as predicting customer bread needs to reduce food waste. Charlie's example directly addresses food waste concerns by using AI for predictive analytics in ordering bread.

In conclusion, AI can significantly impact SDG 12 by enhancing operational efficiency, reducing waste, and promoting responsible consumption and production, as highlighted by Juliet: *"Increasing operational efficiency and therefore having a sustainability outcome,"* aligning with the fight against climate change, SDG 13.

4.4.5 SDG 13: Climate Action

To combat climate change, emissions must decrease. Businesses are exploring AI as a tool to reduce emissions and make environmentally conscious decisions. For instance, Alpha uses AI for port and transportation planning, enhancing efficiency and reducing inactive time and CO₂ emissions. Echo emphasizes fuel-saving simulations for flights, illustrating significant fuel savings even with small adjustments.

Bravo highlights the role of AI in energy conservation, correlating to reduced carbon emissions through responsible consumption. Golf suggests AI can optimize personal energy use, like turning off heating systems or charging electric cars during peak electricity prices. The ability of AI to manage consumption can further reduce carbon emissions. Additionally, reducing food waste, as mentioned under SDG 12, contributes to climate change mitigation.

Beyond emission reduction, the predictive capabilities of AI help society adapt to and mitigate climate-related risks and natural disasters. Foxtrot is piloting AI for predictive maintenance and climate impact analysis, such as flood monitoring.

4.5 Summary

To understand the potential of AI as a catalyst for achieving sustainability, we compiled all sustainability goals from the analysis into Table 5, highlighting the role of AI in advancing key sustainability goals identified in our study.

Table 5. AI and sustainability in the companies

Key Insights from Interviews - Achieving Sustainability Goals with AI				
SDG 8	SDG 9	SDG 11	SDG 12	SDG 13
Job Elimination Developing New Jobs - Transition Ensuring Occupational Safety (HMS) Removing People from Hazardous Operations Safe/Comfortable Working Conditions	Innovative Solutions with AI Infrastructure Requirements Traffic Improvement Smart Data Usage	Decision-making for Development Grid Development/Reinvestment Smart Cities Smart Homes Disaster management Processing Sustainability through IoT Facilitating Goal 8	Efficiency Optimization Energy Consumption in Servers and Data Centers Cloud Services as AI Foundation Resource Consumption Reduction with AI Reducing Food Waste Self-evolving AI Optimizing Transportation and Flow Reducing CO2 Emissions Monitoring Conditions - Adapting to Natural Disasters, Early Warning	Optimize transport and logistics Reduce CO2 emissions Monitor conditions - adapt to natural disasters. Early warning

5. Discussion

Results from the study highlight the prioritization of sustainability among participating businesses and the prevalence of AI usage within these companies and their customers. Norwegian firms employ AI for sustainable purposes aligned with the sustainability goals initiated by UN. This chapter discusses the findings in relation to the research question, existing literature, and implications for practice and further research.

5.1 Artificial intelligence and sustainability

This study stands out by focusing on the role of AI in sustainability, an area with limited prior research. Drawing from existing studies, our research contributes empirical evidence to the question: *"What are the relationships between sustainable development and artificial intelligence?"* Interviews revealed varying emphasis on AI and sustainability across companies. Figure 1 in section 4.1 shows broad focus on certain sustainability goals across companies, while Figure 2 in section 4.3 illustrates the alignment of AI with sustainability focus. Notably, goals 8, 9, 11, 12, and 13 were most associated with AI, consistent with existing literature.

Vinuesa et al. (2020) and Schoormann et al. (2021) suggest that AI predominantly impacts the social dimension of sustainability. However, our expert interviews indicated a stronger AI influence on economic sustainability. This discrepancy may stem from our focus on economic aspects or the broader societal coverage of sustainability goals.

Vinuesa et al. (2020) state: *"AI may act as an enabler for all the targets by supporting the provision of food, health, water, and energy services to the population."* This aligns with our findings on how Norwegian companies promote sustainability using AI. The potential impact of AI on production efficiency (SDG 12) often overlaps with responsible consumption and production (SDG 7) in the findings. AI can improve production efficiency but does also affect energy consumption, necessitating clean and renewable energy for truly sustainable AI solutions.

To understand discrepancies between our findings and prior literature, we examine positive and negative AI effects. Vinuesa et al. (2020) mainly highlight positive AI impacts on sustainability, consistent with our results. The predominance of positive findings in prior research might align with any SDG highlighted in our study. Our experts largely viewed AI positively, contrasting with some negative aspects highlighted in previous studies.

5.2 Ethical Considerations

In the expert interviews, few negative impacts on sustainability goals from AI implementation are identified. Businesses emphasize the opportunities and advantages of technologies. However, concerns are noted in the social and economic dimensions of sustainability, particularly affecting SDGs 7 and 8.

The ethical considerations as regards AI involve increased processing power and energy consumption which is related to SDG 7. This raises questions about the ethical use of energy by businesses, potential energy shortages, and impacts on vulnerable regions. Goal 7 focuses on ensuring universal access to reliable, sustainable energy (UN 2024). For AI to be utilized sustainably, it must be energy-efficient, as highlighted in both literature (Jha et al. 2017) and the interview with Juliet. If the energy consumption by utilizing AI is not optimized, it could negatively impact SDG 7, leading to increased electricity prices and compromising energy sustainability.

Concerning SDG 8, AI implementation could threaten jobs, affecting employees as technology takes over human-operated roles. This aligns with prior research indicating that AI could result in fewer jobs or insecure employment, contrary to the focus on education and skills in previous

studies. Despite goal 8 being mentioned in literature, our interviews with businesses indicated it as the most prominent negative impact.

Another issue with AI use, particularly in terms of privacy, is evident. Previous research highlights responsible exploitation and ethical dilemmas surrounding the technology (Truby 2020; Vakkuri et al. 2021). This study introduces privacy and legislation as barriers to maximizing the potential of AI. Some businesses face challenges accessing AI due to regulatory limitations from Data Protection Authority. Participants express frustration over governmental decisions hindering technology deployment, pointing to the awareness and competence of decision-makers as potential causes. Echo mentions missed opportunities, like using facial recognition for eco-friendly ticketing, due to lack of approval. They further note this occurs in Europe, granting competitive advantages missed by Norwegian entities.

Literature also suggests AI could exacerbate wage disparities (Oluwaseyi and Cena 2024). A US study indicated a 25% increase in wages for higher education and a 30% decrease for those without (Vinuesa et al. 2020). Given our focus on Norwegian businesses, these statistics might differ due to factors like higher taxes. While previous research emphasized the potential of the negative impact of AI regarding SDG 10, our interviews showed limited discussion and no clear link between AI and the goal.

The challenges of AI in India reflect ethical and political issues. Legal complexities and government data handling limitations hinder AI utilization (Wirtz et al. 2020). While there is a desire to harness more AI/ML for better services, facilitating this is challenging due to slow-paced regulatory processes. The expert from India highlights the importance of the slow democratic processes to prevent misuse of governmental data.

Engagement is key to expedite changes aligned with sustainability goals. Previous studies emphasize the need for controlled AI adoption to prevent potential societal consequences (Truby 2020). Effective governance is crucial. India's bureaucratic processes, especially legislation, pose significant hurdles for AI implementation. However, such criteria may also prevent irresponsible development, ensuring AI aligns with sustainability goals.

E-health is particularly affected by these challenges (Panch et al. 2019; Vinuesa et al. 2020). Despite abundant patient data, privacy concerns obstruct AI and ML utilization. For instance, challenges in data ownership and governance impact projects like Charlie, which monitors the elderly in their homes. This highlights the need for future research on sustainable development enabled by AI while preserving privacy to harness its potential fully.

5.3 Research Implications

Future research should combine qualitative studies with quantitative data to generalize findings. While this study delved deeply into sustainability perspectives from individual participants in businesses, subsequent research should quantify these findings for broader practice application. Emphasis should be on refining guidelines for sustainable AI use. A qualitative approach was chosen due to limited prior research in this emerging field, both in sustainability (Watson et al. 2021) and AI for sustainable development (Tomašev et al. 2020).

However, a quantitative approach could offer more generalized results, especially when examining AI maturity.

One challenge was determining the stage of AI implementation in businesses using qualitative data. A mixed methods approach could be beneficial, employing questionnaires to categorize businesses based on their AI maturity. This would allow us to link the emphasis on sustainability in businesses to their level of AI maturity.

This study distinguishes between internal and external sustainability focus within the IT industry. IT consultancies, for instance, prioritize external sustainability, transferring internal practices to clients. Future research should explore the varying impacts of different IT sectors on sustainability to understand the reasons behind this focus variation in Norway.

Further research should address the ethical considerations discussed, linking these dilemmas to AI usage, and avoiding potential negative consequences. Investigating the relationship between sustainability goals 7 and 12 is essential to explore the potential of AI in renewable energy and efficient production.

5.4 Practical implications

Our findings highlight important practical implications. Norwegian businesses, particularly in the IT sector, demonstrate a strong tendency to collaborate across sectors to meet the SDGs. Notably, they engage more actively in global partnerships than previously recognized in existing research.

For example, GoForIT operates as a bridge between academia and industry to advance sustainability initiatives (Krogstie 2023). Both Delta and Bravo applaud this collaborative approach. Additionally, while companies recognize the significance of SDG 17, there is often a limited understanding of its comprehensive scope. The UN emphasizes that achieving the SDGs hinges on robust partnerships across governments, businesses, and civil society (UN 2024).

A key challenge lies in companies prioritizing collaboration over competition when pursuing sustainability goals. Businesses should set sustainability benchmarks and encourage others to participate in joint initiatives, such as GoForIT.

Drawing from our study and existing research, we offer concise recommendations for effectively leveraging AI sustainably. These insights aim to harness the potential of AI as a catalyst in realizing the SDGs from UN by 2030.

Our Recommendations:

- Establish a robust AI implementation infrastructure.
- Maintain clear motivation and purpose for AI deployment.
- Incorporate incentives aligned with sustainability goals.
- Adopt AI deployment on cloud services.
- Adhere to universal sustainability reporting standards.
- Integrate sustainability reporting for investments and financial support.
- Foster global partnerships with appropriate thoroughness on sustainability goals.

- Prioritize energy efficiency and decent work practices.

6. Conclusion

The study interprets alignment of enterprises with specific SDGs, identifying the potential positive impact of AI on SDGs 8, 9, 11, 12, and 13. However, challenges associated with AI were also highlighted, particularly concerning SDG 7 and 8. While AI can expedite progress towards these goals, it may increase electricity costs due to its energy demands and potentially replace jobs, posing employment risks. Ethical dilemmas related to AI, such as data privacy concerns, were also discussed.

This qualitative exploration, involving eleven expert interviews from ten enterprises, provides nuanced insights into the relationship between sustainability and AI within the context of the SDGs from UN. Despite varying sustainability focuses across businesses, SDG 8 and 12 emerged as consistent priorities. Consultancy firms, with their capacity to influence clients, demonstrated distinct approaches to internal and external sustainability.

The research identified three AI adoption stages in enterprises: planning, pilot, and full implementation. AI demonstrates substantial potential as a sustainability catalyst but presents challenges in specific goal areas. Ethical AI deployment emerged as pivotal for successful sustainable development.

Given the qualitative scope of this study, generalizing its findings to the broader Norwegian IT industry requires caution. Consequently, we advocate for complementing this qualitative inquiry with quantitative research to ascertain the broader implications of AI on sustainability. This study underscores the economic and environmental dimensions as the primary sustainability impact areas of AI and offers practical recommendations for sustainable AI implementation.

References

- Akbarighatar, P., Pappas, I., and Vassilakopoulou, P. 2023. "A Sociotechnical Perspective for Responsible Ai Maturity Models: Findings from a Mixed-Method Literature Review," *International Journal of Information Management Data Insights* (3:2), p. 100193.
- Baldi, F., and Pandimiglio, A. 2022. "The Role of Esg Scoring and Greenwashing Risk in Explaining the Yields of Green Bonds: A Conceptual Framework and an Econometric Analysis," *Global Finance Journal* (52), p. 100711.
- Benbya, H., Davenport, T. H., and Pachidi, S. 2020. "Artificial Intelligence in Organizations: Current State and Future Opportunities," *MIS Quarterly Executive* (19, Article 4:4), p. 15 pages.
- Chege, S. M., and Wang, D. 2020. "The Influence of Technology Innovation on Sme Performance through Environmental Sustainability Practices in Kenya," *Technology in Society* (60), p. 101210.
- Chen, A. J., Boudreau, M. C., and Watson, R. T. 2008. "Information Systems and Ecological Sustainability," *Journal of systems and information technology* (10:3), pp. 186-201.
- Corbett, J., and Mellouli, S. 2017. "Winning the Sdg Battle in Cities: How an Integrated Information Ecosystem Can Contribute to the Achievement of the 2030 Sustainable Development Goals," *Information Systems Journal* (27:4), pp. 427-461.
- Corbin, J. 2007. "Memos and Diagrams," *Journal of Qualitative Research*, pp. 25-46.
- Davenport, T. H., and Ronanki, R. 2018. "Artificial Intelligence for the Real World," *Harvard business review* (96:1), pp. 108-116.

- Denicolai, S., Zucchella, A., and Magnani, G. 2021. "Internationalization, Digitalization, and Sustainability: Are Smes Ready? A Survey on Synergies and Substituting Effects among Growth Paths," *Technological Forecasting and Social Change* (166), p. 120650.
- Duan, Y., Edwards, J. S., and Dwivedi, Y. K. 2019. "Artificial Intelligence for Decision Making in the Era of Big Data—Evolution, Challenges and Research Agenda," *International journal of information management* (48), pp. 63-71.
- Dubé, L., and Robey, D. 1999. "Software Stories: Three Cultural Perspectives on the Organizational Practices of Software Development," *Accounting, Management and Information Technologies* (9:4), pp. 223-259.
- Dyllick, T., and Muff, K. 2016. "Clarifying the Meaning of Sustainable Business: Introducing a Typology from Business-as-Usual to True Business Sustainability," *Organization & environment* (29:2), pp. 156-174.
- Elkington, J. 1997. "Cannibals with Forks: The Triple Bottom Line of 21st Century Business, Capstone." Oxford Capstone, London.
- Fernandes, C. I., Veiga, P. M., Ferreira, J. J., and Hughes, M. 2021. "Green Growth Versus Economic Growth: Do Sustainable Technology Transfer and Innovations Lead to an Imperfect Choice?," *Business Strategy and the Environment* (30:4), pp. 2021-2037.
- Feroz, A. K., Zo, H., and Chiravuri, A. 2021. "Digital Transformation and Environmental Sustainability: A Review and Research Agenda," *Sustainability* (13:3), p. 1530.
- Flak, L. S., and Hofmann, S. 2020. "The Impact of Smart City Initiatives on Human Rights," *EGOV-CeDEM-ePart 2020*, p. 165.
- Fui-Hoon Nah, F., Zheng, R., Cai, J., Siau, K., and Chen, L. 2023. "Generative Ai and Chatgpt: Applications, Challenges, and Ai-Human Collaboration," *Journal of Information Technology Case and Application Research* (25:3), pp. 277-304.
- Halagatti, M., Gadag, S., Mahantshetti, S., Hiremath, C. V., Tharkude, D., and Banakar, V. 2023. "Artificial Intelligence: The New Tool of Disruption in Educational Performance Assessment," in *Smart Analytics, Artificial Intelligence and Sustainable Performance Management in a Global Digitalised Economy*. Emerald Publishing Limited, pp. 261-287.
- Hansen, E. B., and Bøgh, S. 2021. "Artificial Intelligence and Internet of Things in Small and Medium-Sized Enterprises: A Survey," *Journal of Manufacturing Systems* (58), pp. 362-372.
- IPCC. 2024. "Sixth Assessment Report." Retrieved 15. march 2024, 2024, from <https://www.ipcc.ch/assessment-report/ar6/>
- Jan, Z., Ahamed, F., Mayer, W., Patel, N., Grossmann, G., Stumptner, M., and Kuusk, A. 2023. "Artificial Intelligence for Industry 4.0: Systematic Review of Applications, Challenges, and Opportunities," *Expert Systems with Applications* (216), p. 119456.
- Jha, S. K., Bilalovic, J., Jha, A., Patel, N., and Zhang, H. 2017. "Renewable Energy: Present Research and Future Scope of Artificial Intelligence," *Renewable and Sustainable Energy Reviews* (77), pp. 297-317.
- Krogstie, J. 2023. "Development of a Toolbox on Sustainable Ict across Industry and Academia: The Goforit Project," *Norsk IKT-konferanse for forskning og utdanning*.
- Kumar, S., Raut, R. D., and Narkhede, B. E. 2020. "A Proposed Collaborative Framework by Using Artificial Intelligence-Internet of Things (Ai-Iot) in Covid-19 Pandemic Situation for Healthcare Workers," *International Journal of Healthcare Management* (13:4), pp. 337-345.
- Kvale, S., and Brinkmann, S. 2009. *Interviews: Learning the Craft of Qualitative Research Interviewing*. Los Angeles, Calif.: Sage.
- Lacity, M., Willcocks, L., and Gozman, D. 2021. "Influencing Information Systems Practice: The Action Principles Approach Applied to Robotic Process and Cognitive Automation," *Journal of Information Technology* (36:3), pp. 216-240.
- Lindseth, H., and Rygg, J. 2022. "Sammenhenger Mellom Bærekraftig Utvikling Og Kunstig Intelligens." UiA Aura.

- Meuser, M., and Nagel, U. 2009. "The Expert Interview and Changes in Knowledge Production," in *Interviewing Experts*, A. Bogner, B. Littig and W. Menz (eds.). London: Palgrave Macmillan UK, pp. 17-42.
- Mikalef, P., Conboy, K., Lundström, J. E., and Popovič, A. 2022. "Thinking Responsibly About Responsible Ai and 'the Dark Side' of Ai." Taylor & Francis, pp. 257-268.
- Miles, M. B., Huberman, A. M., and Saldaña, J. 2018. *Qualitative Data Analysis: A Methods Sourcebook*. Sage publications.
- Maass, W., Parsons, J., Purao, S., Storey, V. C., and Woo, C. 2018. "Data-Driven Meets Theory-Driven Research in the Era of Big Data: Opportunities and Challenges for Information Systems Research," *Journal of the Association for Information Systems* (19:12), p. 1.
- Nishant, R., Kennedy, M., and Corbett, J. 2020. "Artificial Intelligence for Sustainability: Challenges, Opportunities, and a Research Agenda," *International Journal of Information Management* (53), p. 102104.
- Oluwaseyi, J., and Cena, J. 2024. "Analyzing the Impact of Artificial Intelligence on Job," *STATISTICS* (14:1), pp. 150-155.
- Orlikowski, W. J., and Baroudi, J. J. 1991. "Studying Information Technology in Organizations: Research Approaches and Assumptions," *Information Systems Research* (2:1), pp. 1-28.
- Panch, T., Mattie, H., and Celi, L. A. 2019. "The "Inconvenient Truth" About Ai in Healthcare," *NPJ digital medicine* (2:1), pp. 1-3.
- Pappas, I. O., Mikalef, P., Dwivedi, Y. K., Jaccheri, L., and Krogstie, J. 2023. "Responsible Digital Transformation for a Sustainable Society," *Information Systems Frontiers* (25:3), pp. 945-953.
- Saldaña, J. 2021. *The Coding Manual for Qualitative Researchers*. ebook: Sage Publications Ltd.
- Sarker, S., Lau, F., and Sahay, S. 2001. "Using an Adapted Grounded Theory Approach for Inductive Theory Building About Virtual Team Development," *ACM SIGMIS Database: the DATABASE for Advances in Information Systems* (32:1), pp. 38-56.
- Schoormann, T., Strobel, G., Möller, F., and Petrik, D. 2021. "Achieving Sustainability with Artificial Intelligence—a Survey of Information Systems Research," *Proceedings of ICIS*.
- Seidel, S., Bharati, P., Fridgen, G., Watson, R. T., Albizri, A., Boudreau, M.-C. M., Butler, T., Kruse, L. C., Guzman, I., and Karsten, H. 2017. "The Sustainability Imperative in Information Systems Research," *Communications of the Association for Information Systems* (40:1), p. 3.
- Song, M., Fisher, R., and Kwok, Y. 2019. "Technological Challenges of Green Innovation and Sustainable Resource Management with Large Scale Data," *Technological Forecasting and Social Change* (144), pp. 361-368.
- Tan, S. 2023. "Harnessing Artificial Intelligence for Innovation in Education," in *Learning Intelligence: Innovative and Digital Transformative Learning Strategies: Cultural and Social Engineering Perspectives*. Springer, pp. 335-363.
- Tomašev, N., Cornebise, J., Hutter, F., Mohamed, S., Picciariello, A., Connelly, B., Belgrave, D. C., Ezer, D., Haert, F. C. v. d., and Mugisha, F. 2020. "Ai for Social Good: Unlocking the Opportunity for Positive Impact," *Nature Communications* (11:1), p. 2468.
- Truby, J. 2020. "Governing Artificial Intelligence to Benefit the Un Sustainable Development Goals," *Sustainable Development* (28:4), pp. 946-959.
- Turner, D. 2016. "Triangulation in Qualitative Research." Retrieved October 15, 2020, from <https://www.quirkos.com/blog/post/triangulation-in-qualitative-research-analysis/>
- UN. 2016. "Paris Agreement." Retrieved 15th of January, 2024, from <https://www.un.org/en/climatechange/paris-agreement>
- UN. 2024. "United Nations: Getting to Know the Sustainable Development Goals." Retrieved 15 March, 2020, from <https://www.un.org/sustainabledevelopment/sustainable-development-goals/>
- Vakkuri, V., Kemell, K.-K., Jantunen, M., Halme, E., and Abrahamsson, P. 2021. "Eccola—a Method for Implementing Ethically Aligned Ai Systems," *Journal of Systems and Software* (182), p. 111067.
- Vassilakopoulou, P., Haug, A., Salvesen, L. M., and Pappas, I. O. 2023. "Developing Human/Ai Interactions for Chat-Based Customer Services: Lessons Learned from the Norwegian Government," *European journal of information systems* (32:1), pp. 10-22.

- Vassilakopoulou, P., and Hustad, E. 2023. "Bridging Digital Divides: A Literature Review and Research Agenda for Information Systems Research," *Information Systems Frontiers* (25:3), pp. 955-969.
- Venkateswaran, P., Ayasrah, F. T. M., Nomula, V. K., Paramasivan, P., Anand, P., and Bogeshwaran, K. 2024. "Applications of Artificial Intelligence Tools in Higher Education," in *Data-Driven Decision Making for Long-Term Business Success*. IGI Global, pp. 124-136.
- Vinuesa, R., Azizpour, H., Leite, I., Balaam, M., Dignum, V., Domisch, S., Felländer, A., Langhans, S. D., Tegmark, M., and Fuso Nerini, F. 2020. "The Role of Artificial Intelligence in Achieving the Sustainable Development Goals," *Nature communications* (11:1), pp. 1-10.
- Walsham, G. 1995. "Interpretive Case Studies in Is Research: Nature and Method," *European Journal of Information Systems* (4:2), pp. 74-81.
- Walsham, G. 2006. "Doing Interpretive Research," *European Journal of Information Systems* (15:3), pp. 320-330.
- Watson, R. T., Elliot, S., Corbett, J., Farkas, D., Feizabadi, A., Gupta, A., Iyer, L., Sen, S., Sharda, R., and Shin, N. 2021. "How the Ais Can Improve Its Contributions to the Un's Sustainability Development Goals: Towards a Framework for Scaling Collaborations and Evaluating Impact," *Communications of the Association for Information Systems* (48:1), p. 42.
- Wirtz, B. W., Weyerer, J. C., and Sturm, B. J. 2020. "The Dark Sides of Artificial Intelligence: An Integrated Ai Governance Framework for Public Administration," *International Journal of Public Administration* (43:9), pp. 818-829.
- Zhang, Y., Sun, J., Yang, Z., and Wang, Y. 2020. "Critical Success Factors of Green Innovation: Technology, Organization and Environment Readiness," *Journal of cleaner production* (264), p. 121701.
- Ågerfalk, P. J., Conboy, K., Crowston, K., Eriksson Lundström, J., Jarvenpaa, S. L., Ram, S., and Mikalef, P. 2022. "Artificial Intelligence in Information Systems: State of the Art and Research Roadmap," *Communications of the Association for Information Systems* (50:1), pp. 420-438.

Proposals on the reformation of personal income taxation in Greece

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Abstract

The research presents the main results of the questionnaire, answered by tax experts and connoisseurs, with important proposals for the reformation of the Greek tax system regarding personal income taxation and the presentation of the principles on which the formulation of tax policy should be based in relation to the measures for tax system reform.

There are analytical proposals for money transfer system in third world countries mainly to ensure control and taxation of money transfers made through payment institutions, measures to tackle tax evasion, to simplify the tax system, for the objective living expenses (presumptions) for the determination of the tax base and on the establishment of a fair tax system.

Finally, the objectives of the tax policy are presented in order of importance as evaluated by experts according to their sector of employment in the public, private sector. The tax reforms that must be made with the aim of modernizing and harmonizing the tax system, in order to have the expected results and should be designed based on the peculiarities of the Greek economy and the international trends in this field.

Keywords: tax reformation, personal income tax, structural measures

A. Introduction

In every tax system there are regulations which, for mainly economic or social reasons, grant favorable treatment to groups of taxpayers, categories of economic activity or forms of income. This preferential treatment is granted in the form of tax exemptions, deductions or deductions from income subject to taxation, tax reductions, reduced tax rates, etc. Although these regulations entail a significant reduction in tax revenues, they exist in the tax system because they meet specific needs or because it is estimated that the benefit of granting them is greater than their cost, although their cost is not usually known. The tax breaks resemble in many ways hidden subsidies or indirect transfers of the state to taxpayers. They pursue the same objectives, and the corresponding direct costs provide the same benefit to beneficiaries in the form of a reduction in the tax liability as direct costs.

The results of the questionnaire, which was answered by tax experts and experts, are presented, with important proposals for the reform of the Greek tax system through the implementation of specific measures. The research concludes with the presentation of the principles on which tax policy making should be based in relation to the measures for the reform of the tax system, after processing the answers to the survey questionnaire, the proposals of scientific committees and professional associations, the studies from the international bibliography as well as the study of the economic data of personal income tax for the period 1974-2020.

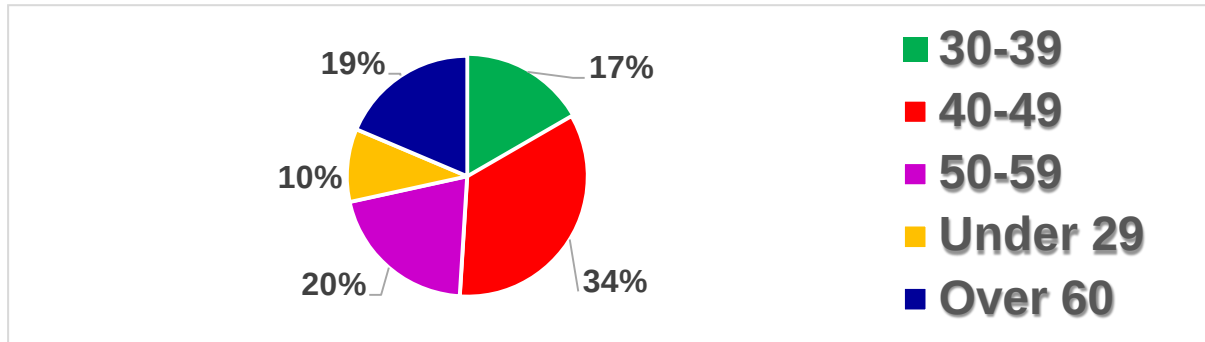
The imposition of taxes in modern states serves on the one hand fiscal purposes and on the other socio-political purposes. The State aims primarily at saving the resources that are necessary to serve the needs of all kinds of citizens, public safety, public health, education, administration of justice, etc. It is considered as an obvious duty of the citizens, because the tax is not only income but also a means of exercising economic (stabilization and development of the country) and social policy (combating the unequal distribution of wealth).

B. Questionnaire structure

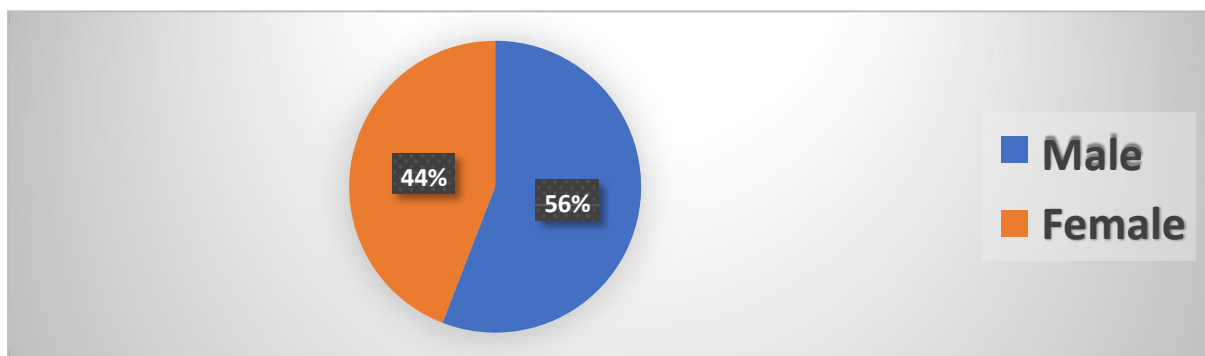
In the context of the personal income tax survey, an academic questionnaire was developed and the anonymity of the person completing the questionnaire was strictly observed. It was answered by tax experts in both the public and private sectors.

The questions were structured in such a way as to extract the detailed proposals of specialized and leading tax scientists as well as there was the possibility of freely capturing proposals beyond the narrow limits of the choices of a question. The demographic data are as follows:

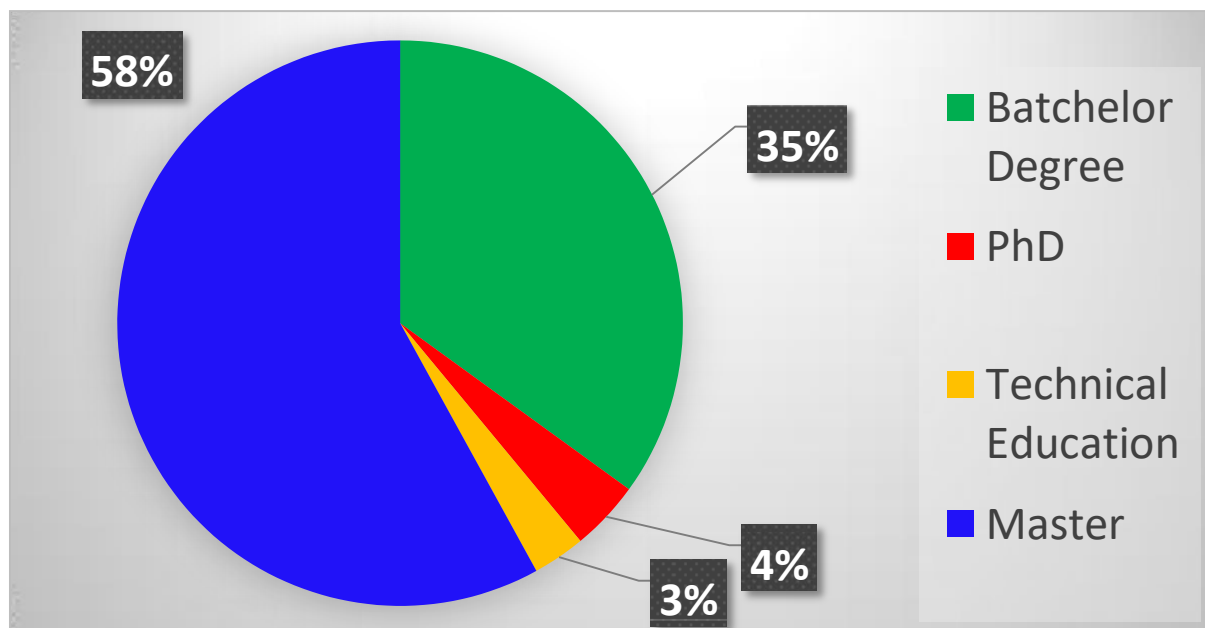
Age



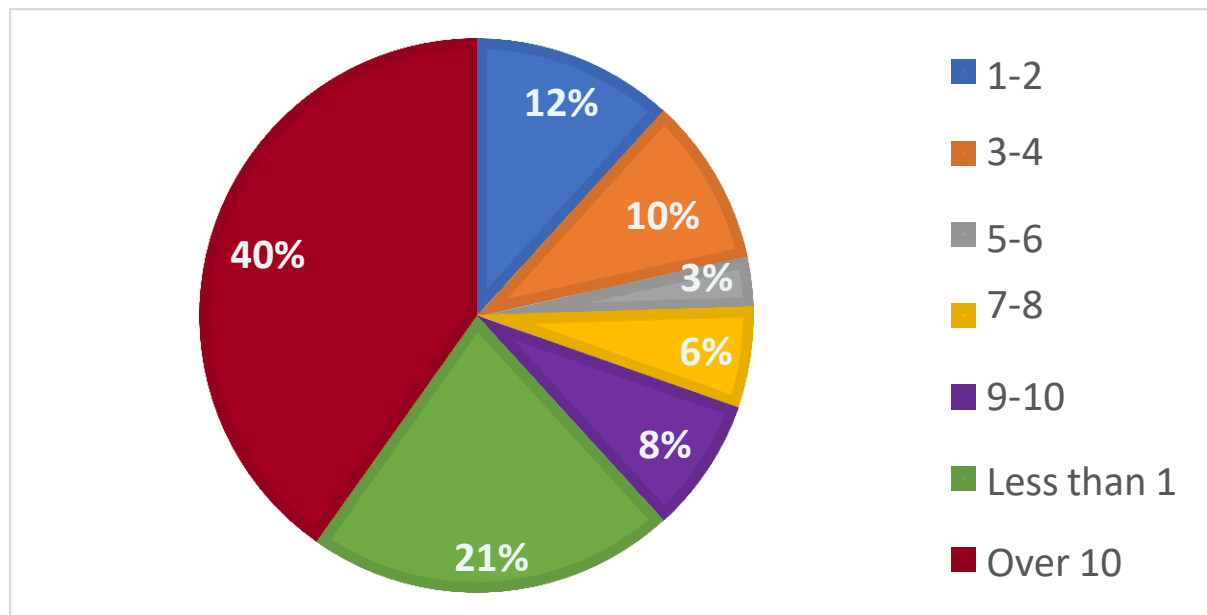
Gender



Level of study



Years of involvement in Taxation issues

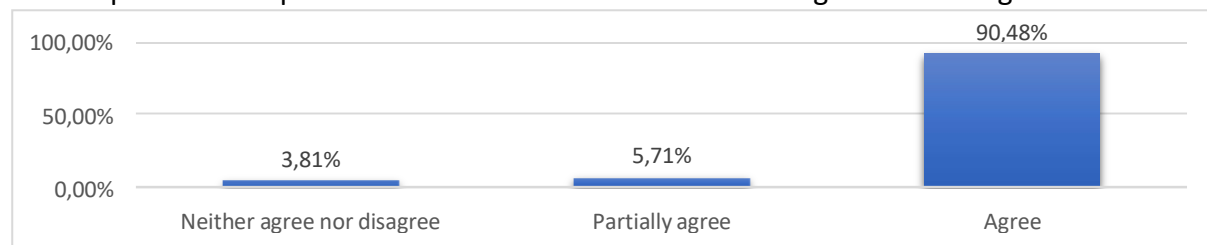


C. Questionnaire results

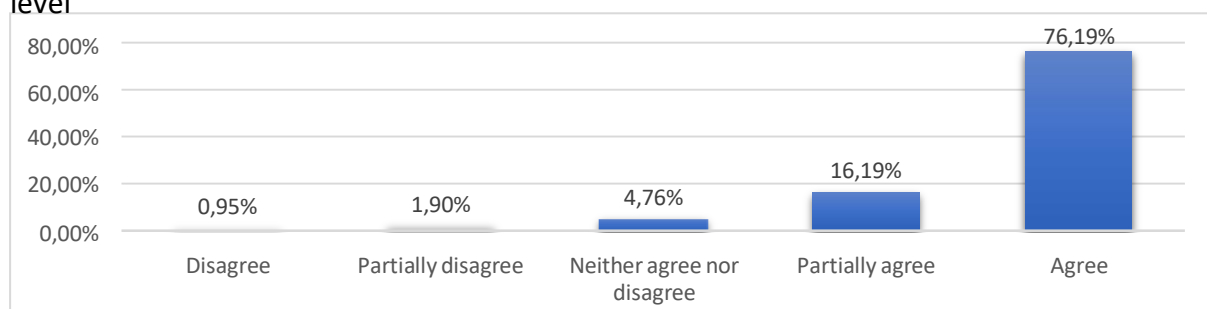
The processing of the questionnaire responses reveals the following findings:

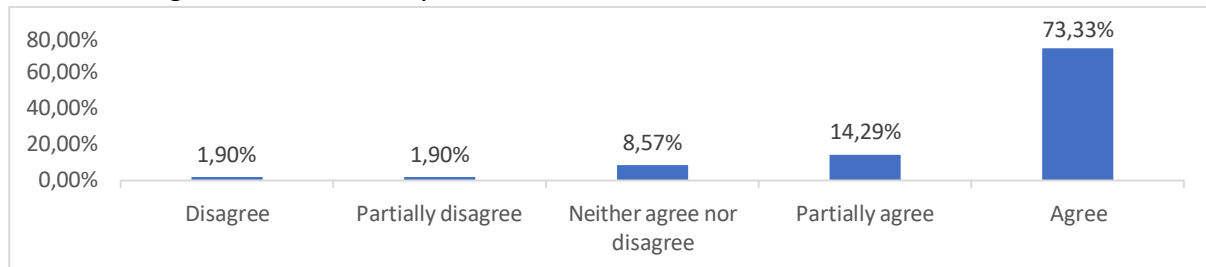
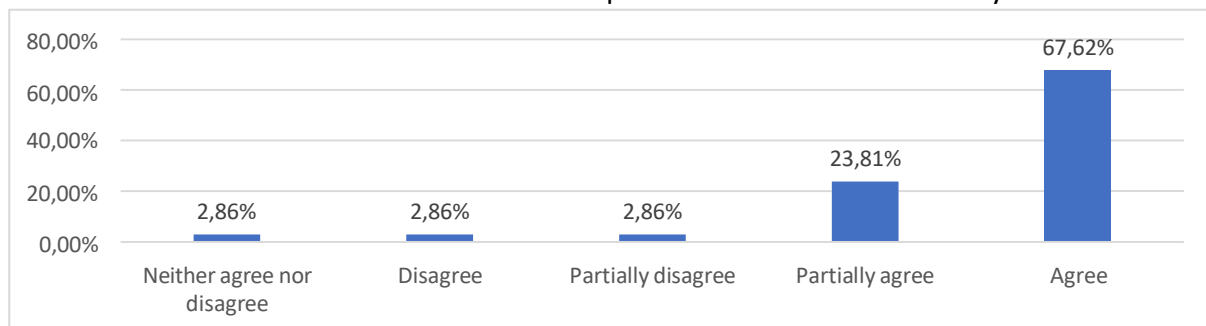
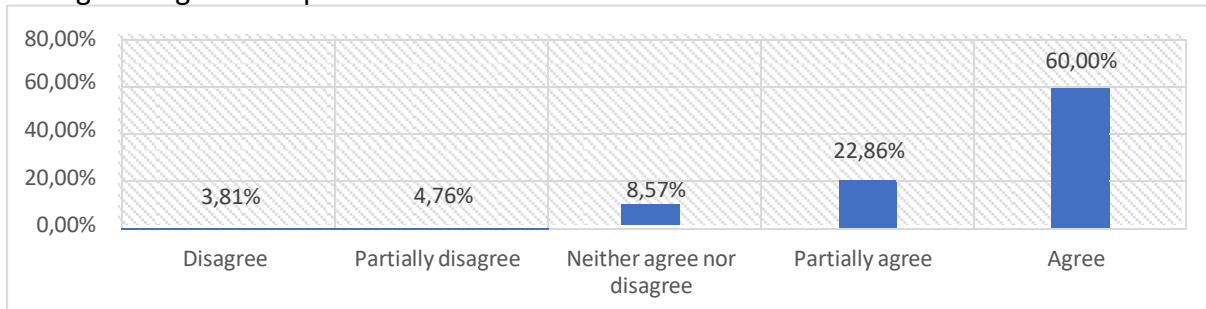
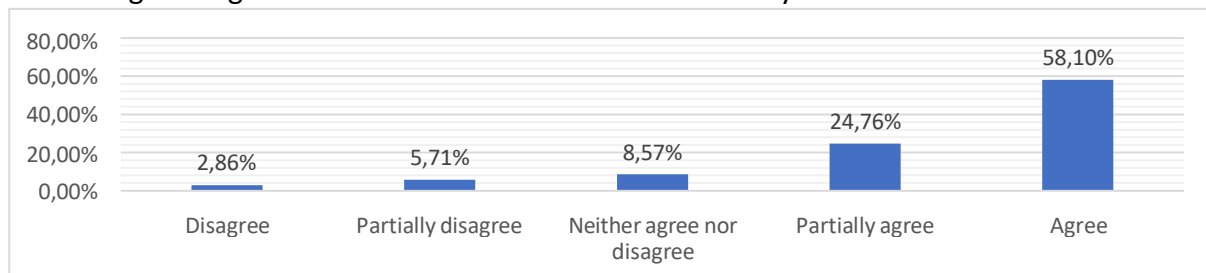
1. What should be the objectives of tax policy?

The simplification of procedures to facilitate citizens in fulfilling their tax obligations

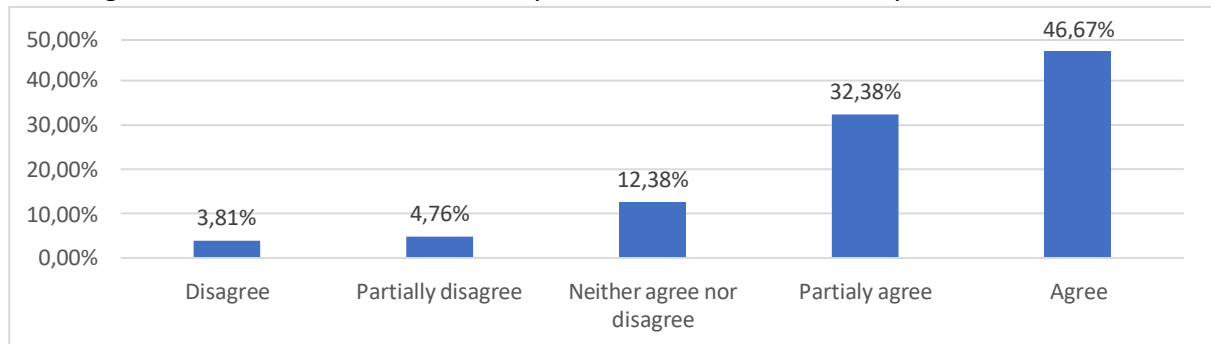


The integration of information systems for the monitoring of tax information, the cross-checking of data and the electronic service of taxpayers and services at formal and national level



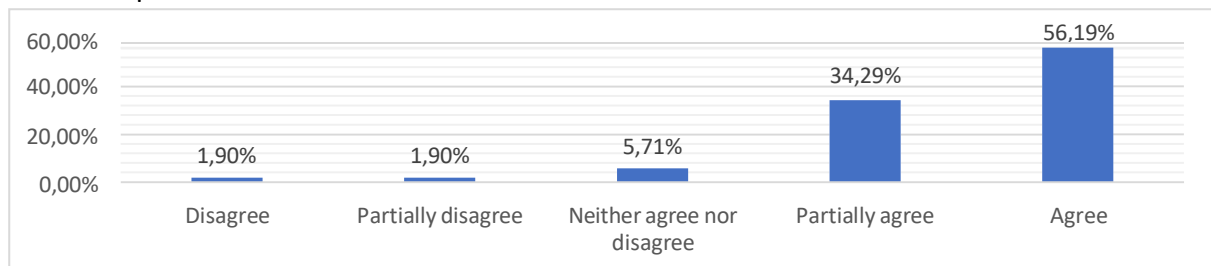
Better management of the tax system**A fairer distribution of the tax burden and the protection of the economically weaker classes****Strengthening the competitiveness of businesses****The strengthening of the control mechanisms of the Ministry of Finance**

Ensuring sufficient revenue to finance expenditure and achieve a surplus

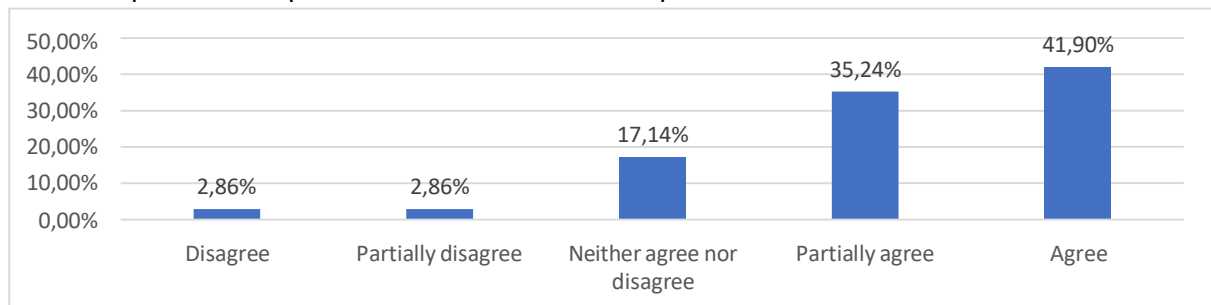


2. When imposing a tax, research should be carried out:

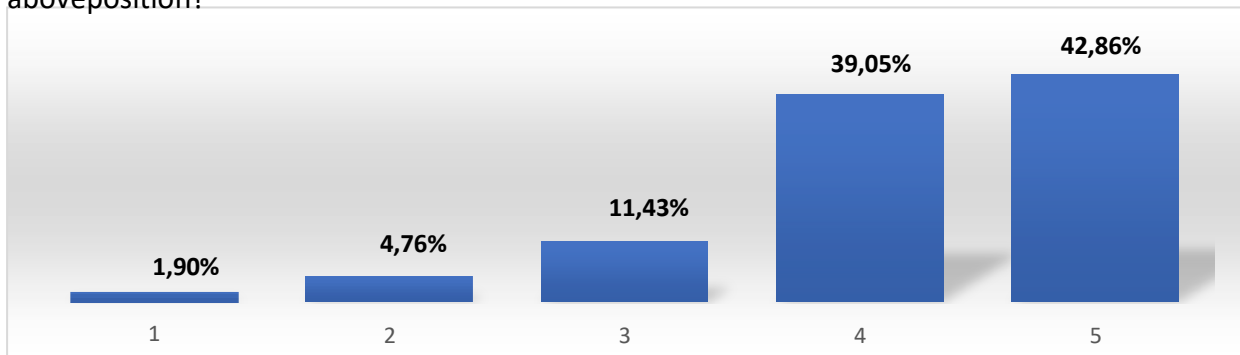
For the expected collection rate as well as the limit of income restriction



The focal point for disposable incomes for consumption and investment

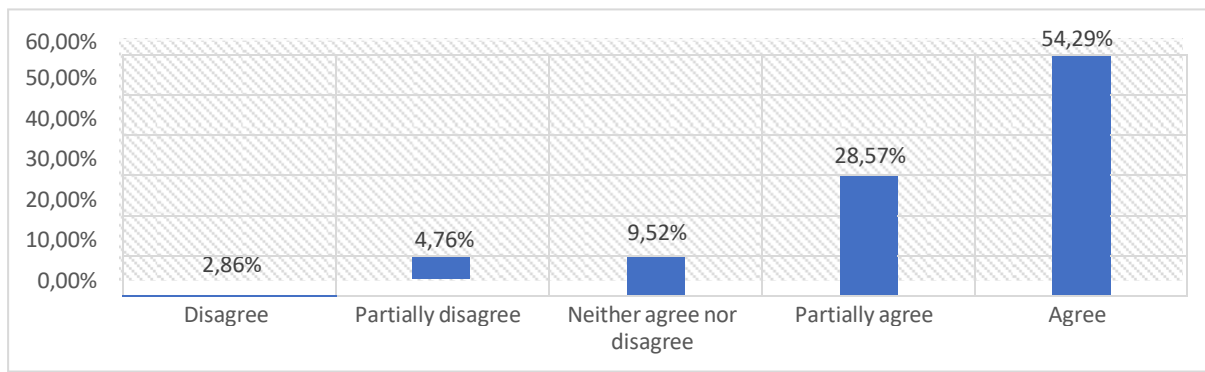


3. The personal income tax burden can be described as high in Greece with negative effects on incentives for work, entrepreneurship, investment and innovation. Do you adopt the aboveposition?

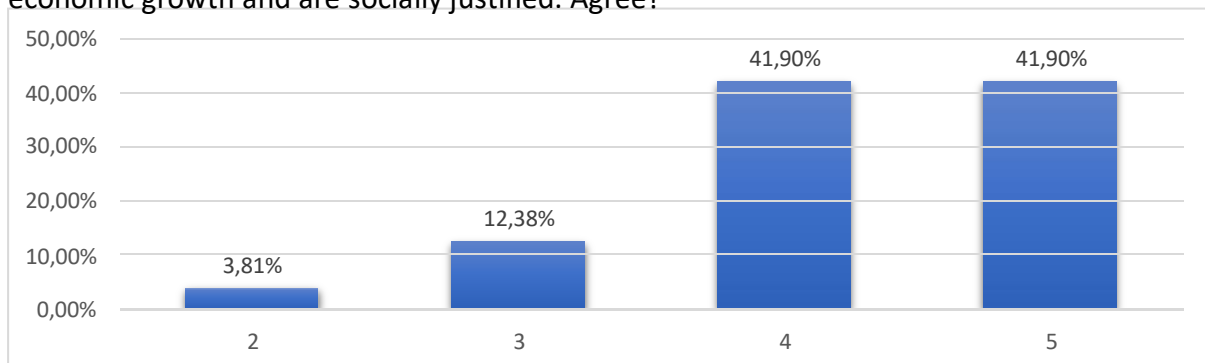


On a scale of 1 ("Not at all") and incrementally up to 5 ("Absolutely")

4. Tax revenues for employees and pensioners remain the main source of personal income tax. Do you consider that a review of the personal income tax system is needed, involving other groups of professionals (such as traders, industrialists, freelancers) in the tax burden, so that it is governed by objectivity and equal treatment of taxpayers.

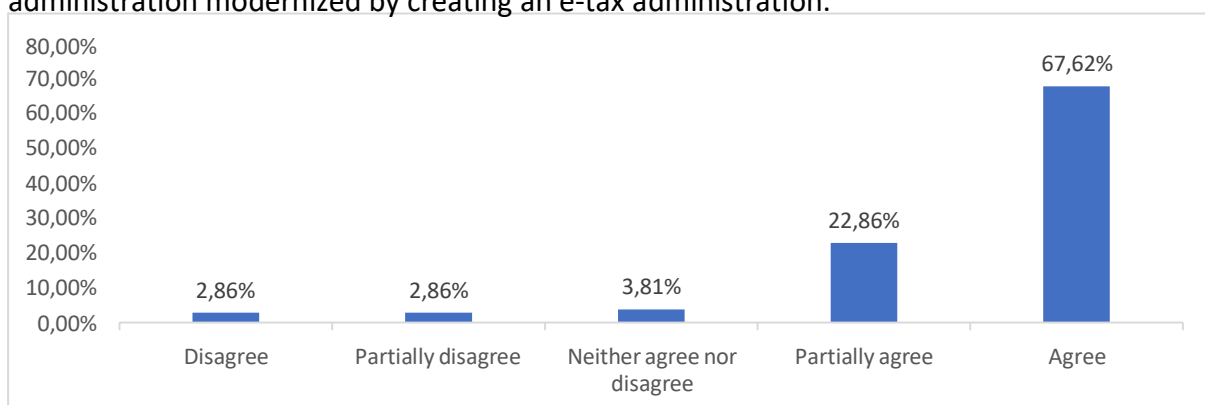


5. In order to restore tax fairness, it is necessary to review all tax exemptions and reductions and deductions from net income and to maintain only those that contribute to economic growth and are socially justified. Agree?

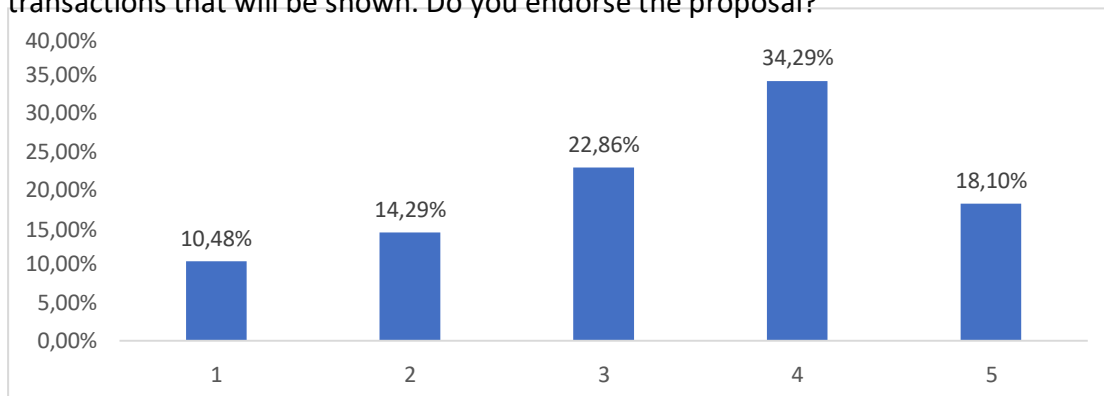


On a scale of 1 ("Not at all") and incrementally up to 5 ("Absolutely")

6. The use of plastic money and e-invoicing should be widely publicized and tax administration modernized by creating an e-tax administration.



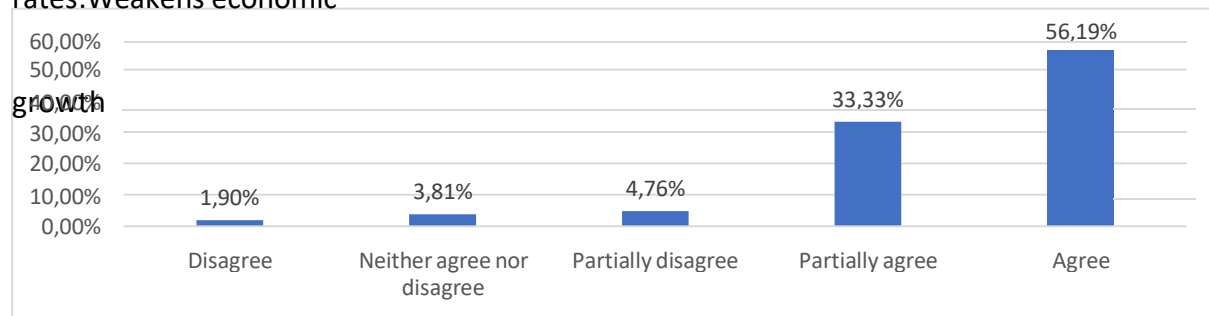
7. The deduction of expenses from receipts at a rate of 100% of the expenditure and the loss of revenue that will occur from this deduction of expenses will be offset by the taxation of freelancers and businesses and by the increase in VAT revenues from the additional transactions that will be shown. Do you endorse the proposal?



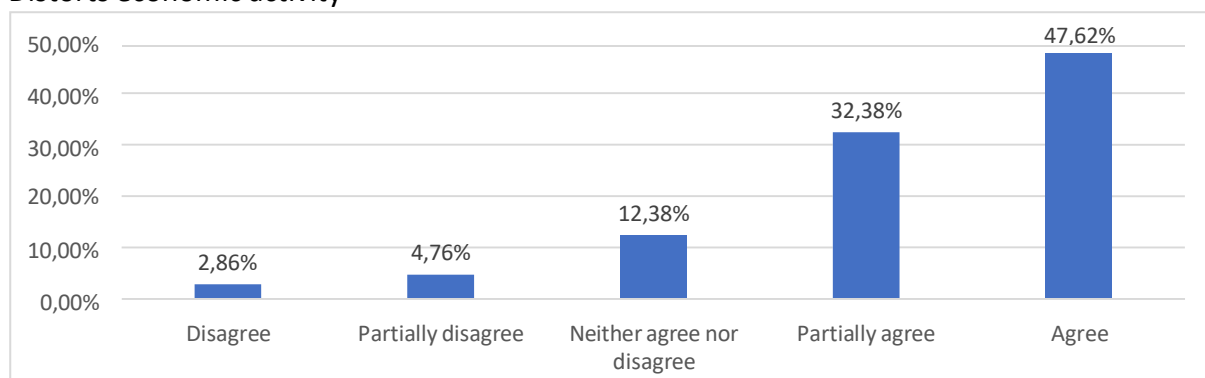
On a scale of 1 ("Not at all") and incrementally up to 5 ("Absolutely")

8. The use of high tax

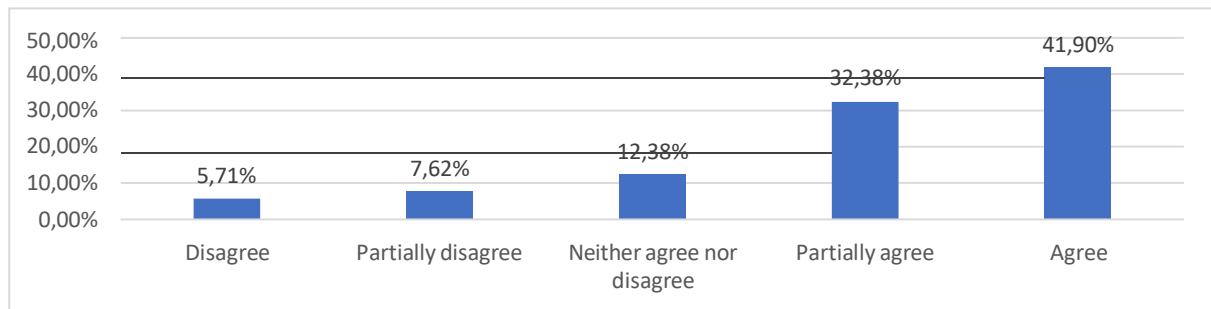
rates:Weakens economic



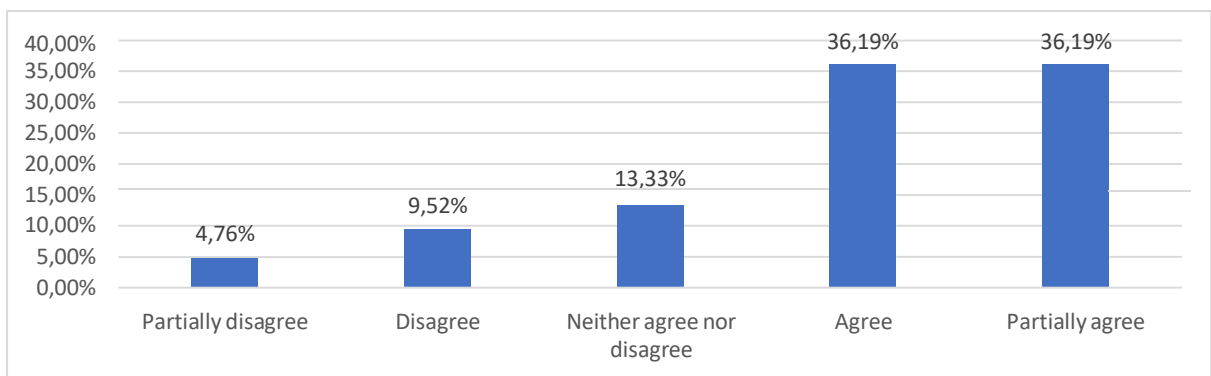
Distorts economic activity



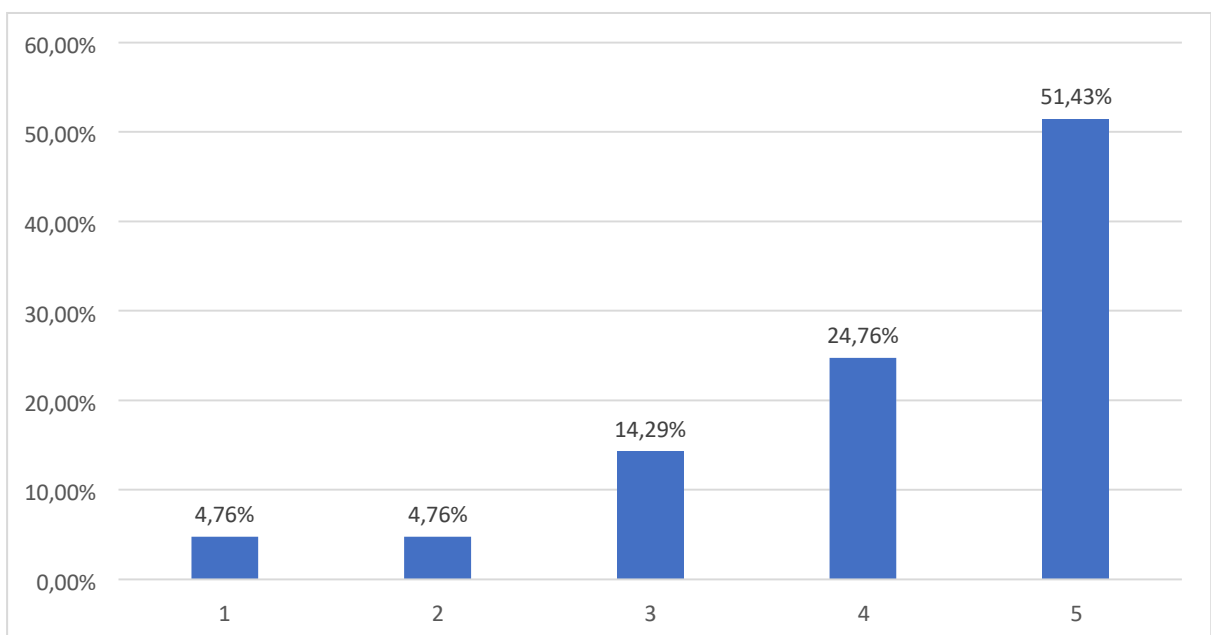
An unfair distribution of the tax burden is created



Discriminates against taxpayers

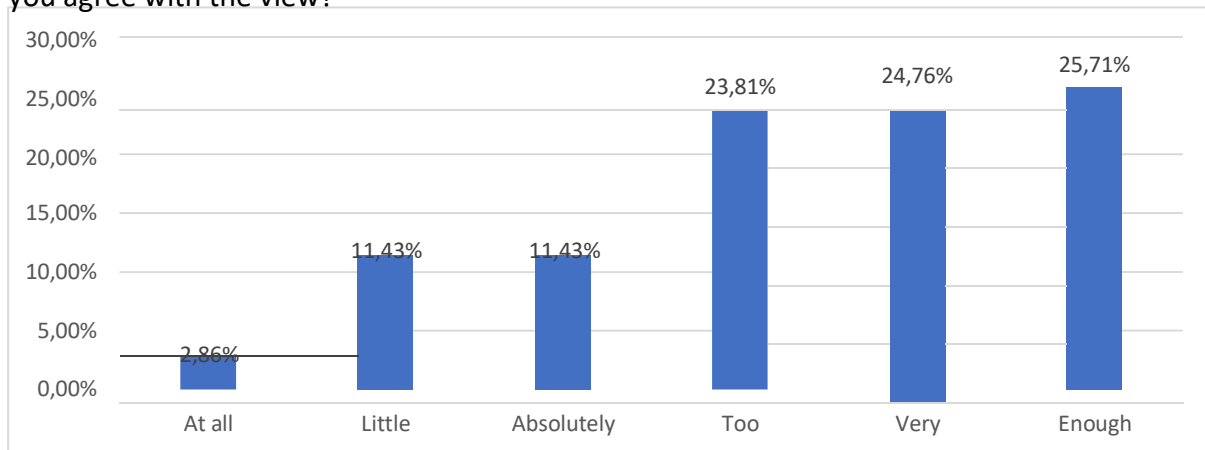


9. Employees and pensioners not only have the highest percentage participation in the tax burden, but also appear to be the richest Greeks, as their participation rate in the total declared income of individuals is consistently above 65%. Agree?

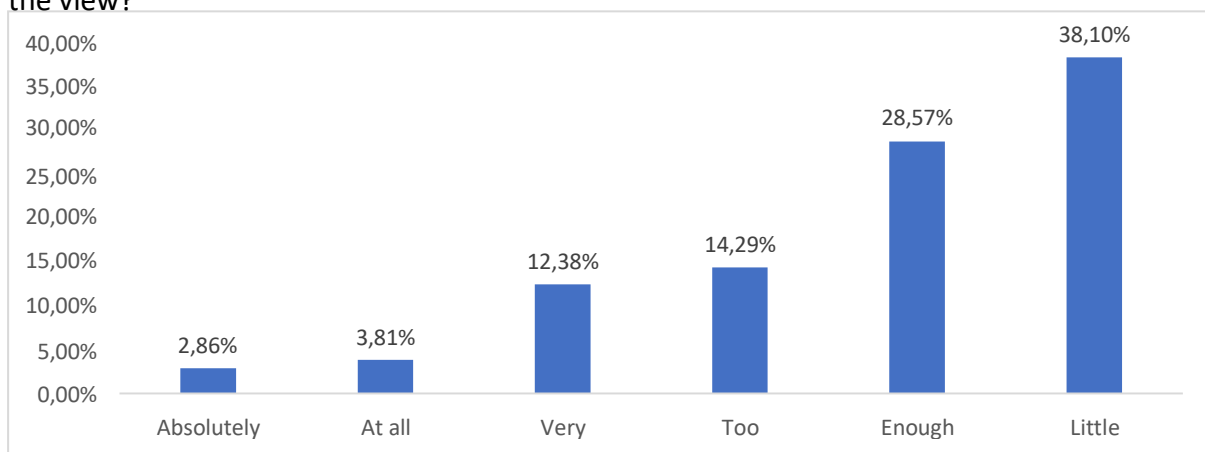


On a scale of 1 ("Not at all") and incrementally up to 5 ("Absolutely")

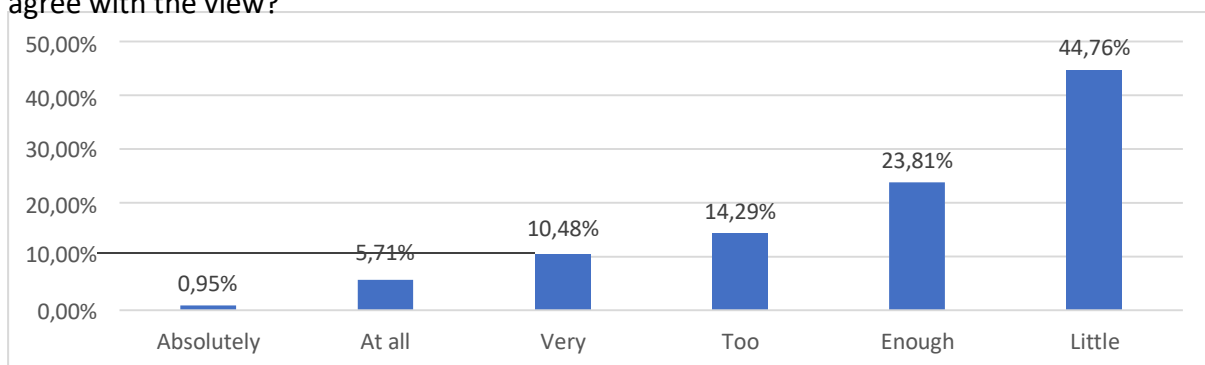
10. The main objective of the legislation on presumptions was the concerted effort to limit widespread tax evasion and consequently to increase the tax revenues of the Greek State. Do you agree with the view?



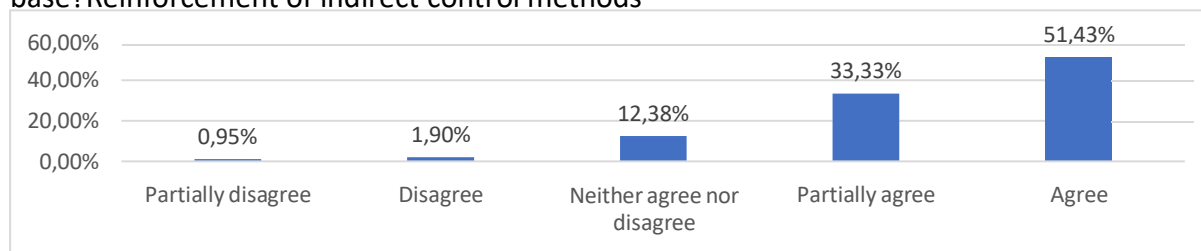
11. The attempt of several taxpayers to conceal income was prevented by statutory presumptions indicating a wealth which is not shown to the tax authority. Do you agree with the view?



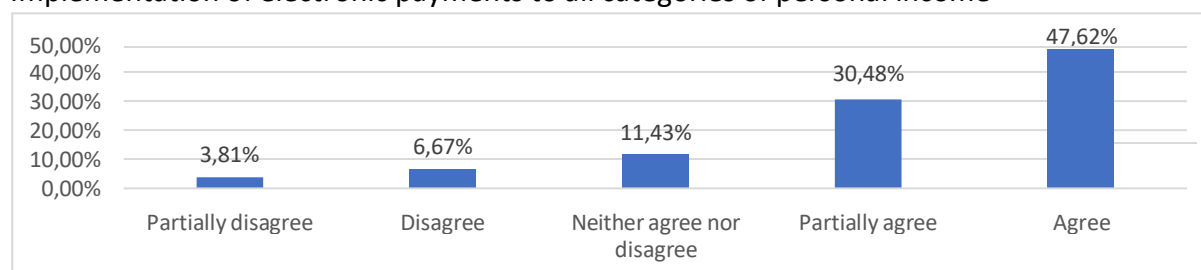
12. The application of the system for determining income on the basis of imputed subsistence and asset acquisition costs reduced tax evasion and increased income tax revenue. Do you agree with the view?



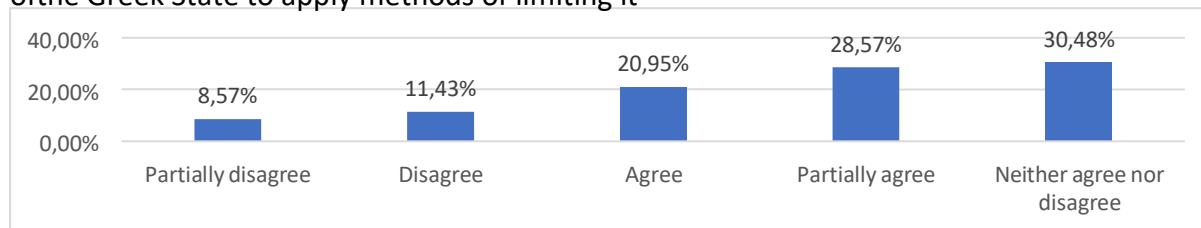
13. What would you suggest doing about living presumptions to determine the tax base? Reinforcement of indirect control methods



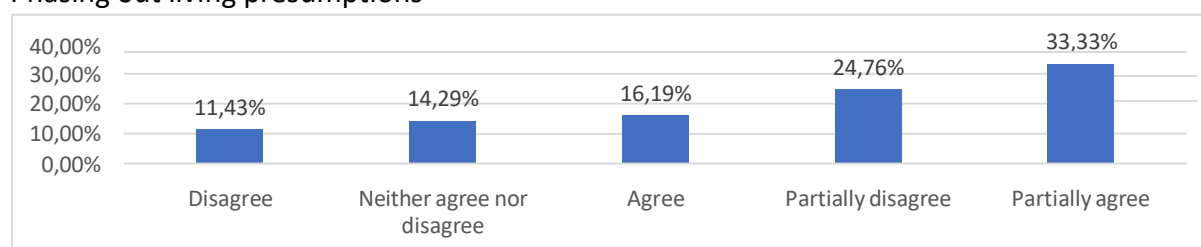
Implementation of electronic payments to all categories of personal income



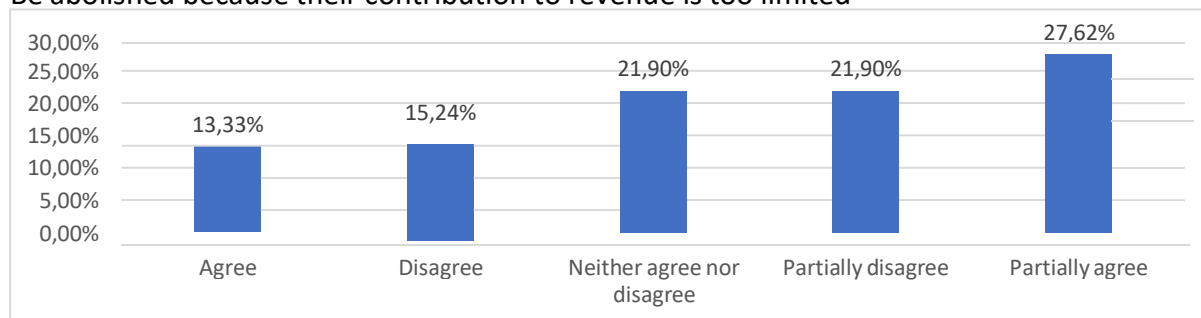
Their implementation is deemed necessary due to widespread tax evasion and the inability of the Greek State to apply methods of limiting it



Phasing out living presumptions

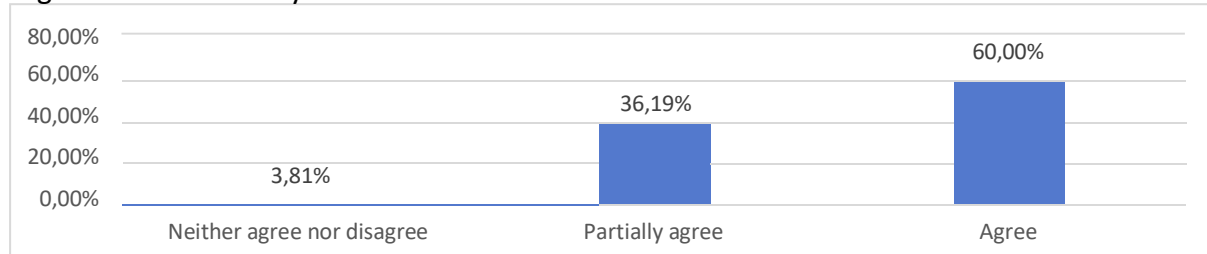


Be abolished because their contribution to revenue is too limited

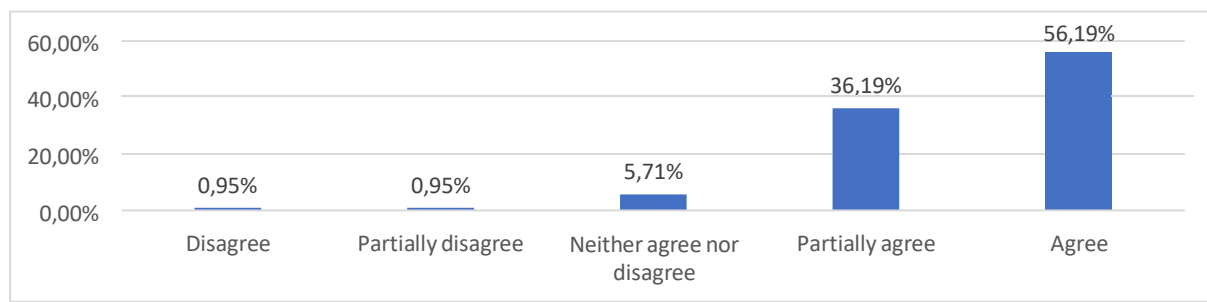


14. The disproportionate structure of tax revenues reflects and reproduces chronic distortionsof the Greek economy such as:

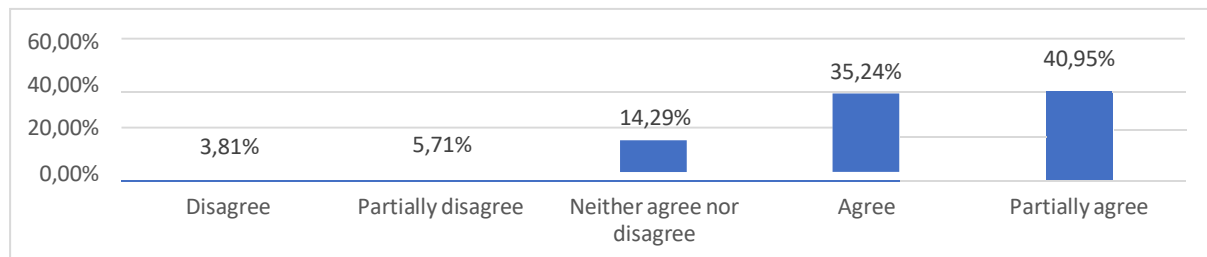
High shadow economy



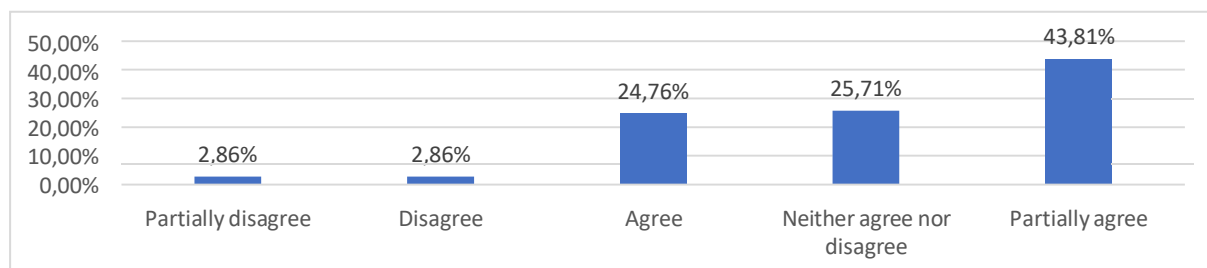
High proportion of undeclared or declared work



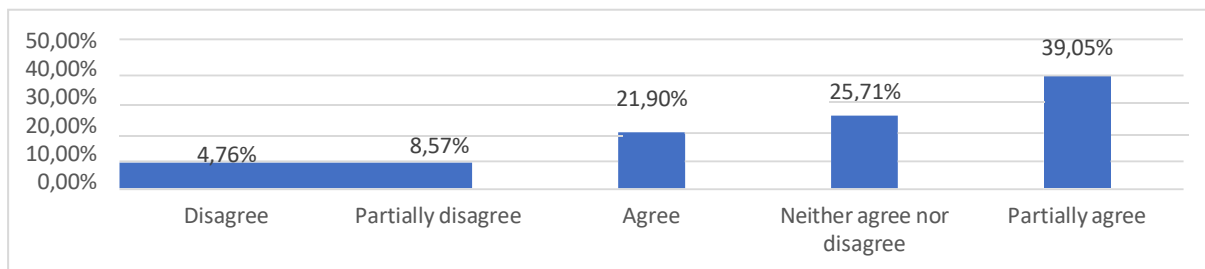
Low productivity and added value



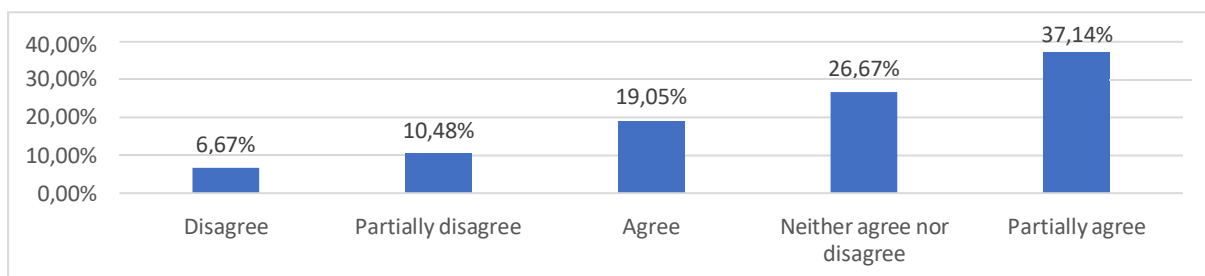
High dependence on consumption



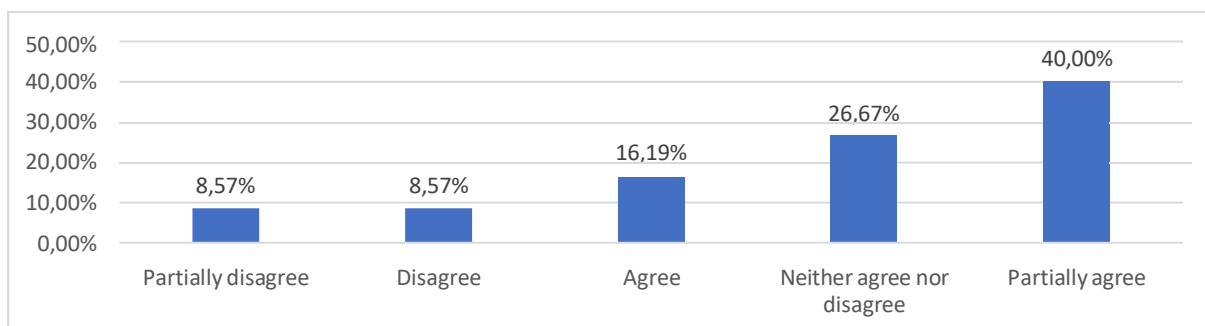
Small percentage of economically active population



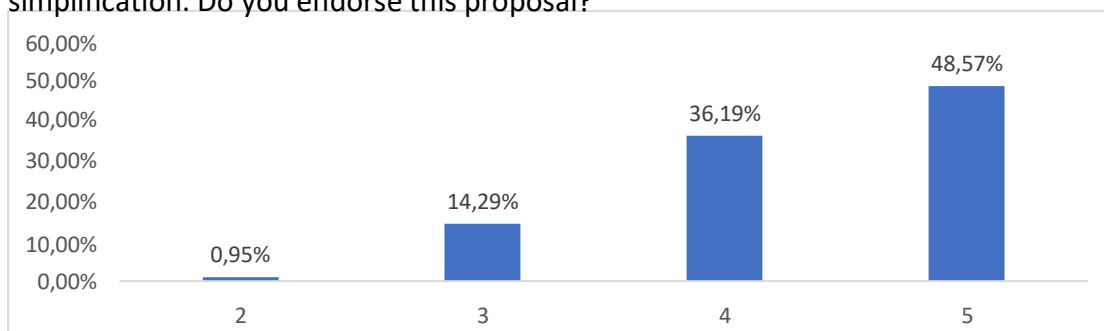
High unemployment



Many self-employed



15. The studies on the reform of the tax system (most recently by the Pissarides Committee) propose the modification of tax rates and income tax brackets in the direction of further tax simplification. Do you endorse this proposal?

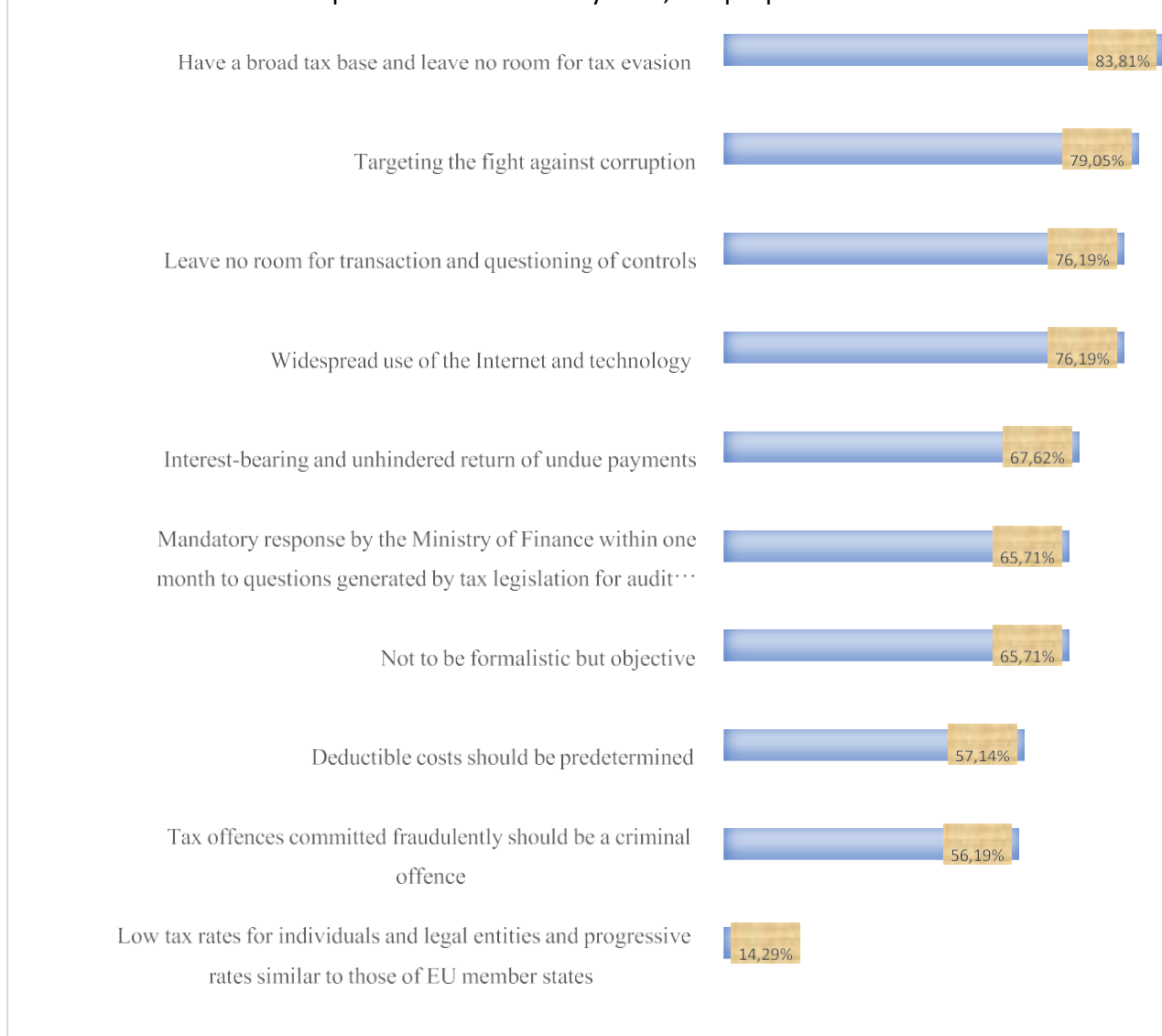


On a scale of 1 ("Not at all") and incrementally up to 5 ("Absolutely")

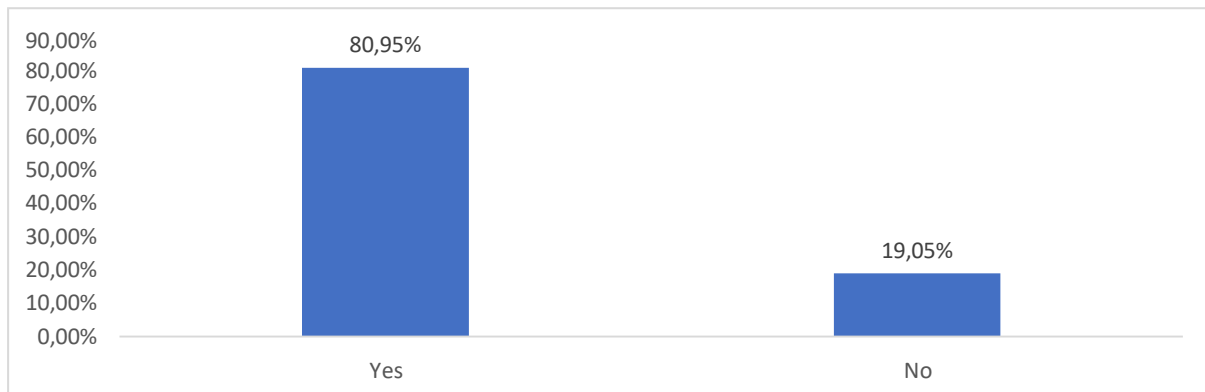
16. The targeted use of electronic payments would act as an incentive to shrink the shadoweconomy.



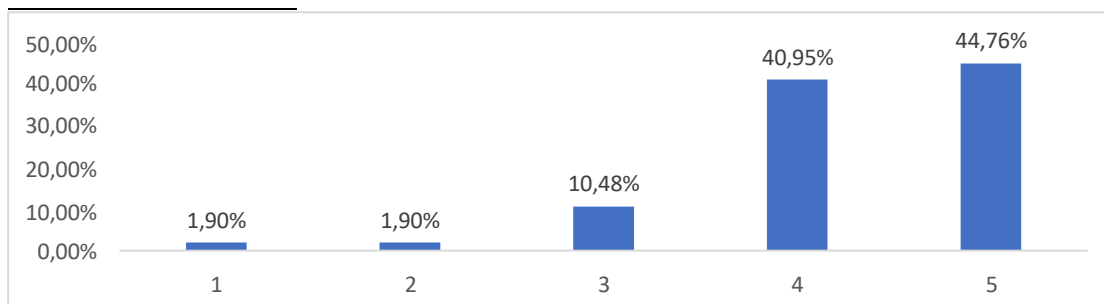
17. In order to create a fair personal income tax system, it is proposed:



18. For certain expenditure (plumbing, electricians, repairs of private dwellings, shops, etc.) which is not easy to ascertain, it is necessary to allow those costs to be deducted, in whole or in part, based on legal justifications, from the net profits of the natural persons paying those costs.

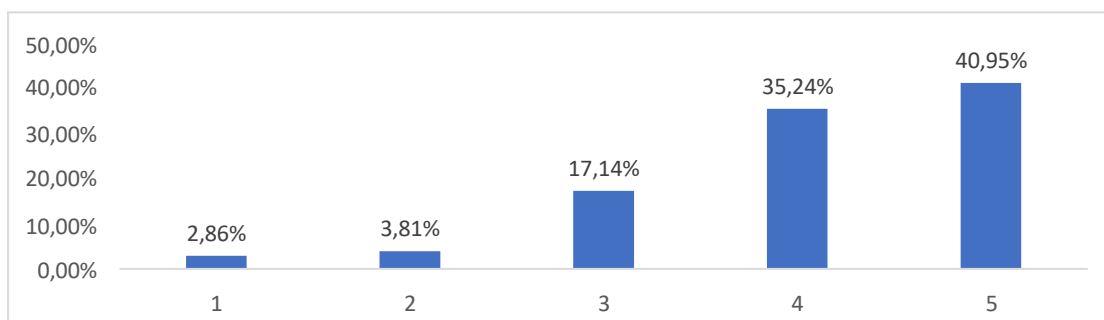


19. Taxpayers shall be entitled to deduct from the balance of the above profits the following expenses, on the basis of legal justifications, the costs of medical and hospital care, with limitations, depending on the type and amount of net profits that can be covered. Do you agree with the proposal?



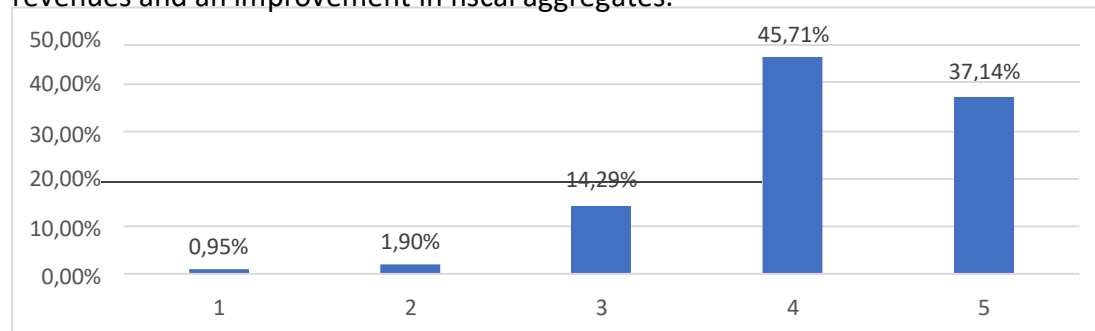
On a scale of 1 ("Not at all") and incrementally up to 5 ("Absolutely")

20. High tax rates combined with lenient penalties for tax offenders can be seen as the mainfactors leading to tax avoidance and evasion.



On a scale of 1 ("Not at all") and incrementally up to 5 ("Absolutely")

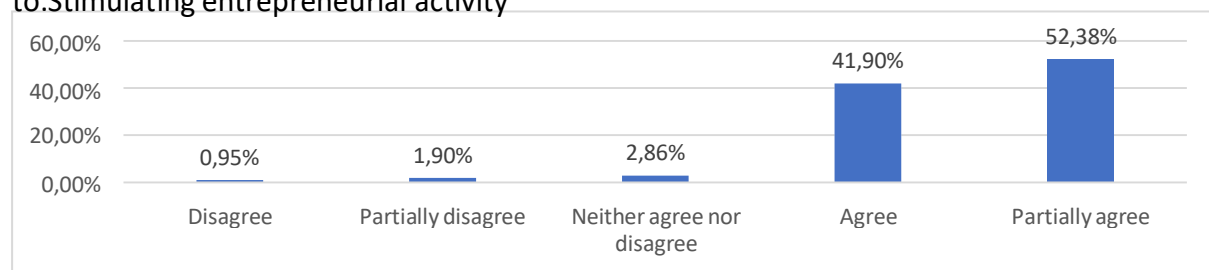
21. The reduction of tax rates and the increase in investment public expenditure will contribute to an increase in disposable income, a boost in consumption, an increase in tax revenues and an improvement in fiscal aggregates.



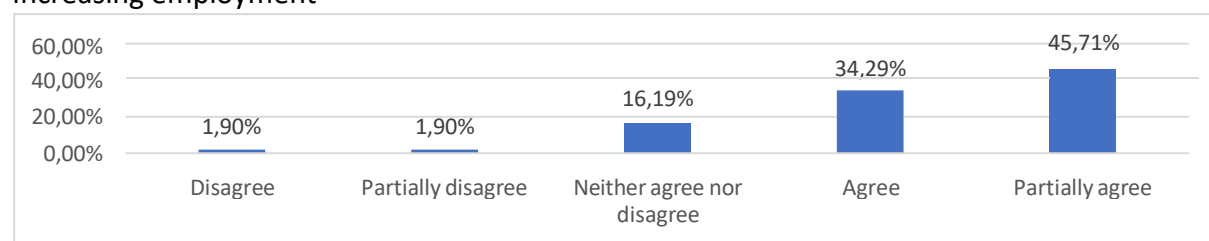
On a scale of 1 ("Not at all") and incrementally up to 5 ("Absolutely")

22. The reduction of maximum and intermediate rates will help

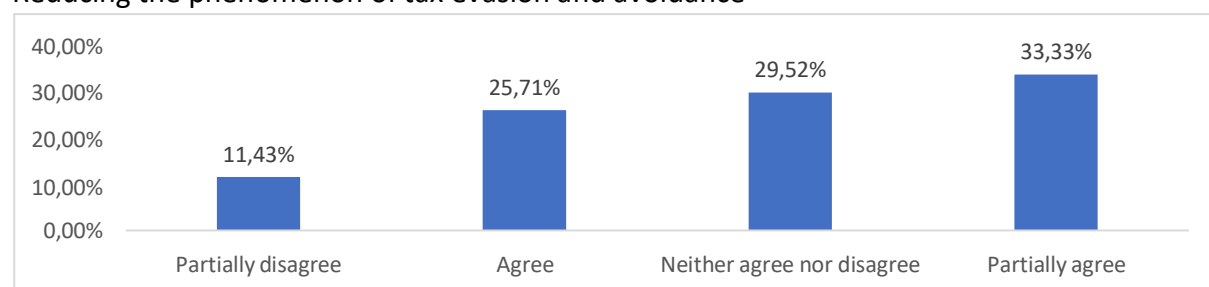
to: Stimulating entrepreneurial activity



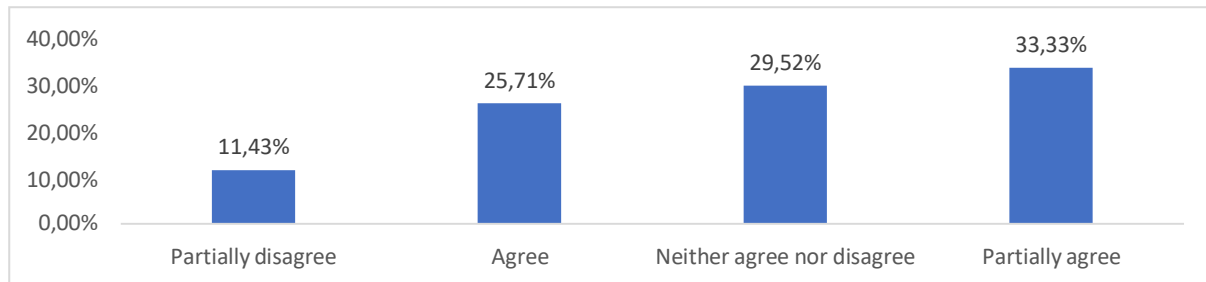
Increasing employment



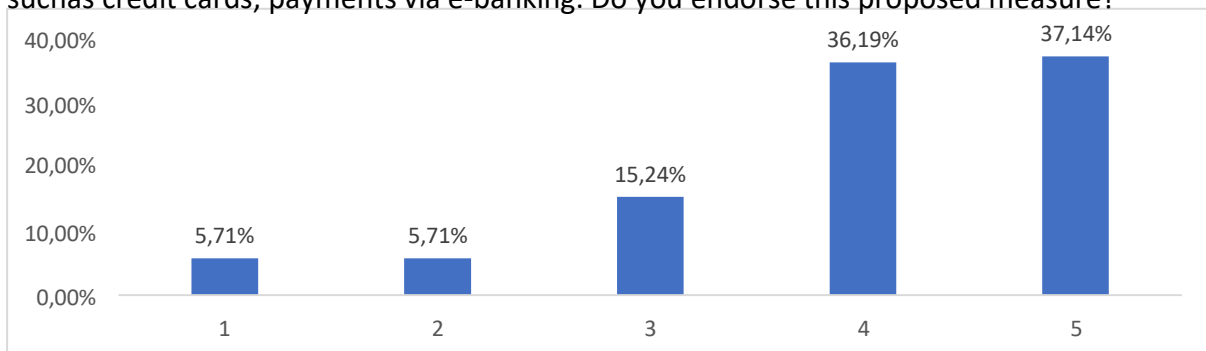
Reducing the phenomenon of tax evasion and avoidance



The reduction of the amount of overdue debts

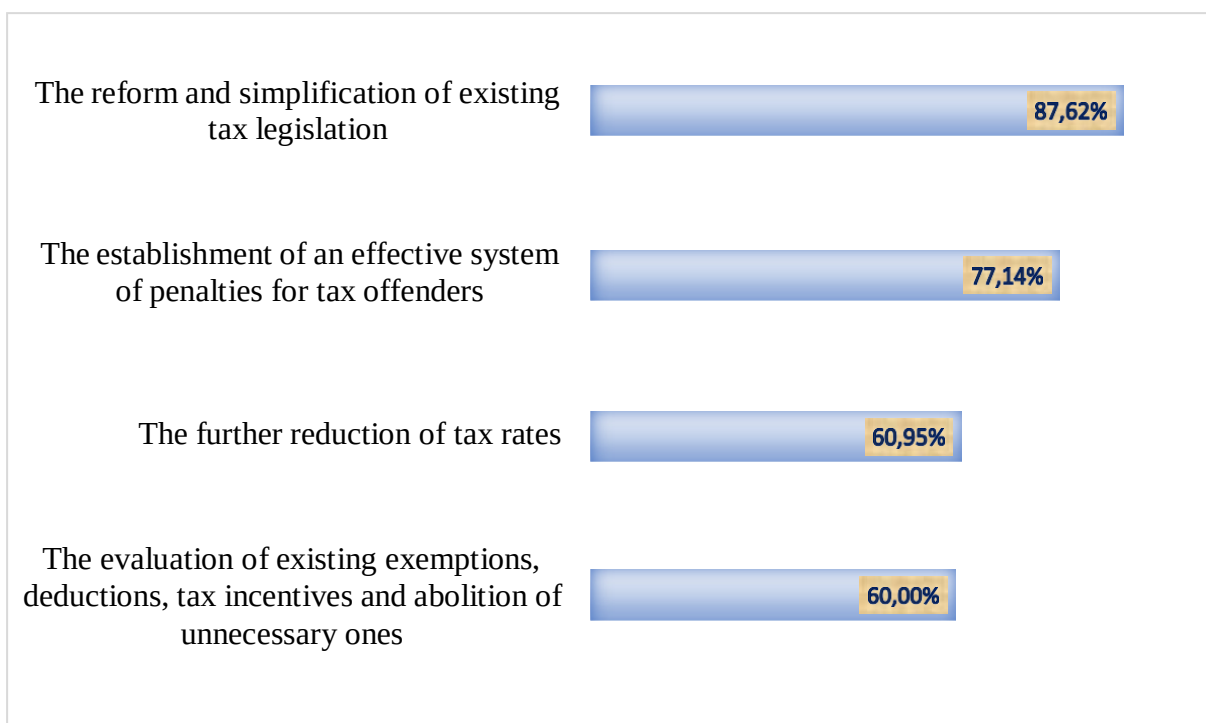


23. There is a need to initiate the introduction of compulsory payment for income earners, self-employed persons, employees and pensioners and farmers through electronic means such as credit cards, payments via e-banking. Do you endorse this proposed measure?

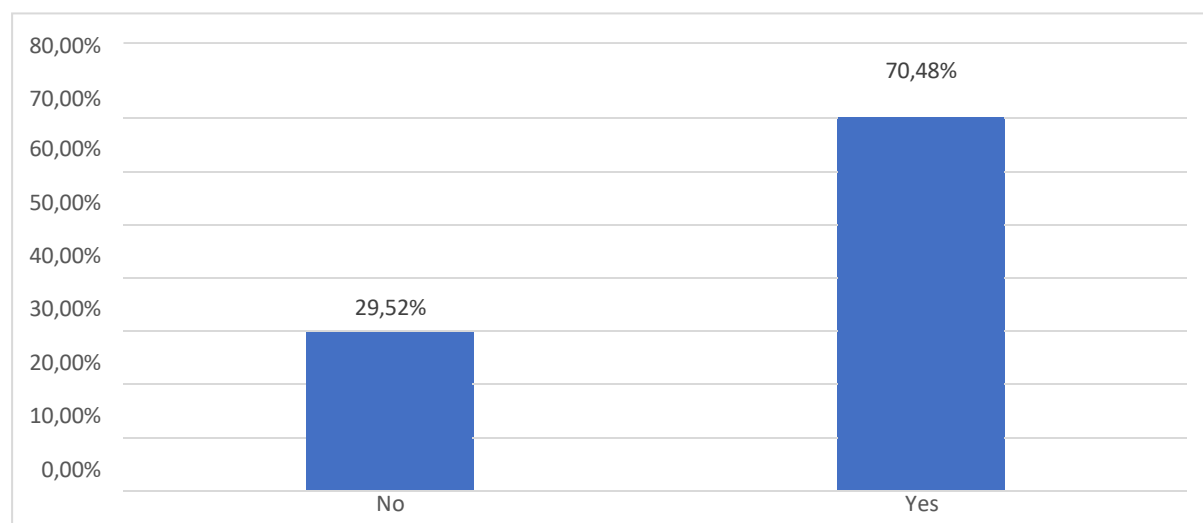


On a scale of 1 ("Not at all") and incrementally up to 5 ("Absolutely")

24. Drastic measures to tackle tax evasion are:



25. To define the tax (economic) scale on a new basis by a special committee (experts) in accordance with Article 4 para. 5 of the Constitution, to draw up for each year uniform for all incomes of natural persons, with a scale, differentiating certain incomes, from salaried services and pensions, from agricultural enterprises and from real estate. Do you agree with the above proposal?



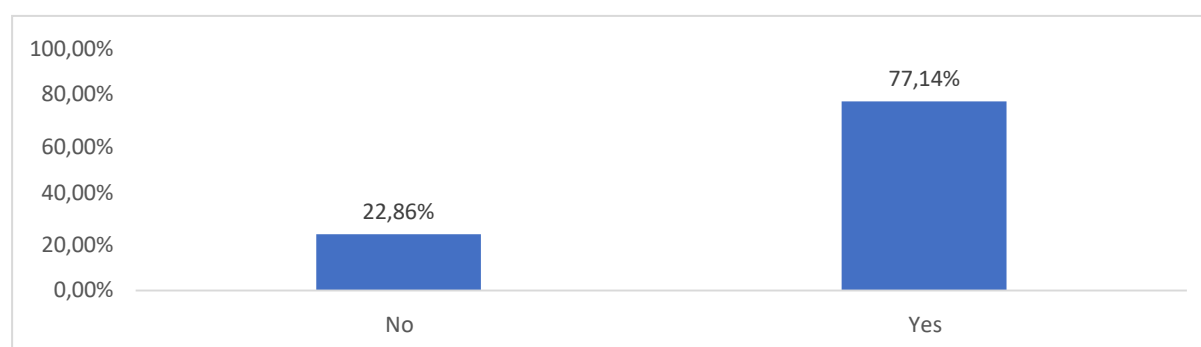
26. The system of forwarding money to third world countries is described as 'uncontrolled'. How to ensure that transfers of money made through payment institutions such as Western Union and MoneyGram are controlled and taxed.

For the system of forwarding money to third world countries, in order to ensure the control and taxation of money transfers made through payment institutions (such as Western Union and MoneyGram), the following are also proposed after processing the replies through the questionnaire:

- i. Creation of an international regulatory framework, Control through cooperation between authorities in an international context on payment platforms, obligation to notify transactions with specific criteria that conceal tax evasion or acquisition of tax advantage, liability of persons, sanctions.
- ii. Imposition of a tax on cross-border capital movements.
- iii. Withholding tax on shipment, if the amount has not been taxed, and reimbursed by payment institutions.
- iv. Compulsory affiliation of all countries to the OECD and to mutual transnational administrative assistance.
- v. Application of a methodology of other European Union countries, which have achieved a drastic reduction.

- vi. Further Cooperation with the European Payments Council (EPC) and the Single European Payments Area (SEPA) as well as with other relevant international bodies for cooperation in securing and taxing money transfers
- vii. Transfers could be reported on a specific reporting platform. This phenomenon has been observed for several years and not only in third world countries but also in countries neighboring us. Albanian/Georgian etc. immigrants have been using these payment institutions for years in order to transfer the money they receive in Greece from undeclared fees to their home country. It is a matter of purely political will.

27. There is a need to set up a special committee with a chairman and members who have tax knowledge and experience in tax matters. It will assess the impact of the tax system on economic activity, propose measures for fairer income redistribution and design a broad tax reform. Do you agree with the proposal?



D. Conclusions – suggestions

The goal is the complete modernization of the tax system, so that it responds more fully to the principles of social justice, contributes to the economic development of the country and is governed by simple and modern procedures that apply to all tax objects. The aim is to deepen the proposals for tax reform based on the particularities of the Greek economy, international trends in this field and the weaknesses of the tax system. For the completeness of the research, it was considered important to compare the reports on the reform of personal income tax that have been prepared with a development plan for the Greek economy and have been presented, published by scientific bodies, University Professors, tax executives in conferences, workshops, scientific journals and discuss the issue of taxation highlighting its important characteristics. The consequences of a tax reform are analyzed and how it should take the form of reform, which, however, requires new legislation that will bring about radical and deep breakthroughs that respond to the new conditions and the internationalization of the economy. Proposals for a package of structural measures, which

are necessary for the country's adaptation to the wider European environment and the elimination of weaknesses that increase its distance from other member-states.

The innovation of this research is that it can be the trigger for the general improvement of the Greek personal income tax system by adopting substantiated proposals for imposed amendments to the tax law, to be in line with the provisions of the current Constitution.

References

Bronchi C.: (2001), OECD Publishing, 'Options for Reforming The Tax System in Greece'.
Committee for the Reform of the Greek Tax System, March: (2002), 'Report on the reform of the Greek tax system', pp. 70-71.

Foundation for Mediterranean Studies: (1993), 'Tax regime, shadow economy and tax evasion in Greece', Papazisis Publications.

Gibson, Hall S. G, D. H. and Tavlas G. S.: (2011), The Greek Financial Crisis: Growing Imbalances and Sovereign Spreads'.

Ioannidis Y.: (2015), University Library of Munich, 'The political economy of the distributional character of the Greek taxation system (1995–2008)'.

IOBE: (2004), 'Study on tax reform'.

IOBE: (2018), 'Income Tax in Greece. Comparative analysis and reform proposals'.

Kaplanoglou G. and Rapanos V.: (2012) 'Economic and societal institutions and the tax system: The case of Greece'.

Leventi C. and Picos F.: (2019), EUROMOD at the Institute for Social and Economic Research, 'The tax structure of an economy in crisis: Greece 2009-2017'.

Papatheodorou C.: (1998), London School of Economics and Political Science, 'Inequality in Greece: an analysis by income source'.

The Impact of Disclosure Timeliness and Cybersecurity Risk Management Assurance on Investors' Judgments and Decisions

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Abstract

In 2023, the U.S. Securities and Exchange Commission released new guidance for public company disclosure of cybersecurity incidents. The new guidance mandates disclosure within four days of recognizing a cyber incident as material to investor decision making. Given the vague nature of the materiality decision in regard to cyber breaches, we examine investor reaction to disclosure timeliness. We also examine the efficacy of cybersecurity risk management assurance to mitigate the negative reaction of investors. We find investors have strong negative reactions to both assessments of management credibility and stock valuations. Timely disclosure reduces these effects. Assurance only mitigates negative effects when disclosures are timely.

Key words: Cybersecurity Incident Disclosure, Cyber Breach, Cyber Risk Management, Cyber Risk Management Assurance, Disclosure Timeliness, Litigation Reduction Hypothesis, Voluntary Assurance

Introduction

The U.S. Securities and Exchange Commission (SEC) adopted final rules in late 2023, mandating disclosure requirements related to material cybersecurity incidents (Gerding 2023). Disclosure of cybersecurity incidents is required within four business days after an SEC registered company determines breach is material to investors (Gerding 2023). Management and auditors have both expressed concern over determining when an incident is “material” enough to be important to investors, a difficult and highly subjective decision (Stark 2023).

Nonetheless, after a cyber breach is discovered, managers face competing incentives to delay or release bad news. Although managers have incentives to release bad news on a timelier basis to lower litigation costs (Skinner 1994, 1997), managers also have financial incentives to delay or obscure the disclosure of bad news (Kothari et al. 2009). In light of the competing incentives, it is important to understand the factors affecting how investors react to the timeliness of management’s disclosures. Understanding investors’ reactions to the timeliness of disclosures is even more significant considering that the change in share value, in connection with the disclosure of bad news, is one of the main factors influencing litigation outcomes (Skinner 1994, 1997).

The purpose of this study is twofold. First, we aim to scrutinize how disclosure timeliness impacts investor's judgments and decisions. Second, we explore the use of voluntary cybersecurity risk management (CyRM) assurance as a potential tool to mitigate the damaging effects of delayed disclosures. This study helps further our understanding of how investors incorporate their perceptions of management's efforts to address multifaceted disclosures in their investment decisions. This study is important beyond just the impact of the new SEC regulations as the AICPA/CPA Canada, are actively engaged in developing disclosure guidelines and CyRM assurance products to address the increased risk of cyber- attacks. Understanding the value relevance of CyRM assurance may help regulatory bodies to understand and promote the related benefits.

Theory & Hypotheses

Prior research on bad earnings news indicates that more timely disclosures are associated with lower settlement amounts (Skinner 1997) and overall lower incidences of litigation (Donelson et al. 2012). These findings are attributed to the litigation reduction hypothesis which suggests that "more timely disclosure of bad news leads to lower expected legal costs" (Skinner 1997, 251). The legal rationale for this phenomena is explained, in the context of bad earnings news, using the SEC disclosure requirements which mandate prompt announcements of material facts regarding a company's financial condition and the timely disclosure of any material fact regarding a previous disclosure that has become misleading (Skinner 1997). Accordingly, more timely disclosure of bad news is expected to deter litigation motivated by allegations of non-compliance with SEC-mandated disclosures.

Consistent with U.S. securities laws, public companies are required to disclose timely, comprehensive, and accurate information about risks and events relevant to an investment decision (SEC 2011). For cybersecurity this includes timely disclosure of material cyber breaches (Gerding 2023). As such, consistent with prior literature on timely disclosure of bad earnings news and considering that similar disclosure requirements will be applicable, we argue that more timely disclosure of cybersecurity incidents will deter litigation, leading to lower expected legal costs. The delayed disclosure of cybersecurity incidents should put investors at greater risk due to increased exposure to legal liability; in turn, the perceived failure of management to contain the damage results in investors' lower performance expectations and lower valuation judgments.

H1: Timely disclosure of a cybersecurity incident will result in higher stock price valuation judgments.

Prior research suggests the observed negative impact of announcements of cyber breach on a company's market value may be due to investors' perceptions about the loss of reputation and consumer confidence. These expectations impact investors' estimation of future cash flows (Cavosuglu et al. 2004). Investors' perceptions of management forthcomingness may also explain prior findings that support the litigation reduction hypothesis. For instance, prior research documents a positive relationship between perceptions of disclosure forthcomingness and assessment of management credibility (Libby and Tan 1999). More timely disclosures of cybersecurity incidents should lead to more favorable investor assessment of management credibility.

The assumption that "timely disclosure may enhance managers' perceived competence or credibility, engendering a less severe negative stock price reaction" (Donelson et al. 2012,

1970) suggests that the timeliness of disclosures should impact investors' valuation judgments through investors' assessment of management credibility. We expect that investors' assessments of management credibility will mediate the relationship between disclosure timeliness and investors' valuation judgments.

H2a: Timely disclosure of a cybersecurity incident will result in more favorable assessments of management credibility.

H2b: Assessments of management credibility mediate the effects of disclosure timeliness on valuation judgments.

The baseline hypotheses predict that the timeliness of disclosures will be positively associated with investors' assessments of management credibility and valuation judgments; these predictions are mainly motivated given the negative legal consequences of delayed disclosures of bad news which leads to investors' lower performance expectations and management credibility assessments. Findings from prior research suggest that companies engage in voluntary assurance services, mainly, to enhance their credibility and reputation (Simnett, Vanstraelen, and Chua 2009). We build on Wallace's (1980; 2004) insurance hypothesis to explore the potential usefulness and value of voluntary assurance as a mitigating factor that may help offset the negative impact of delayed disclosures of bad news. Although assurance over CyRM should be valuable in any disclosure scenario, CyRM assurance services should be more valuable in circumstances where management is unable to make timely disclosures, as the higher the litigation risk, the more the need for reputational insurance.

H3: CyRM assurance will have a more positive effect on perceptions of management credibility in the presence of less timely disclosures.

Research Methods

A 2 x 2 experimental design is used in which the timeliness of disclosure (more timely versus less timely) and CyRM assurance (assurance versus no assurance) are manipulated between-subjects. A sample of 144 experienced and knowledgeable non-professional investors is recruited to observe participants' decision behavior.

Participants are instructed to evaluate a company for stock price valuation, based on the information available. First, participants receive information about the company. After being provided with a brief description of the company, participants are instructed to make an initial valuation of the company's stock price. Participants then review a press release that announces a data breach. The press release includes information about the disclosure timeliness, the extent of the breach, and resources dedicated to help victims of the attack. Selected financial information and information about the presence or absence of CRM assurance is presented next. Participants are asked to reconsider their initial valuation judgments, and to answer additional case and demographic questions.

The independent variables of interest are disclosure timeliness and CyRM assurance. Timeliness is operationalized as the difference between the date when the company learned of the breach and the date the breach was disclosed. Participants in the more timely condition are notified that the company disclosed the incident within three days, while in the less timely conditions participants are notified that the company disclosed the incident three months

after discovery. In both conditions (assurance and no assurance), participants learn that the company has a CyRM program in place and that controls are operating effectively. The presence of CyRM assurance is operationalized by notifying participants whether the company engaged or did not engage in CyRM assurance in the fiscal year prior to the incident.

The dependent variable is investors' perceived value of a company's stock price (valuation judgments). Valuation judgments are measured using a 7-point, fully labeled, scale that ranges from "very low" (equal to 1) to "very high" (equal to 7). Management credibility is a mediator in that represents participants' assessment of management competence and trustworthiness, the two components of management credibility. Participants' assessment of management competence and trustworthiness are measured using 7-point, fully labeled, scales that range from "very incompetent" (equal to 1) to "very competent" (equal to 7) and from "very untrustworthy" (equal to 1) to "very trustworthy" (equal to 7), respectively. The average value of these two measures is used to assess the measure of management credibility.

Results

H1 predicts that more timely disclosure of a cybersecurity incident leads to more favorable investors judgments. H1 is tested using analysis of variance (ANOVA) and the results support the hypothesized relationship between timeliness and valuation judgments ($F=29.426$, $p<0.001$) indicating that more timely disclosures lead to more favorable investor valuation judgments.

H2a predicts that more timely disclosure of a cybersecurity incident leads to more favorable assessments of management credibility. The results of the ANOVA support H2a and indicate that disclosure timeliness is positively associated with management credibility assessments ($F=41.118$, $p<0.001$).

H2b predicts that management credibility mediates the relationship between disclosure timeliness and valuation judgments. The results of the PROCESS mediation analysis confirm our expectation that more favorable assessments of management credibility leads to higher valuation judgments ($t=7.872$, $p<0.001$). The analysis of the indirect effect of disclosure timeliness and valuation judgments confirm that management credibility mediates the relationship between disclosure timeliness and valuation judgments. The results support H2b.

H3 predicts that a more positive effect on investor perceptions of management credibility in the presence of less timely disclosures. The mean management credibility assessments in the not timely/CyRM assurance condition (mean=4.21) is higher than the mean in the not timely/not CyRM assurance condition (mean=3.90) and the mean management credibility assessments in the timely/ CyRM assurance condition (mean=5.64) is higher than the mean in the timely/no CyRM assurance condition (mean=4.94). However, these values indicate that assurance has a greater positive impact on the favorability of credibility assessments for the timely condition than for the not timely condition. The simple effects analysis confirms the significant interaction is disordinal ($t=2.594$, $p<0.005$) but the moderation effect of the interaction is in the opposite direction of the hypothesis. Moreover, while the difference in management credibility assessments between the timely/CyRM assurance and timely/no CyRM assurance conditions is statistically significant ($t=2.547$, $p=0.006$), management credibility assessments are not statistically significantly different ($t=1.121$, $p=0.132$) between the not timely/CyRM assurance and not timely/no CyRM assurance. These results fail to

support H3 and suggest that CyRM assurance enhances management credibility only when a breach has been timely disclosed.

Conclusions

This study explores the impact of the timeliness of cybersecurity breach disclosures and CyRM assurance on investors' valuation judgments and management credibility assessments. We predict and find that more timely disclosure of a cybersecurity breach increases management credibility assessments and results in more favorable stock price valuations. We also find that the relationship between disclosure timeliness and valuation judgments is mediated by management credibility assessments.

The results of this study are important considering the evidence of the increasing cost of cybersecurity breaches, and particularly the negative market reaction to cyber-attacks. Our findings suggest that timely disclosures can help mitigate the negative stock price reaction associated with the disclosure of cyber-attacks and that a combination of timely disclosure and prior CyRM assurance provide the highest benefits. These results are relevant for companies interested in reducing the cost of cyber-attacks and also inform regulators and standard setters, such as the SEC and the AICPA/CPA Canada. For the SEC, the results confirm the importance of timely disclosure of cybersecurity incidents and reinforce the newly issued mandates for public companies. For the AICPA/CPA Canada, the results reinforce the two auditing bodies' interest in promoting and developing guidance for cybersecurity disclosures and associated voluntary assurance over the underlying cybersecurity risk management processes, strategies and governance. While our study has focused on investors which has also been the focus of the new SEC guidelines (Gerding 2023), future research should also consider the effects of cybersecurity incidents on other keystakeholders such as suppliers, customers and other business partners (i.e., cyber supply chain risk management) (Sutton et al. 2008; Hampton et al. 2021).

References

- Cavusoglu, H., B. Mishra, and S. Raghunathan. 2004. The effect of internet security breach announcements on market value: Capital market reactions for breached firms and internet security developers. *International Journal of Electronic Commerce*, Vol. 9, No. 1, pp. 70- 104.
- Donelson, D. C., J.M. McInnis, R.D. Mergenthaler, and Y. Yu. 2012. The timeliness of bad earnings news and litigation risk. *The Accounting Review*, Vol. 87, No. 6, pp. 1967-1991.
- Gerding, E. 2023. Cybersecurity disclosure. U.S. Securities and Exchange Commission: www.sec.gov/news/statement/gerding-cybersecurity-disclosure-20231214.
- Hampton, C., S.G. Sutton, V. Arnold, and D. Khazanchi. 2021. Cyber supply chain risk management: Toward an understanding of the antecedents to demand for assurance. *Journal of Information Systems*, Vol. 35, No. 2, pp. 37-60.
- Kothari, S. P., S. Shu, and P.D. Wysocki. 2009. Do managers withhold bad news? *Journal of Accounting Research*, Vol. 47, No. 1, pp. 241-276.

Libby, R., and H.T. Tan. 1999. Analysts' reactions to warnings of negative earnings surprises. *Journal of Accounting Research*, Vol. 37, No. 2, pp. 415-435.

Simnett, R., A. Vanstraelen, and W.F. Chua. 2009. Assurance on sustainability reports: An international comparison. *The Accounting Review*, Vol. 84, No. 3, pp. 937-967.

Skinner, D. J. 1994. Why firms voluntarily disclose bad news. *Journal of Accounting Research*, Vol. 32, No. 1, pp. 38-60.

Skinner, D. J. 1997. Earnings disclosures and stockholder lawsuits. *Journal of Accounting and Economics*, Vol. 23, No. 3, pp. 249-282.

Stark, T. 2023. New SEC cyber rules are about to go into effect. Expect some bumps. *Washington Post: The Cybersecurity 202*.
www.washingtonpost.com/politics/2023/12/14/new-sec-cyber-rules-are-about-go-into-effect-expect-some-bumps/.

Sutton, S.G., D. Khazanchi, C. Hampton, and V. Arnold. 2008. Risk analysis in extended enterprise environments: Identification of critical risk factors in B2B e-commerce relationships. *Journal of the Association for Information Systems* Vol. 9, No. 3-4, pp. 151-174.

U.S. Security and Exchange Commission Division of Corporation Finance (SEC). 2011. CF Disclosure Guidance: Topic No. 2 Cyber Security.

Wallace, W. A. 1980. The economic role of the audit in free and regulated markets. *OpenEducation Resources*, 2.

Wallace, W. A. 2004. The economic role of the audit in free and regulated markets: A look back and a look forward. *Research in Accounting Regulation*, Vol. 17, pp. 267-298.

Sustainability Reporting Standards: Evidence from the Athens Stock Exchange

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Purpose

The purpose of the present study is to explore whether companies' size and their industry type influence their management's decision to adopt sustainability standards. As Kinderman (2020) observes, while financial reporting is required by law, non-financial disclosure is usually voluntary, in other words a matter of full discretion of company executives. According to Boiral and Heras-Saizarbitoria (2020), when non-financial disclosure takes place, assurance statements for sustainability reports tend to appear as unreliable, with a hyperreality trend. Along the lines with the above is the research of Tsalis et al. (2020) who, while studying a small number of Greek companies during the period 2014-2016, observe that companies provide more information about their strategies for the environment and much less about their strategies for society and corporate governance.

Methodology

Our analysis was conducted on companies listed on the Athens Stock Exchange. Setting the 25th of January 2024 as the reference date, one hundred sixty-four (164) companies listed on the Athens Stock Exchange were recorded. We collected data from their annual financial reports of the year 2022, as well as from their sustainable development reports of the same year. Given the fact that many standards exist, we used multiple linear regression, in order to examine the compliance of Greek companies with three (3) frameworks for sustainable development: the Ten Principles

of the United Nations Global Compact (UNGC), the 17 United Nations Sustainable Development Goals (SDGs) and the Athex ESG Stock Exchange Index.

Findings

According to Directive (EU) 2022/2464, listed companies with more than 500 employees are required to report in accordance with sustainability reporting standards. Companies will have to apply the new rules for the first time in the 2024 financial year, for reports published in 2025 (European Parliament, 2022). Up until then, companies follow European Directive 2014/95/EU, which states that large public-interest companies exceeding 500 employees should include in their report a non-financial statement with information on environmental, social and labor matters. After studying the annual financial reports of the 164 companies for the year 2022, as well as their sustainable development reports of the same year, we spotted forty-seven (47) with more than 500 employees, categorized as large companies, that comply with sustainability standards: twenty-one (21) large companies applied all three (3) International Sustainability Standards under research, while only five (5) listed companies applied none of the above. Thirty-four (34) met the conditions for inclusion in the Athex ESG stock market index, while only twenty-nine (29) companies adopted the ten Principles of the United Nations Global Compact (UNGC). Finally, thirty-five (35) large companies adopted the 17 United Nations Sustainable Development Goals (SDGs).

Originality

Our paper contributes to the international literature by providing an empirical depiction of the extent of sustainability standards adoption by companies listed on the Athens Stock Exchange. Furthermore, our research examines the role that the companies' size, as well as their industry sector, play in the adoption of Sustainability Standards.

Limitations

The limitation of our research lies in the fact that the companies under research were drawn from the website of the Athens Stock Exchange in the year 2024, while the Annual Financial Reports and the Sustainable Development Reports of the companies inevitably refer to the year 2022. Monitoring sustainability reporting standards for the coming years will be of interest.

Keywords

Sustainability Reporting Standards, companies' size, industry sector, Athens Stock Exchange, Ten Principles of the United Nations Global Compact (UNGC), 17 United Nations Sustainable Development Goals (SDGs), Athex ESG Stock Exchange Index.

References

- Boiral, O. and Heras-Saizarbitoria, I. (2020), "Sustainability reporting assurance: creating stakeholder accountability through hyperreality?", *Journal of Cleaner Production*, Elsevier, Vol. 243, p. 118596.
- Directive 2014/95/EU of the European Parliament and of the Council of 22 October 2014. (2014), *Amending Directive 2013/34/EU as Regards Disclosure of Non-Financial and Diversity Information by Certain Large Undertakings and Groups*, Strasbourg.
- Directive (EU) 2022/2464 of the European Parliament and of the Council of 14 December 2022. (2022), *Amending Regulation (EU) 537/2014, Directive 2004/109/EC, Directive 2006/43/EC and Directive 2013/34/EU, as Regards Corporate Sustainability Reporting*, *Official Journal of the European Union*, Strasbourg.
- European Parliament. (2022), "Sustainable economy: Parliament adopts new reporting rules for multinationals", 10 November, available at: <https://www.europarl.europa.eu/news/en/press-room/20221107IPR49611/sustainable-economy-parliament-adopts-new-reporting-rules-for-multinationals> (accessed 27 April 2024).
- Kinderman, D. (2020), "The challenges of upward regulatory harmonization: The case of sustainability reporting in the European Union", *Regulation & Governance*, Wiley Online Library, Vol. 14 No. 4, pp. 674–697.
- Tsalis, T.A., Malamateniou, K.E., Koulouriotis, D. and Nikolaou, I.E. (2020), "New challenges for corporate sustainability reporting: United Nations' 2030 Agenda for sustainable development and the sustainable development goals", *Corporate Social Responsibility and Environmental Management*, Wiley Online Library, Vol. 27 No. 4, pp. 1617–1629.

The impact of executives' financial background on corporate innovation

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Abstract

Based on the data sample of A-share manufacturing firms listed in China's Shanghai and Shenzhen markets from 2016 to 2022, this paper provides an in-depth discussion of the relationship between executives' financial background and corporate innovation while examining the moderating role of managerial ownership. The study finds that top managers with financial background are willing to take up funds that could be allocated to innovative projects due to a preference for investments in financial assets and projects that are familiar to the individual and quick returns to improve their performance, which is consistent with the crowding out theory. Further research finds that if executives hold shares, their interests will converge with those of shareholders rather than being limited to improving short-term performance for personal gain, so they will be more concerned with the long-term development and value of the company and will focus on innovative investments that bring essential improvements to the company in their decision-making. Furthermore, the negative impact of executives' financial background on firms' innovation diminished after the COVID-19 pandemic, leading to the conjecture that the epidemic caused executives to place more excellent value on firms' ability to innovate.

Keywords

Corporate innovation, financial performance, executive background, managerial ownership

Introduction

Innovation is the main driving force that leads to national strength and social development, as well as the primary engine that promotes efficient and sustainable economic development. As major economic activity participants, enterprises are critical players in promoting the high-quality development of the national and global economy. Innovation is not only the requirement of the state for enterprises but also the need of the companies themselves. In the business environment, marketing is the king of the era has gradually declined, the current era of more emphasis on good products, which requires firms to engage in innovative activities to generate a steady stream of products that meet consumer needs. In the commercial market, competitiveness with existing companies in the industry is crucial for the company, and innovation can help them measure their strengths and weaknesses and thus provide direction and motivation to compete (Zhao et al., 2022). For a company, innovation is the foundation and power source of development, which not only means that the firm can master more and more science and technology to promote the sustainable development of the company but also can guide the research and development force of the enterprise to reform and improve the products from the source that can support it to increase the performance (Azar and Ciabuschi, 2017). It can enable enterprises to increase the potential value and and promote the joint development of many aspects, including scientific and technological innovation, business model innovation, management innovation, product innovation, etc., so that the product shows diversity or uniqueness and thus walks into the industry's forefront. Now the era of continuous development, customer demand is also changing, if an enterprise stagnation to keep pace with the times will certainly be eliminated by the market, but it knows how to change with the market and continue to carry out research and development, improves the ability of the innovation and enhances the core competitiveness of the company will continue to survive and be in a favourable position in the peer competition.

According to the separation of powers theory, the ownership of a company belongs to the shareholders, while the control power belongs to the executives. As an indispensable and essential position in a firm, top managers have a very significant influence on all kinds of decisions, from daily operations to long-term strategy, so they need to have enough professionalism and good decision-making skills of their own to support their management of the company (Pfeifer, 2015). With the growing realisation of how much influence executives have over their companies, scholars have made the research of executives a concern. In recent years, there have been a number of studies in this area in different directions, which explain the impact of the different characteristics and backgrounds of executives on various aspects of the firm, including the influence on firm innovation. Of these studies, the vast majority have produced more successful results and a consistent view. For instance, overconfidence (Galasso and Simcoe, 2011; Hirshleifer et al., 2012; Li and Zhang, 2022) and narcissism (Zhang et al., 2017; Kashmiri et al., 2017) on the part of senior managers can drive companies to increase innovation. Other examples are younger (Barker and Mueller, 2002; Chowdhury and Fink, 2017), more educated (Lin et al., 2011), more diverse in education (Bromiley and Rau, 2016), studying polytechnics or science-related professions (Loukil et al., 2020), with higher levels of trust (Kong et al., 2021) and with overseas background and experience (Cao et al., 2022) executives are more likely to focus on innovation-related activities. However, there are still several areas where no uniform conclusions have been reached so far, such as gender (Han et al.,

2019; Strohmeyer et al., 2017; Prabowo and Setiawan, 2021) and tenure (Barker and Mueller, 2002; Wu, 2014; Cucculelli, 2018) of executives. In addition to these, the impact of executives' financial backgrounds on corporate innovation has also yet to yield a consistent view. On the one hand, it is argued that the financial experience of executives can help firms to gain advantages in terms of finance, just like credit, which ensures that all types of innovative activities are carried out and that they can use their expertise to enable firms to improve the efficiency of their investments, including investments in innovation (Cosci et al., 2016; Li et al., 2023). On the other hand, some scholars believe that senior managers with a financial background are more likely to invest in more established and lucrative projects rather than innovative projects where there are too many unknowns, and they also favour financial investments that have shorter investment cycles, quicker profitability and are more familiar and specialised thus crowding out investments in innovation (Custodio and Metzger, 2014; Liu et al., 2020). Moreover, some findings indicate that the presence or absence of finance or accounting background of executives has no significant effect on firms' innovation (Barker and Mueller, 2002). Therefore, it is necessary to conduct further research on the relationship between executives' financial background and firm innovation.

In particular, with the dramatic impact of the COVID-19 pandemic on the business environment globally in 2019, the market environment has changed considerably, and many of the previous findings are likely to change with it. Therefore, it is necessary to conduct research considering the impact of the COVID-19 pandemic.

The purpose of this paper is to examine the impact of executives' financial backgrounds on firm innovation, explicitly considering the moderating effect of executive shareholdings and the contrasting effects before and after the epidemic. By analysing a sample of Chinese manufacturing firms listed on the Shanghai and Shenzhen stock exchanges from 2016 to 2022, this paper finds that the financial background of executives plays a negative role in corporate innovation. However, this negative effect can be moderated by increasing executive shareholding. In addition to these, this paper also demonstrates that the negative effect of executives' financial background on firms' innovation is reduced after the COVID-19 pandemic compared to the pre-epidemic period, which can reflect the fact that the impact of the epidemic has had a considerable impact on firms causing executives to pay more attention to innovation activities as well.

This study makes several contributions: Firstly, it uses a different way of measuring innovation than most other existing studies in this direction. Past research has primarily measured the level of innovation in terms of the number of patents in such away that it focuses on the outputs and outcomes of innovation at the expense of the inputs. It is worth noting that patents are not necessarily converted into productivity, and many patents are just in name only and do not play any role in the enterprise. Having more patents like this is meaningless, so the number of patents cannot be a good measure of innovation. By using the indicator of R&D investment as a proportion of operating revenue to measure innovation, this paper focuses on the firm's investment in innovation, thus complementing other studies and literature in the field that focus only on outputs. Secondly, few studies in the field to date take the COVID-19 pandemic into account, and the vast majority of the literature needs to include pre-epidemic and post-epidemic comparisons, so this paper supplements this

missing section. Thirdly, this paper adds to the scholarship on the issue and does its part to reach an early and consistent conclusion.

Literature Review

This paper collates and summarises the literature on corporate innovation and executive characteristics and is divided into the following three sections. Overall, there has been much literature on the many different characteristics of executives that have varying degrees of impact on corporate innovation, but there has yet to be a unified conclusion on the impact of executives' financial background on innovation. Some scholars believe that finance experts can help firms to have an advantage in borrowing and thus obtaining sufficient funds to promote innovative activities, while others argue that knowledge of financial expertise makes them more willing to invest in financial assets and thus preempts investment in innovation. Therefore, the issue needs further research and analysis.

He and Tian (2018) claim that corporate innovation is a decisive factor in a company's long-term competitive position in the marketplace and is widely noted. It can also help companies to assess their strengths and weaknesses better and drive them forward (Zhao et al., 2022). In different cycles of economic development, innovation can take on different characteristics, especially in times of recession or exploring new markets, when disruptive innovation is likely the only but powerful way to break the deadlock (Yu & Hang, 2010). However, it is a long-term process with high risks, and small mistakes can lead to the failure of a significant investment of human and material resources (Bergemann & Hege, 2005; Hall et al., 2005; Holmstrom, 1989). Innovation is therefore crucial for a company. According to past research, it is influenced by a combination of external environmental factors and internal organisational factors.

Many scholars have made numerous findings from the perspective of external environmental factors. According to Yi et al. (2012), institutional environment unpredictability has a significant impact on innovation. Fang et al. (2017) further stress the significant influence of external institutions, showing that innovation is higher where there is a high level of intellectual property protection and that different outcomes are depending on the nature of the firm under the influence of the institution, with privately owned firms generally outperforming state-owned firms in terms of quantity and quality of patents. Howell (2017) analyses the US market and finds that regular government R&D subsidies can effectively incentivise firms to undertake innovative R&D activities and positively impact patent applications, and that these effects are powerful for financially constrained firms. Through the analysis, Bradley et al. (2017) illustrate how trade unions as separate entities have a detrimental effect on corporate innovation. Bhattacharya et al. (2017) demonstrate how uncertainty about external policies seriously affects businesses' innovative activity. Brown and Martinsson (2019) research the information environment, finding that the information richness in the market is conducive to enterprises' research and development. Lou et al. (2022) additionally state that changes in external national policies significantly impact the behaviour of firms, including innovation, and the uncertainty in economic policy can negatively impact firms' innovation.

There have also been many research results from the perspective of internal organisational factors. Through a study of 180 business undergraduates, Chen et al.

(2012) argue that corporate incentives have a stimulating effect on innovation. One study suggests that the internal competitive environment of the company also has an impact on the company's innovation, significantly since a highly uncertain competitive environment may inhibit the company's innovation ability (Qian et al., 2013). Minetti et al. (2015) find the relationship between firm ownership structure and corporate innovation, where conflicts and contradictions between major and minor shareholders can harm innovation when corporate ownership is concentrated. Tian et al. (2018) analyse how this affects corporate innovation from the organisational culture perspective and identify a complex relationship between the two for further research. Zhong (2018) focuses on the role of transparency in companies, finding that it is effective in improving the efficiency of innovation in companies and the management of research and development work. Krammer (2022) takes the human resource policy as an example to verify the impact of corporate policy on corporate innovation, such as performance-based compensation policy can effectively improve enterprises' innovation ability, which is in line with Chen et al. (2012).

As one of the most influential people in a company, any decision made by an executive has a massive impact on the firm. Because of the complexity of the internal and external environments of an organisation, it is impossible for managers to have complete control over the whole environment and everything. Based on past research, characteristics can be divided into personality and personal background. For the former, Peterson et al. (2012) examine the relationship between the personalities of executives and firm performance, specifically that low levels of narcissism and founder experience contribute to their leadership behaviour and thus to firm performance. Huang et al. (2022) focus on the risk tolerance of senior managers, demonstrating through the introduction of incentives that CEOs who struggle with risk need higher compensation and more benefits to make risky strategic decisions, which complements research on the influence of bias in the minds of executives on their decision-making. For the latter, Hambrick and Mason (1984) argue that executives' decisions are highly subjective and are influenced by their personal experiences and cognition, among other things, which is consistent with the view of the Upper Echelon theory. Muttakin et al. (2019) study CEOs with the background in chief financial officer work experience and concluded that such executives make more conservative decisions on financial matters.

In particular, there are a number of scholars who have also produced research in the area of the financial background of executives. Custodio and Metzger (2014) believe that CEOs with a financial background are more financially sophisticated, they are more sensitive and responsive to relevant financial information, and they are willing to maintain a lower level of cash and increase the debt financing of firms. In addition to this, these executives may also be able to benefit from their past personal relationships in financial institutions. Kalelkar and Khan (2016) study the direction of audit fees and find that if senior executives are financial experts, they will effectively reduce the audit fees of firms mainly because there are less likely to manage earnings under the management of such CEOs. Oradi et al. (2020) argue that there is a negative relationship between the financial background of executives and internal control deficiencies from an internal control perspective, which in turn shows that they can help companies deal with the problems they encounter when managing internal controls. Xu and Zhang (2023) demonstrate that the financial background of executives has a dampening effect on the artificial intelligence transformation of companies in the manufacturing sector, even though this is a trend in technology

development. Therefore, the financial background of executives has a significant impact on them personally and their companies.

To date, there have been many research findings in this area, and they can also be divided into two perspectives: personality traits and background traits.

On the one hand, it focuses on the perspective of personality traits. The first is in relation to the overconfidence of executives, and there are relatively uniform views about it. Galasso and Simcoe (2011) believe that overconfident executives are more likely to lead their companies towards innovation and that this influence is exacerbated by competition in the marketplace. Hirshleifer et al. (2012) hold the same view that overconfident executives choose to invest more in research and development activities and thus increase the innovation capacity of their companies, in addition to finding that such senior managers can exploit opportunities more fully and efficiently and increase the value of their companies, but these are limited to innovative industries. Li and Zhang (2022) also find the same points when they apply the study to the Chinese market that the overconfidence of CEOs is positively correlated with the ability to innovate of their firms and is more likely to achieve innovative research and development results in new areas. The second is about executive narcissism. Using multiple sources of data, Zhang et al. (2017) find that narcissistic senior managers are more likely to foster a culture of innovation and achieve innovative performance. Kashmiri et al. (2017) used the sample of US listed companies to verify that narcissistic CEOs tend to introduce more new products into their companies and are more willing to break new ground. Furthermore, there are many other directions of research in this field.

On the other hand, it focuses on the perspective of background traits. In terms of ages, Barker and Mueller (2002) concluded from a study of 172 companies that companies with younger CEOs generally have higher R&D expenditures. Chowdhury and Fink (2017) verify the indirect relationship between the age of senior managers and firm risk and argue that older CEOs may spend less on risky projects such as research and development at the expense of firm value under the same investment condition, which is similar to the conclusion of Barker and Mueller (2002). In terms of genders, Han et al. (2019) support the role of gender diversity in executive management, finding that female CEOs significantly contribute to innovative behaviour in companies and that the more equal the gender culture in companies, the more conducive they are to innovation. The results of Prabowo and Setiawan's study (2021), based on a sample of some developing and underdeveloped countries, are consistent with those of Han et al. (2019) in demonstrating that firms led by female CEOs are more likely to be more innovative, and in finding that firm size and female ownership have a positive impact on their innovation. However, Strohmeier et al. (2017) argue that female executives are more risk-averse than male executives and therefore firms are less innovative, but they also show that areas such as organisational innovation and marketing innovation are not influenced by gender. Therefore, there is still controversy about the impact of executive gender on corporate innovation that requires further research in the future. In terms of tenure, Wu (2014) research the Chinese market and find that the tenure of CEOs enhances their knowledge of the industry and thus contributes to the product innovation activities of companies. Nevertheless, Cucculelli (2018) stresses the importance of short-tenured executives and believes that such executives could drive the innovation activities of the firms more effectively. Moreover, there is research that demonstrates that the impact of a CEO on a company's R&D expenditure

increases with his or her tenure (Barker and Mueller, 2002). Thus, there is controversy in this area as well. In terms of the educational level and educational background, Lin et al. (2011) study 1,088 companies from China and show that the executives with high levels of education are willing to invest more in companies' innovation activities, which contribute to new product development and sales. Bromiley and Rau (2016) believe that the educational diversity of executives has a positive effect on the innovation efficiency and output of firms. Loukil et al. (2020) target the developed market, France, for example, and analyse thirteen years of data to find that executives with different educational backgrounds invest differently in innovation in their companies. Specifically, the CEOs who are business-educated favour short-term lucrative investments at the expense of long-term and high-risk projects and therefore they are more likely to spend less on innovation activities, while the CEOs educated in science-related disciplines are more inclined to try and introduce new things and changes and are more willing to invest more of their budget in innovation activities. However, Barker and Mueller (2002) argue, in contrast to many academics, that there is no significant relationship between the executives' educational attainment and the R&D expenditure of firms when they have obtained a university degree, but that if the executives' field of study is science-related, it significantly increases the R&D expenditure of companies, which is consistent with the conclusions of Loukil et al. (2020).

From the above, it can be seen that many of the characteristics of top managers play a significant role in the innovation activities of a company. However, there are inconsistencies in the results of the previous research regarding the relationship between the financial background of executives and corporate innovation, with some suggesting a positive correlation, others a negative correlation, and still others suggesting that there is no significant correlation between the two. Sampling and analysing European markets, including larger countries such as the UK and France, as well as smaller countries such as Austria and Hungary, Cosci et al. (2016) find that firms are generally more constrained in their funding for innovation and are hindered from innovating, which leads to a high need for bank lending, but that executives with financial backgrounds can help firms to mitigate such problems effectively. The financial background of top managers helps reduce information asymmetries and plays a positive role in banks' assessment of a company's credit programme, which in turn helps the company obtain more R&D funding to invest in innovative activities. Li et al. (2023) demonstrate how senior managers with finance backgrounds can use their expertise to help companies reduce the incidence of investment inefficiencies and increase efficiency, including investment in innovation, to improve company performance. Therefore, compared with companies with non-financial CEOs, companies with financial CEOs have easier access to the capital market and stronger financing capabilities, and they have more specialised advantages in capital operations such as fund-raising and investment, which are more conducive to the increase in R&D investment, and thus the increase in R&D results. However, Custodio and Metzger (2014) find that CEOs who are financial experts are willing to invest in more mature, successful and profitable projects, and that they are more likely to favour innovative projects with sufficient evidence of success, reflecting a failure to create an environment conducive to innovative business activity. Focusing on data from the Chinese market and introducing the crowding out theory, Liu et al. (2020) prove that executives with financial backgrounds, due to performance and pressure from stakeholders, are more likely to invest in financial investments in which they are

more specialised and have a shorter payback period, thus crowding out funds invested in R&D, etc., given their limited financial resources, and ultimately negatively affecting the firm's innovation activities. The exposure effect in social psychology suggests that the general public prefers what they know, and individuals make behavioural choices that favour what they are good at and away from what they are not good at, which supports the view of Liu et al. (2020) that financial expert executives prefer to invest in financial assets. Hence, CEOs with financial experience are better at working with capital, and therefore they are more likely to work with capital and invest less in research and development. Furthermore, the findings of Barker and Mueller (2002) in examining the impact of six different career experiences of CEOs on firm innovation show no significant correlation between executives' financial or accounting backgrounds and firm innovation. While CEOs with finance backgrounds are backed by expertise in corporate finance and risk assessment, their impact on corporate investment and venture innovation remains to be determined.

Overall, although there has been some literature on the relationship between executives' financial background and corporate innovation, it has yet to yield a unified view, and further research is necessary to provide new evidence. Moreover, given the significant impact of culture on businesses and managers worldwide and the fact that there is now more research on Western nations, it is essential to increase the examination of the Chinese market. Moreover, due to the outbreak of COVID-19 in 2019, the global economy and enterprises in various countries have been affected to varying degrees, but only a limited number of studies have considered it, so it is also necessary to verify its impact on corporate innovation.

Hypothesis Development

Based on the above literature review section on the impact of executive characteristics, it is clear that the characteristics of senior managers have a crucial role in the company's operations and decision-making. Marquis and Tilcsik (2013) develop the classic imprinting theory, based on the higher echelon theory, which emphasises the need for a certain environmental sensitivity period for the formation of values and cognitive foundations. This theory suggests that the "cognitive imprint" formed during the sensitive period will have a lasting impact on their subsequent careers. The financial industry is typically a high-risk, high-return and seductive industry, and the financial experience of executives constitutes a sensitive period in the environment (Calluzzo and Dong, 2015). Managers with finance experience have a more specialised and in-depth knowledge of the financial sector, which they can use to help their company make decisions on investments and other related areas. (Graham et al., 2013). Due to their relative familiarity with the workings of financial markets and investment strategies, when executives from financial backgrounds invest in financial assets, the "cognitive imprint" of the financial industry tends to make executives overconfident in investing in financial assets, thereby underestimating the risks of financial investments and developing a preference for financial investments. Based on the crowding out effect mentioned earlier, the increasing share of financial assets, given limited resources, will inevitably crowd out investment in innovation and lead to a decline in the return on physical investment, which provides medium to long-term profits for companies. As a result, even less investment in innovation hinders the development of innovative companies.

In addition, due to the late start of the Chinese capital market and the imperfect regulatory mechanism, there are many speculators in the market who engage in short-term arbitrage. Laverty (1996) also states that managers make decisions in favour of investing in short-term profitable projects to improve the performance of firms quickly. The "cognitive imprint" of executives from financial backgrounds is likely to lead them to develop a mindset of using short-term speculation to make profits, while the high investment and long cycle nature of innovation activities is contrary to the short-term speculation philosophy of executives from financial backgrounds, so they are reluctant to engage in such long cycle and high-risk investment activities and are therefore likely to reduce innovation spending.

In summary, the financial experiences of top managers can cause them to devote less attention to innovative activities when making company decisions. Therefore, the first hypothesis H1 of this paper is proposed:

H1: The financial background of executives has a negative impact on firm innovation.

According to the theory of separation of powers, the ownership and control of a company are intended to be separated, with the former belonging to the shareholders and the latter to the manager of the company, which creates a principal-agent conflict between the two parts. Based on the agency problem, shareholders, as owners of the company, pursue the long-term development of the company to maximise their own interests, while executives, as decision-makers of the company, pay more attention to the short-term growth of the company's performance and therefore are likely to give up some of the longer-term profitability of the project, so there is a conflict of interest between the two (Zardkoohi et al., 2017). As can be seen from the above, the innovative activities of firms can contribute to their growth and competitiveness, which undoubtedly benefits shareholders. But at the same time, these activities are long-term and high-risk, which is detrimental to the performance of senior managers and to their personal interests.

In the face of agency problems, the managerial ownership can effectively help converge the interests of managers and shareholders, thus reducing agency costs and making senior managers more concerned about the long-term development and value of the company (Rashid, 2016). As executives hold more shares, the more their interests are aligned with those of their shareholders, so as executives' interests become more closely aligned with those of their shareholders, the more they will consider how to maximise the value of the firm and the more likely they will invest in innovation-related activities to improve the competitiveness and growth of firms (Lin et al., 2011). The financial background of senior managers has led them to place greater emphasis on financial assets for short-term profitability at the expense of innovative investments, but when they hold the stake of the company, they take on the position of not just being managers of the company, but also owners of the company, which makes them think more about the long-term interests of the company than about short-term performance growth. Consequently, managerial ownership allows CEOs with the financial background to focus more attention on investing in innovative activities.

In summary, the managerial ownership of top managers aids in reducing the detrimental effects of their financial backgrounds on business innovation. Therefore, the second hypothesis H2 of this paper is proposed:

H2: Executives' managerial ownership contributes to reducing the negative impact of their financial background on enterprise innovation.

With the outbreak of COVID-19 in 2019, the economies of countries worldwide have been hit hard, with numerous businesses unable to function and facing the prospect of bankruptcy. As a result of the various policies implemented as a result of the epidemic, such as entry and exit restrictions and mandatory quarantine, there have been many changes in the daily lives of people, including government agencies, companies and organisations, which have been greatly affected (Zimmerling and Chen, 2021). For a company, its production and business activities cannot be carried out generally during the epidemic, and it also needs more human and material resources. It is difficult to survive if it remains in its original state, so innovation and development to improve competitiveness is urgent. The COVID-19 epidemic is both an opportunity and a challenge for companies, the market fluctuates considerably many companies are overwhelmed by the pressure and choose to go out of business, but innovation is their weapon in the face of the challenge, which can help them to be in a favourable position in the wave of competition.

In summary, the COVID-19 pandemic is a driver that can drive business innovation and has the potential for long-term impact, resulting in executives with financial backgrounds being more focused on innovation in their companies. Therefore, the last hypothesis H3 of this paper is proposed:

H3: Under the influence of the COVID-19 pandemic, executives with financial backgrounds place more emphasis on innovation in their companies than in the past.

Methodology

This study examined A-share companies listed in Shanghai and Shenzhen and selected a sample of companies in the manufacturing sector. The manufacturing industry is one of the main drivers of national economic growth, playing a vital role in the entire economic system, and it is also a vital driving force for scientific and technological innovation, which requires constant technological updating and improvement to promote the research and development of new products and the improvement of production processes. Therefore, the manufacturing industry, which is an essential and representative industry, is chosen as a sample for the study. The data selected are between 2016 and 2022 that from the CSMAR and the BoardEx.

In this paper, the sample is screened as follows: (1) ST and *ST firms are excluded; (2) firms with missing or abnormal financial data are excluded; (3) firms listed in the current year are excluded. After the screening, 10500 sample data were finally obtained.

Variable definitions

There are two main ways to measure corporate innovation: one is the intensity of innovation input, usually measured by the natural logarithm of R&D expenses, the natural logarithm of R&D personnel, the ratio of R&D expenses to the total number of employees, the ratio of R&D expenses to operating revenues, and the ratio of R&D

expenses to total assets; and the other is the outcome of innovation output, usually measured by the number of patents filed and the number of patents granted. Past studies have typically used the number of patents as a measure of innovation (Galasso and Simcoe, 2011; Fang et al. 2017; He and Tian, 2018; Liu et al. 2020). However, this paper mainly focuses on the degree of importance that the top managers with financial background to the corporate innovation, therefore, the explained variable is selected as corporate innovation input indicators, and the proportion of R&D expenses to operating income is used to measure corporate innovation. The proportion of R&D expenses to operating revenues can effectively avoid errors caused by large gaps in R&D investments due to factors such as company size.

The executives referred to in this paper are represented by the Chief Executive Officers. CEOs are the leaders of the firm and have the ultimate executive, operational, managerial, and decision-making authority in firms, and therefore, the degree of emphasis on innovation has a decisive impact on the innovation input of enterprises. The financial background of executives refers to the experience of top managers in financial institutions such as policy banks, commercial banks, insurance companies, securities companies, fund management companies, futures companies, investment banks, trust companies, investment management companies, and exchanges. In order to measure this variable, this paper uses a dummy variable value 1 to indicate that the CEO has a financial background and vice versa with value 0 to indicate that there is no financial background.

Some studies of management share ownership have demonstrated the benefits it can bring to a company (Lin et al., 2011; Rashid, 2016). It can be calculated by dividing the number of shares held by the manager by the total number of shares in the company, where the number of shares held by the CEO is used instead of the number of shares held by the manager.

Control variables

Based on the results of previous studies in the related areas, the following control variables were selected for this paper: board size (BSIZE), percentage of independent directors (INDEP), age of the company (AGE), size of the company (SIZE), gearing ratio (LEV), return on assets (ROA), net profit growth rate (GROWTH), gender of executives (GENDER), overseas background of executives (OVERSEAS), and the percentage of shares held by the largest shareholder (TOP1).

BSIZE is the number of directors on the board. INDEP is obtained by calculating the ratio of the number of independent directors to the size of the board. AGE is measured by the number of years the company has been in existence. Because the value of company size is excessively huge and varies greatly across firms, SIZE is calculated by taking the logarithm of the firm's total assets. LEV is calculated by dividing total liabilities of the company by its total assets at the end of the year. ROA is the ratio of a company's net profit for the year to its total assets at the end of the period. By dividing the difference between the company's net profit for the current year and its net profit for the prior year by the prior year's net profit, GROWTH can be computed. GENDER is measured using a dummy variable, which is value 1 for men and value 0 for women. The same applies to OVERSEAS, which is valued at 1 if the executive has overseas experience, and 0 if he or she does not. The ratio of the number of shares

held by the first largest shareholder to the total number of shares in the firm can be calculated for TOP1.

Research model

In order to verify the relationship between the financial background of executives and firm innovation, the following model is derived based on the above hypotheses and modifications of previous studies:

Model 1:

$$\begin{aligned} INNO = & \alpha_0 + \alpha_1 FB + \alpha_2 BSIZE + \alpha_3 INDEP + \alpha_4 AGE + \alpha_5 SIZE + \alpha_6 LEV + \alpha_7 ROA \\ & + \alpha_8 GROWTH + \alpha_9 GENDER + \alpha_{10} OVERSEAS + \alpha_{11} TOP1 + \sum_{firm} \\ & + \sum_{year} \end{aligned}$$

Model 2:

$$\begin{aligned} INNO = & \alpha_0 + \alpha_1 FB + \alpha_2 FB * MO + \alpha_3 MO + \alpha_4 BSIZE + \alpha_5 INDEP + \alpha_6 AGE \\ & + \alpha_7 SIZE + \alpha_8 LEV + \alpha_9 ROA + \alpha_{10} GROWTH + \alpha_{11} GENDER \\ & + \alpha_{12} OVERSEAS + \alpha_{13} TOP1 + \sum_{firm} + \sum_{year} \end{aligned}$$

Modelling is done using double fixed effects, with model 2 being based on model 1 with the addition of the effect of the moderator variable MO. To make the results more accurate, it controls for firm and year fixed effects.

Regression Analysis

In order to verify the effect of senior managers' financial background on corporate innovation, the double fixed effects models were established, fixing the time effect and the individual effect of the firm respectively, and then the double fixed effects multiple regression was conducted using Stata, and the regression results are shown in Table 1.

The first is the analysis of Model 1 with no moderating effect. It shows that the financial background of executives has a significant negative impact on firm innovation (significant at the 5% level), and the degree of innovation of firms decreases by 6.9% with increasing the number of financial backgrounds of executives by one unit, which supports the hypothesis 1 (H1) of this paper holds. According to the imprinting theory, when executives are financial experts or have a financial background, their relevant experience, professional competence and knowledge will form an imprint on them that influences their thoughts and behaviours and is reflected in their cognitive and competence aspects (Marquis and Tilcsik, 2013). On the cognitive side, such senior managers prefer to make profits by choosing short-term and high-return investments based on their financial experience. In terms of competence, they are professionals in the financial field, they are familiar with financial instruments, they are good at considering and handling projects in this area,

and they have their own social network in the financial circle so that they can obtain relevant information more quickly, so they prefer to invest in financial assets and make the company more financial. Therefore, when CEOs who are financial experts make decisions, they tend to invest corporate funds in financial assets that they are more familiar with and understand, which makes limited funds unable to take into account other aspects at the same time and excludes other projects that could have been invested under the crowding out theory, including innovative projects such as product R&D and improvement, thus negatively affecting corporate innovation (Liu et al., 2020). With regard to the gender of executives and overseas background, the former has a non-significant negative effect on innovation, while the latter has a positive effect and is significant at the 10% level. Combined with the results of the correlation analysis in the previous section, there is a significant negative correlation at the 1% level between the gender of senior managers and corporate innovation, but after adding the effects of other variables, the linear relationship becomes weaker or there is multicollinearity with the other variables, so that in the overall view, gender has a negative impact on the company's innovation. Their overseas background significantly positively affects corporate innovation, as evidenced by a 46% increase in corporate innovation for each additional unit of overseas background. This is since senior managers with overseas backgrounds are able to learn about foreign knowledge and technologies that are leading or different from those in the country and have an international outlook, and such talents can make use of their comprehensive knowledge to complement each other's strengths and introduce advanced overseas technologies and management experience into the enterprise, thereby promoting corporate innovation and development. Therefore, it demonstrates the importance of executives from different backgrounds and characteristics to corporate innovation, and companies should try to diversify when recruiting top managers. For the other firm levels, the board size, percentage of independent directors, and firm age all show a boost to firm innovation at the 10% significance level, as evidenced by the fact that as they each increase by one unit each, the ratio of firms' investment in innovation increases by 8.3%, 5.3%, and 27.6% respectively. However, the coefficient of the gearing ratio is -0.187 and is significant at the 5% level, indicating that the gearing ratio inhibits firms from engaging in innovation. It is generally accepted that the level of corporate debt affects the investment efficiency of firms, and the maturity structure of debt also leads to underinvestment, especially in short-term debt, which can lead to inefficiencies including investment in innovation. In addition, senior managers tend to choose a more conservative investment strategy when faced with over-indebtedness in their firms, discouraging innovative activities that require long-term investment to generate returns. The remaining firm size, return on assets, profit growth rate, and the percentage of ownership of the first largest shareholder have no significant effect on corporate innovation.

Model 2 is based on model 1, with managerial ownership added as a moderator variable. The results of the regression show that when the CEO holds company stock, it can effectively promote corporate innovation with a coefficient of 0.126 and significant at the 5% level, and the interaction term FB*MO is also significant at the 5% level, suggesting that it moderates the effect of executive financial background on the level of firm innovation and the proof of hypothesis 2 (H2) is obtained. When top managers do not hold shares in their own companies, they only have control of the firms as professional managers, and at this time they are more concerned with short-term performance growth and thus demonstrate their ability to realise their interests.

However, when they hold the shares of firms, they are not only professional managers but also shareholders of the company, and their interests become jointly derived from short-term performance growth and the company's long-term development and value enhancement, which makes the value of the shares rise, so they need to think about the future of the company (Lin et al., 2011; Rashid, 2016). Innovation as a powerhouse of business development can fundamentally drive up the future value of a company, which leads financial expert executives who hold shares in their own companies to focus on innovative projects in their investment decisions rather than just those in the financial sector that they are familiar with. The other variables of the model basically maintain the same results as the model with no moderating effect under the influence of moderation, except that some coefficients change slightly, like the coefficient of executive financial background changes from -0.069 to -0.072, but the level of significance remains unchanged.

Table 1. Regression analysis

The results of regression analysis.

	(1)	(2)
	INNO	INNO
<i>FB</i>	-0.069**	-0.072**
	(-0.02)	(-0.03)
<i>MO*FB</i>		-0.259**
		(-0.31)
<i>MO</i>		0.126**
		(0.11)
<i>GENDER</i>	-0.127	-0.143
	(-0.10)	(-0.11)
<i>OVERSEARS</i>	0.460*	0.550*
	(0.37)	(0.42)
<i>BSIZE</i>	0.083*	0.091*
	(0.02)	(0.02)
<i>INDEP</i>	0.053*	0.053*
	(0.09)	(0.09)

<i>AGE</i>	0.276*	0.313*
	(1.57)	(1.70)
<i>SIZE</i>	-0.198	-0.258
	(-0.38)	(-0.48)
<i>LEV</i>	-0.187**	-0.156**
	(-0.08)	(-0.08)
<i>ROA</i>	-0.182	-0.060
	(-0.42)	(-0.37)
<i>GROWTH</i>	0.068	0.056
	(0.16)	(0.13)
<i>TOP1</i>	0.078	0.069
	(0.214)	(0.21)
<i>_cons</i>	10.42	10.42
	(0.71)	(0.71)
<i>N</i>	10500	10500

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Heterogeneity analysis

The samples were categorised chronologically before and after the COVID-19 pandemic in 2019, with data before 2019 categorised as pre-epidemic and those after as post-epidemic, and then analysed for heterogeneity, with results shown in Table 2. Compared to pre-epidemic, it finds that the coefficient of the effect of the financial background of executives on firm innovation changes from -0.056 to -0.034 after the COVID-19 pandemic and is significant at the 10% level and the 5% level, respectively, and that specifically an increase of one unit in the financial background of the CEOs in the pre-epidemic period will reduce the ratio of firms' innovation inputs by 5.6%, but after the epidemic, it will be reduced by only 3.4%. As a result, its negative impact on firm innovation slows down after the COVID-19 pandemic, proving that hypothesis 3 (H3) of this paper is valid. The impact of senior managers' gender and overseas background on innovation also improved after the epidemic, with the coefficient on gender going from -0.092 to -0.081 but still not significant, while overseas background rose from 0.119 to 0.221, suggesting that with the addition of one unit of executives with overseas backgrounds, the firm's ratio of investment in innovation goes from an increase of 11.9% to an increase of 22.1%.

In summary, it can be reflected that no matter what backgrounds or personal traits executives have, and no matter what kind of influence their characteristics may have on innovation, they all improve in the direction of favouring corporate innovation after the COVID-19 pandemic, which is manifested in that the negative impacts can be mitigated while the positive impacts have been enlarged. The economic impact of the epidemic on the world is enormous, in this calamity countless enterprises have high losses or even difficulty maintaining basic operations and chose to go bankrupt and close down. With the exception of a few industries such as healthcare and pharmaceuticals that are in great demand by society, the majority of industries are in great crisis and the business environment has changed drastically. In the case of the manufacturing industry analysed in this paper, most companies went through a difficult period of shutdowns, and when work resumed, they were constrained by policies, resources and many other conditions like supply chain disruption and were forced to innovate in order to maintain the old status quo, which was not possible in the post-epidemic environment. Not only is the post COVID-19 pandemic environment forcing enterprises to innovate, but the enterprises themselves need to take the initiative to innovate in order to seek long-term development and avoid unknown crises in the future. Also, taking the manufacturing industry as an example, with the development of information technology, the transformation and upgrading of the manufacturing industry in the direction of intelligent manufacturing and unmanned production is the trend of development in order to reduce the cost of production as well as to avoid the recurrence of crises such as the epidemic, which makes the shortage of labour resources, so the enterprises need to increase innovation to meet this trend. In addition to this, the core technology of many products is held in other countries, and the impact of the COVID-19 pandemic has led to restrictions on imports and exports, and companies relying on these imported parts or technology are likely to be unable to carry out production, which shows that enterprises need to step up R&D efforts to achieve their own technological achievements, and control their destiny in their own innovative capabilities (Zimmerling and Chen, 2021).

In other aspects of the analytical results, the effects of board size, firm age, firm size, and the percentage of ownership of the first shareholder on firm innovation all have improved after the epidemic and are significant at the 10%, 5%, 1%, and 5% levels, respectively. Firms with large board sizes and large shareholding of the first major shareholder have better monitoring of executives and corporate decision-making, and the board and shareholders can work together to push the firm to increase innovation to face the impact of the epidemic. And with their strong heritage, experience and resources, companies of higher vintage and larger scale will also proactively choose to increase their R&D efforts in the face of the impact of the outbreak in order to innovate for the future of their business.

Table 2. Heterogeneity analysis

The results of heterogeneity analysis.

	Before the COVID-19	After the COVID-19
	INNO	INNO
<i>FB</i>	-0.056*	-0.034**
	(-0.11)	(-0.07)
<i>GENDER</i>	-0.092	-0.081
	(-0.14)	(-0.12)
<i>OVERSEAS</i>	0.119**	0.221*
	(0.75)	(0.82)
<i>BSIZE</i>	0.042*	0.047*
	(1.29)	(1.31)
<i>INDEP</i>	0.088	0.074
	(1.06)	(0.95)
<i>AGE</i>	0.037***	0.045**
	(1.73)	(1.85)
<i>SIZE</i>	-0.068***	-0.054***
	(-3.28)	(-3.12)
<i>LEV</i>	-0.011**	-0.025**
	(-0.42)	(-0.440)
<i>ROA</i>	-0.142	-0.187
	(-7.91)	(-8.05)
<i>GROWTH</i>	0.0051	0.0044
	(0.003)	(0.002)
<i>TOP1</i>	0.017**	0.025**
	(2.56)	(2.68)
<i>_cons</i>	0.429**	0.512**
	(2.30)	(2.56)

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The Summary of Main Findings

This paper examines the impact of executives' financial background on firm innovation using data from a sample of manufacturing firms listed on China's Shanghai and Shenzhen stock exchanges from 2016 to 2022. The main findings and results are the following: (1) Compared to non-financial CEO firms, financial CEOs inhibit firm innovation to a certain extent. The reason for this is mainly due to the fact that financial expert executives are familiar with financial domain expertise and are also more likely to invest company funds in projects in their own domains of knowledge, such as financial assets, thus crowding out funds that could be invested in innovative projects. (2) Increasing executives' shareholding in the firm can mitigate the negative impact of their financial background on corporate innovation. When senior managers hold shares in the company, their interests become more connected or even convergent with those of the company's shareholders, so they also pay more attention to the future interests and long-term development of the company and value all kinds of innovative activities. (3) Compared to before the COVID-19 pandemic, the negative impact of senior executives' financial background on firm innovation is reduced after the pandemic. The epidemic has made it difficult for many companies to maintain day-to-day operations or even go out of business, and they have had to find ways to improve their competitiveness, so top managers, regardless of their backgrounds or attributes, are placing a greater emphasis on innovations that can help their organisations to get out of trouble and grow.

It takes a different approach to measuring innovation than the vast majority of the previous literature, in that the general measurement can be categorised into inputs and outputs, with almost all previous studies choosing the latter and very few using the former, so it rounds off the study of the issue and makes the results more accurate. At present, studies of the relationship between executive characteristics and corporate innovation have yet to take the COVID-19 epidemic into account. Although the epidemic is over it is undeniable that it has brought about many dramatic changes in people's lives and impacted many traditional industries, and it may have had a greater or lesser impact on the findings and conclusions of research in this area, so it is necessary to validate further the impact it has had. This paper goes some way to complement the research in this area.

The results of this study suggest a number of enlightenments and practical policies. Firstly, firms pursuing innovation should hire executives with diverse backgrounds and hiring more senior managers with financial backgrounds is not advantageous for fostering innovation. Having many CEOs who invest their money mainly in financial products because they are confined to their own comfort zones may crowd out innovation funding, leading to restrictions on innovation financing and thus negatively affecting innovation investment and outcomes. It can improve the management selection mechanism to avoid the decision-making bias caused by homogeneous selection, and enterprises should try to diversify their backgrounds when selecting executives, to achieve the optimal effect of the imprinting theory by complementing the strengths of various backgrounds. Secondly, the negative impact of executives' financial background on innovation can be moderated by increasing their shareholdings. Enabling senior managers to hold shares can mitigate conflicts

between them and shareholders and reduce the incidence of executives crowding out innovation funding in search of quick short-term returns on financial investments. Thirdly, executives of all backgrounds and characteristics should increase their focus on innovation, which, despite its high degree of uncertainty and risk, is still a powerhouse for the long-term future growth of firms. Overall, executives with diverse backgrounds and ownership of company stock can create a corporate environment that is more conducive to innovation.

There are some limitations to this paper. Firstly, different countries have different levels of economic development and business environments, and different environments for firms to innovate, like some countries have policies that are very supportive of innovation, which can go a long way in encouraging firms to focus on and invest in innovative activities. Secondly, different industries attach different importance to and rely on innovation, such as the manufacturing industry or high-tech industry than agriculture, services, etc. will attach more importance to innovation and invest more in this area, this paper only studied the manufacturing industry cannot represent the other industries that rely on innovation to a lesser extent. Thirdly, there currently needs to be an optimal way to measure innovation, neither from an input nor an output perspective, which both have certain limitations of their own. Lastly, due to the limited data available, only listed companies can be studied, but there is still a significant proportion of unlisted companies, so the results lack representativeness for other unlisted companies.

With regard to suggestions for future research, it should further study more companies in different country regions and different industries to arrive at a viewpoint that the academic community can uniformly recognise. And more effort could be put into the question of how to measure innovation in the future in order to find out the optimal way to measure it. In addition to these, future research could collect data from unlisted companies for the study thereby increasing the accuracy and representativeness of the results.

References

- Azar, G. & Ciabuschi, F. (2017), "Organizational innovation, technological innovation, and export performance: The effects of innovation radicalness and extensiveness", *International business review*, vol. 26, no. 2, pp. 324-336.
- Barker, V.L. & Mueller, G.C. (2002), "CEO Characteristics and Firm R&D Spending", *Management science*, vol. 48, no. 6, pp. 782-801.
- Bergemann, D. & Hege, U. (2005), "The Financing of Innovation: Learning and Stopping", *The Rand journal of economics*, vol. 36, no. 4, pp. 719-752.
- Bhattacharya, U., Hsu, P., Tian, X. & Xu, Y. (2017), "What Affects Innovation More: Policy or Policy Uncertainty?", *Journal of financial and quantitative analysis*, vol. 52, no. 5, pp. 1869-1901.
- Bradley, D., Kim, I. & Tian, X. (2017), "Do Unions Affect Innovation?", *Management science*, vol. 63, no. 7, pp. 2251-2271.
- Bromiley, P. & Rau, D. (2016), "Social, Behavioral, and Cognitive Influences on Upper Echelons During Strategy Process: A Literature Review", *Journal of management*, vol. 42, no.1, pp. 174-

Brown, J.R. & Martinsson, G. (2019), "Does Transparency Stifle or Facilitate Innovation?", *Management science*, vol. 65, no. 4, pp. 1600-1623.

Calluzzo, P. & Dong, G.N. (2015), "Has the financial system become safer after the crisis? The changing nature of financial institution risk", *Journal of banking & finance*, vol. 53, pp. 233-248.

Cao, X., Wang, Z., Li, G. & Zheng, Y. (2022), "The impact of chief executive officers' (CEOs') overseas experience on the corporate innovation performance of enterprises in China", *Journal of innovation & knowledge*, vol. 7, no. 4, pp. 100268.

Chen, C.X., Williamson, M.G. & Zhou, F.H. (2012), "Reward System Design and Group Creativity: An Experimental Investigation", *The Accounting review*, vol. 87, no. 6, pp. 1885-1911.

Chowdhury, J. & Fink, J. (2017), "How Does CEO Age Affect Firm Risk?", *Asia-Pacific journal of financial studies*, vol. 46, no. 3, pp. 381-412.

Cosci, S., Meliciani, V. & Sabato, V. (2016), "Relationship lending and innovation: empirical evidence on a sample of European firms", *Economics of innovation and new technology*, vol. 25, no. 4, pp. 335-357.

Cucculelli, M. (2018), "Firm age and the probability of product innovation. Do CEO tenure and product tenure matter?", *Journal of evolutionary economics*, vol. 28, no. 1, pp. 153-179.

Custodio, C. & Metzger, D. (2014), "Financial expert CEOs: CEO's work experience and firm's financial policies", *Journal of financial economics*, vol. 114, no. 1, pp. 125-154.

Fang, L.H., Lerner, J. & Wu, C. (2017), "Intellectual Property Rights Protection, Ownership, and Innovation: Evidence from China", *The Review of financial studies*, vol. 30, no. 7, pp. 2446-2477.

Galasso, A. & Simcoe, T.S. (2011), "CEO Overconfidence and Innovation", *Management science*, vol. 57, no. 8, pp. 1469-1484.

Graham, J.R., Harvey, C.R. & Puri, M. (2013), "Managerial attitudes and corporate actions", *Journal of financial economics*, vol. 109, no. 1, pp. 103-121.

Hall, B.H., Jaffe, A. & Trajtenberg, M. (2005), "Market Value and Patent Citations", *The Rand journal of economics*, vol. 36, no. 1, pp. 16-38

Hambrick, D.C. & Mason, P.A. (1984), "Upper Echelons: The Organization as a Reflection of Its Top Managers", *The Academy of Management review*, vol. 9, no. 2, pp. 193-206.

Han, S., Cui, W., Chen, J. & Fu, Y. (2019), "Female CEOs and Corporate Innovation Behaviors—Research on the Regulating Effect of Gender Culture", *Sustainability (Basel, Switzerland)*, vol. 11, no. 3, pp. 682.

He, J. & Tian, X. (2018), "Finance and Corporate Innovation: A Survey", *Asia-Pacific journal of financial studies*, vol. 47, no. 2, pp. 165-212.

Hirshleifer, D., Low, A. & Teoh, S.H. (2012), "Are Overconfident CEOs Better Innovators?", *The Journal of finance (New York)*, vol. 67, no. 4, pp. 1457-1498.

Holmstrom, B. (1989), "Agency costs and innovation", *Journal of economic behavior & organization*, vol. 12, no. 3, pp. 305-327.

Howell, S.T. (2017), "Financing Innovation: Evidence from R&D Grants", *The American economic review*, vol. 107, no. 4, pp. 1136-1164.

Huang, Y., Chin, Y. & Lee, C. (2022), "Which executive characteristics influence risk-taking

Kalelkar, R. & Khan, S. (2016), "CEO Financial Background and Audit Pricing", *Accounting horizons*, vol. 30, no. 3, pp. 325-339.

Kashmiri, S., Nicol, C.D. & Arora, S. (2017), "Me, myself, and I: influence of CEO narcissism on firms' innovation strategy and the likelihood of product-harm crises", *Journal of the Academy of Marketing Science*, vol. 45, no. 5, pp. 633-656.

Kong, D., Zhao, Y. & Liu, S. (2021), "Trust and innovation: Evidence from CEOs' early-life experience", *Journal of corporate finance (Amsterdam, Netherlands)*, vol. 69, pp. 101984.

Krammer, S.M.S. (2022), "Human resource policies and firm innovation: The moderating effects of economic and institutional context", *Technovation*, vol. 110, pp. 102366.

Laverty, K.J. (1996), "Economic "Short-Termism": The Debate, the Unresolved Issues, and the Implications for Management Practice and Research", *The Academy of Management review*, vol. 21, no. 3, pp. 825-860.

Li, Z. & Zhang, Y. (2022), "CEO Overconfidence and Corporate Innovation Outcomes: Evidence from China", *Frontiers in psychology*, vol. 13, pp. 760102-760102.

Li, Z., Pryshchepa, O. & Wang, B. (2023), "Financial experts on the top management team: Do they reduce investment inefficiency?", *Journal of business finance & accounting*, vol. 50, no. 1-2, pp. 198-235.

Lin, C., Lin, P., Song, F.M. & Li, C. (2011), "Managerial incentives, CEO characteristics and corporate innovation in China's private sector", *Journal of Comparative Economics*, vol. 39, no. 2, pp. 176-190.

Liu, B., Zhou, W., Chan, K.C. & Chen, Y. (2020), "Corporate executives with financial backgrounds: The crowding-out effect on innovation investment and outcomes", *Journal of business research*, vol. 109, pp. 161-173.

Lou, Z., Chen, S., Yin, W., Zhang, C. & Yu, X. (2022), "Economic policy uncertainty and firm innovation: Evidence from a risk-taking perspective", *International review of economics & finance*, vol. 77, pp. 78-96

Loukil, N., Yousfi, O. & Cheikh, S.B. (2020), "Innovation effort and CEO's characteristics", *International journal of innovation management*, vol. 24, no. 5, pp. 2050079.

Marquis, C. & Tilcsik, A. (2013), "Imprinting: Toward a Multilevel Theory", *The Academy of Management annals*, vol. 7, no. 1, pp. 195-245.

Minetti, R., Murro, P. & Paiella, M. (2015), "Ownership structure, governance, and innovation", *European economic review*, vol. 80, pp. 165-193.

Muttakin, M.B., Khan, A. & Tanewski, G. (2019), "CFO tenure, CFO board membership and accounting conservatism", *Journal of contemporary accounting & economics*, vol. 15, no. 3, pp. 100165.

Oradi, J., Asiaei, K. & Rezaee, Z. (2020), "CEO financial background and internal control weaknesses", *Corporate governance: an international review*, vol. 28, no. 2, pp. 119-140.

Peterson, S.J., Galvin, B.M. & Lange, D. (2012), "CEO Servant Leadership: Exploring Executive Characteristics and Firm Performance", *Personnel psychology*, vol. 65, no. 3, pp. 565-596

Pfeifer, C. (2015), "The nexus between top managers' human capital and firm productivity", *Applied economics letters*, vol. 22, no. 12, pp. 982-986.

Prabowo, R. & Setiawan, D. (2021), "Female CEOs and corporate innovation", *International*

Qian, C., Cao, Q. & Takeuchi, R. (2013), "Top management team functional diversity and organizational innovation in China: The moderating effects of environment", *Strategic management journal*, vol. 34, no. 1, pp. 110-120.

Rashid, A. (2016), "Managerial Ownership and Agency Cost: Evidence from Bangladesh", *Journal of business ethics*, vol. 137, no. 3, pp. 609-621.

Strohmeier, R., Tonoyan, V. & Jennings, J.E. (2017), "Jacks-(and Jills)-of-all-trades: On whether, how and why gender influences firm innovativeness", *Journal of business venturing*, vol. 32, no. 5, pp. 498-518.

Tian, M., Deng, P., Zhang, Y. & Salmador, M.P. (2018), "How does culture influence innovation? A systematic literature review", *Management decision*, vol. 56, no. 5, pp. 1088- 1107.

Wu, J. (2014), "The effects of external knowledge search and CEO tenure on product innovation: evidence from Chinese firms", *Industrial and corporate change*, vol. 23, no. 1, pp. 65-89.

Xu, P. & Zhang, Z. (2023), "Facilitation or inhibition? Impact of CEO's financial background on industrial AI transformation of manufacturing companies", *Frontiers in psychology*, vol. 14, pp. 1126801-1126801.

Yi, Y., Liu, Y., He, H. & Li, Y. (2012), "Environment, governance, controls, and radical innovation during institutional transitions", *Asia Pacific journal of management*, vol. 29, no.3, pp. 689-708.

Yu, D. & Hang, C.C. (2010), "A Reflective Review of Disruptive Innovation Theory", *International journal of management reviews: IJMR*, vol. 12, no. 4, pp. 435-452.

Zardkoohi, A., Harrison, J.S. & Josefy, M.A. (2017), "Conflict and Confluence: The Multidimensionality of Opportunism in Principal-Agent Relationships", *Journal of business ethics*, vol. 146, no. 2, pp. 405-417. Zhang, H., Ou, A.Y., Tsui, A.S. & Wang, H. (2017), "CEO humility, narcissism and firm innovation: A paradox perspective on CEO traits", *The Leadership quarterly*, vol. 28, no. 5, pp. 585-604.

Zhao, Y., Liu, D., Zhang, W. & Chen, S. (2022), "Top management service commitment and new product development in manufacturing firms: the moderating role of dysfunctional competition", *The Journal of business & industrial marketing*, vol. 37, no. 1, pp. 14-28.

Zhong, R. (2018), "Transparency and firm innovation", *Journal of accounting & economics*, vol. 66, no. 1, pp. 67-93.

Zimmerling, A. & Chen, X. (2021), "Innovation and possible long-term impact driven by COVID-19: Manufacturing, personal protective equipment and digital technologies", *Technology in society*, vol. 65, pp. 101541-101541.

Legal Issues about the Implementation of Smart Contracts

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Abstract

Smart contracts formalize and secure business relationships in a paper-based world. They reduce the mental and computational transaction costs imposed by principals, third parties or their tools. The traditional stages of search, negotiation, commitment, performance and decision making are the scope of smart contracts. It is a combination of protocols and user interfaces to standardize and secure human relationships on computer networks, facilitating all stages of the contracting process. This provides a new way to formalize and secure digital relationships. The goals and design principles of these systems are based on legal theory, economic theory, and protocol security theory. The basic idea of smart contracts is that many types of contractual provisions (titles, deposits, property specifications, etc.) can be replaced in hardware and software in such a way that it is too costly or impossible for the violator contract, the breach thereof. It is pointed out that smart contracts cover all the stages related to a contract: search, negotiation, commitment and, particularly important, their execution. A legislative framework has already been established for the establishment and operation of smart contracts, however several legal issues arise that this study approaches and attempts to analyze.

Keywords : legislation, blockchain, artificial intelligence, liability, contract law.

1 Introduction

Smart contracts are described as contracts whose terms are written in computer language rather than legal terms. Smart contracts can be executed automatically by computer systems, based on blockchain technology. Potential advantages of smart contracts include low costs due to the absence of third-party mediation. In contrast, drafting traditional contracts is expensive since their preparation often requires contractors, legal advisors, experts, third party service providers. Also, thanks to the advent of cryptocurrencies such as Bitcoin and Ethereum, many smart contract applications are possible as payments can also be made in cryptocurrencies. But in order to ensure that contracts are drawn up and performed correctly, the

Contracting parties must ensure that they are able to do so. To do this, the parties must establish a relationship of trust and have a sense of legal certainty.

Transactions carried out via blockchain with smart contracts are verified by the consent of the users of the network and not by a third party intermediary. Instead of allowing credit providers, credit institutions, insurance companies, etc. to act the digital transfer of assets, according to the contractual terms, the encryption of the smart contract is sufficient to autonomously and automatically execute the agreement. Blockchain speeds up transactions as it operates twenty-four hours a day, seven days a week, especially when you consider the time it takes to send money to another country through the banking intermediary. In other words, blockchain and smart contracts can minimize transaction time and cost, which in turn leads to long-term business efficiency. However, since blockchain is a relatively new and disruptive technology, it will take time and special provisions to introduce it into the system structures of governments and businesses and convince users to implement it.

2. The advantages

Smart contracts can reduce, in addition to transaction costs, legal costs. As there is no intermediary or central authority in the blockchain network, and transactions are openly verified and added to the blockchain by miners - traders, much of the transactional and legal costs that normally arise from trading are removed. Such costs are in the nature of service fees or administrative fees or legal fees related to the preparation, supervision and conclusion of written contracts. A common example is the contract entered into for a credit card purchase. When a consumer buys goods from a merchant and pays by credit card, the merchant applies a surcharge (said to represent the merchant's cost of accepting credit card payments) and the credit card company also imposes a fee. All of these costs can be completely avoided by using blockchain (1). Smart contracts, then, are a means by which operational and commercial costs can be dramatically reduced for businesses, governments and consumers (2).

Another benefit of smart contracts is increased transparency and anonymity. Transaction settings made through smart contracts, with distributed ledger technology, are visible to all stakeholders. This transparency increases trust between the parties. In addition, the parties benefit from anonymity, which they could not enjoy in traditional commercial transactions (3). Smart contracts can be programmed to buy specific products at specific prices. The seller connects directly to the buyer's digital wallet, (4) rather than connecting to the buyer's personal and financial information through a trusted intermediary.

3. The legislative framework in Greece

In Greece, the step for regulating the exploitation and use of advanced technologies was given by Law 4961/2022, (5) which aims at the rational utilization of the possibilities provided by modern technologies, with the ultimate goal of consolidating

the digital transformation of the country(6). Earlier, Directive 2019/770/EU regarding "contracts for the supply of digital content and digital services" (7) and Directive 2019/771/EU regarding "certain aspects concerning contracts for the sale of goods" (8) had been transferred to the Greek legal order, which contributed to the modernization of legislation, regarding electronic and digital commerce.

In the fifth chapter of Part B of Law 4961/2022, basic provisions are introduced for the regulation of the application of distributed ledger technology, such as the conditions for the validity of recording transactions in blockchain system and in other databases of distributed ledger technology and regulate issues about transformation, validity, force and proof of these records. Finally, the matters of establishment, validity and proof of smart contracts are regulated and reference is made to the application of the provisions of the Civil Code and the Code of Civil Procedure that apply to contracts. According to the explanatory statement of the law (9), the relevant regulations are necessary in order to achieve legal certainty and to establish the confidence of the trading parties in the innovative technologies, which have remained largely unregulated, despite the predicted size of the scope of their future possibilities. As a result, the main benefits of these technologies remain unexploited and investments are discouraged. On the contrary, this regulation creates the framework that will encourage the use of smart contracts and distributed ledger technologies, providing a first regulatory framework for these transactions. The short-term goals of the regulation refer to the legislative clarification of the basic concepts related to distributed ledger technologies and the creation of legal certainty for conducting transactions using smart contracts, while in the long-term it is expected to utilize, to the maximum extent possible, the advantages of these technologies.

Law 4961/2022 establishes for the first time an innovative national legislative framework that defines concepts and aspects of modern technology, such as: Artificial Intelligence (AI), the Internet of Things (IoT: Internet of Things), the provision of postal services using unmanned aircraft systems (UAS), distributed ledger technologies (DLT), smart contracts and 3D-printing.

Article 31 of Law 4961/2022 attempts to define the basic concepts. Paragraph 1 of the above article defines "Blockchain" as a type of distributed ledger technology that records data in blocks, which are connected to each other in chronological order and form a chain of consensus, decentralized and mathematically verifiable nature, which is mainly based on the science of cryptography". In paragraph 9 of the same article the "smart contract" is defined as a set of coded computer operations, which is finalized and executed through distributed ledger technology in an automated electronic form through instructions for the execution of actions, omissions or tolerances, which are based on the existence or non existence of specific conditions, according to conditions recorded directly in electronic code, programmed instructions or programmed language. Finally, in par. 13, "Distributed Ledger Technology network node" is defined as the device or software application that is part of a

network and holds a full or partial copy of the files of all transactions in a distributed ledger.

Article 47 of Law 4961/2022 regulates the issues of legal validity of data records or transactions carried out through a blockchain system or other distributed ledger technology. Specifically, in pars. 2 and 3, it is provided that the invalidity of the record or the transaction will be judged according to the invalidity provisions of the Civil Code (articles 130, 138, 159 and 174-179 C.C.), and the defectiveness of the parties will, will be judged according to the provisions on annulment (articles 140-157 of the Civil Code). In par. 5 of the same article there is the express provision that in the event that a record or transaction takes place in the blockchain, or another DLT., for which the invalidity conditions of par. 2 or 3 are met, then the court will be able to order the record or transaction to be restored to its previous state or to restore the damage caused to the injured party.

Article 48 of Law 4961/2022 establishes the proof of registration or of a transaction carried out through blockchain before the judicial authorities, with the help of an expert in cryptography. Article 49 of Law 4961/2022 defines the point at which smart contracts become binding for the contracting parties, recognizing the validity of smart contracts that meet the conditions set, in the same way as those set for registrations or transactions in a blockchain, with the provisions on nullity and annulment of the C.C. where the conditions for the validity of the contracts, defects of will and the liability arising from the contracts are provided for. Article 50 stipulates that in the cases where the place of signature or seal is required, when concluding a smart contract, then it can be electronic (10).

Finally, article 51 regulates the issue of the burden of proof and the means of proof in cases where disputes arise during the implementation of smart contracts. It is stipulated that a smart contract is a document within the meaning of article 339 of the Code of Civil Procedure (CCP), while the provisions of articles 432-465 of CCP apply to its use as evidence. and the help of an expert in cryptography, for the decoding in Greek or another language, with the indication that if the recording is done in another language, an official translation must also be submitted, in accordance with the provisions of article 454 of the CCP.

According to the provisions of Article 30, "smart contracts should have the same level of protection and legal certainty as any other contracts created by different means". The law also includes requirements related to the protection of trade secrets, the archiving and protection of data and ensuring that transactions can be interrupted and terminated according to the needs of the parties.

Also, smart contracts are protected through strict control mechanisms and are subject to harmonized standards under European data protection law. In particular, there are strict compliance requirements for smart contract developers, such as the EU Declaration of Conformity. According to EU preparatory legislative texts "the seller

of a smart contract or, failing that, the person whose business or profession entails the development of smart contracts for others under a data sharing agreement, conducts a compliance assessment to meet the essential requirements (11).

4. Characteristics of "smart contracts".

The "four key goals of the smart contract" (12) are:

- a) Observability, which means transparency in the actions of each party involved in the smart contract.
- b) Verifiability, which is the ability to prove that the contract has been performed or violated.
- c) Confidentiality, meaning that the content of the contract must be expressly limited to the parties involved and there are no unnecessary third parties.
- d) Implementation, which implies the existence of the code, designed to minimize the need for external enforcement.

The success of the smart contract is directly linked to the developer's ability to fulfill the above four objectives mentioned by Szabo and the requirements imposed by the law to be legally binding.

In smart contracts, a proposal is made explicit by including the contract in the blockchain platform, and more specifically by registering the proposal in the nodes of the network using the proposer's private key and digital signature. The receiver expresses his willingness to enter into the contract using his own private key and digital signature, accepting the terms and conditions set by the proposer in the contract posted on the platform. At this point, after the identification of the declarations of intent of the users/parties (proposal and acceptance), the parties can consider that they have entered into a contract, which can be considered to have been created and produce legal effects (13).

A smart contract is triggered by a message sent using a public key infrastructure, over an internet connection, similar to an email (14). In this case, it is necessary to determine whether the offer has been validated and whether it has been accepted. The obvious question is whether acceptance occurs after it has been sent by the party seeking to purchase the goods, after it has been received and validated by the consent of network users, or after it has been encoded and added to the blockchain (15).

The second identification requirement needs interpretation, since a statement recorded in a decentralized database is a resource, the content of which can be read (16). The statement recorded on the blockchain network carries the address of the account, which is displayed as an alphanumeric (e.g. 0xC741d6es0Bf654EC938163faBaf45698582653). Such series of numbers and letters are recognizable even though they do not obviously refer to a specific person. Digital

technology can be used to authenticate parties. The identification requirement is implemented by a similar process to that of plain text e-mails, which can be legally binding. Compared to a plain mail message, which carries, for example, the user's first and last name, the account address provides much better identification. All transactions performed on the blockchain are cryptographically signed with the private key (an even larger string of seemingly random letters and numbers), to confirm the participation and consent of the contracting parties. This property makes authentication to the blockchain network much more secure than authentication through an identity statement that closes a plain mail message.

Furthermore, since smart contracts are automated, it may not be possible to enforce rules on maximum interest rates. Even if the debtor objects to the payment, the computational code will return money to the creditor. This means that smart contracts are outside traditional contractual remedies, and unjust enrichment and compensation will play a larger role in smart contract dispute resolution(17). If a smart contract is embedded in a traditional contract, there is no need to worry about ensuring the legitimacy of the contract. However, when a smart contract is designed to be legally binding on its own, it is important to carefully consider it during its design. Whether a contract is legally binding or not is primarily a matter of jurisdiction.

5. Legal Issues

However, many legal issues arise in the operation and implementation of smart contracts. First smart contracts rely on the underlying code for automatic execution. The code of a smart contract is only as good as the person who wrote it. If the code is imprecise or contains errors it can lead to unintended and unforeseeable consequences which can render the smart contract unenforceable.

Intellectual property rights are another legal problem in implementing smart contracts. Their use may infringe industrial and intellectual property rights, such as patent rights and copyrights. This is especially important in the context of using smart contracts to manage cases where proprietary software and technology may be used. The parties should ensure that they have the necessary rights and licenses to use any proprietary software and technology. Failure to secure the necessary rights can lead to costly legal claims and disruption of the smart contract implementation. Furthermore, the blockchain technology itself, used in smart contracts, considers itself immutable, meaning that once data is recorded on the blockchain, it cannot be modified or deleted. This property raises concerns regarding the protection of confidential information and trade secrets in smart contracts (18). For example, confidential information about a project may be recorded on the blockchain, making it available to unauthorized parties. Also, smart contracts must comply with relevant anti-money laundering legislation.

In addition, articles 47 and 49 of Law 4961/2022 provide for the proportional application of the provisions of the Civil Code, which, however, may create legal

uncertainty, as well as the fictitious declaration of will or the declaration of will by an incapacitated person, according to articles 138 and 130 of the Civil Code, has an effect on the validity of the contract, while, according to the definition of smart contracts, as set out in article 31 of the law, artificial intelligence systems - in which it is not possible to diagnose the will, nor any defects in its diagnosis - are not excluded from entering into smart contracts (19). Of course, similar issues also exist in distance contracts regarding the person of the consumer.

6. Conclusions

In the rapidly evolving landscape of technology and innovation, geographic boundaries are being transcended and traditional companies are allowed to more easily enter global markets. With the combination of blockchain and smart contracts, the business landscape is being reshaped in ways that were previously unimaginable, especially regarding new smart contract application ideas. By using new distributed ledger technologies, companies can streamline cross-border transactions, reduce costs and eliminate the need for intermediaries. This opens up new opportunities for business expansion and facilitates international trade.

Smart contracts as self-executing agreements that automatically trigger actions when predefined conditions are met, are incorruptible, immutable and airtight, enabling entrepreneurs to create secure and automated transactions. They are a solution to the bloated nature of some contracts as they can streamline the contracting process, saving time and cost. They also provide additional security and transparency to all parties. At the European and Greek level, the legislative and regulatory framework has been created that provides the recognition of smart contracts, ensures the protection of personal data and intellectual property rights and introduces dispute resolution mechanisms, with the aim of contributing to the further development of innovative technologies.

Smart contracts can be applied in many areas such as procurement, supply chain management and payments. By automating repetitive tasks, companies can free up resources to focus on their core business, resulting in increased productivity and cost savings.

However, some contracts can have serious negative consequences for parties if smart contracts are not managed properly. Complex commercial contracts are full of "if/then" terms and conditions, dependent on the state of objectively verifiable events, often requiring manual management and prone to misapplication or inadvertent non-application. Thus, smart contracts can be characterized as "smart" to the extent that they offer the efficiency of automated contractual performance and reduce the risk of human error and the prospect of a dispute. Many aspects of sophisticated commercial agreements are not subject to automation, including matters that require subjective human judgment, the provision of sophisticated or human-intensive services, or the resolution of disputes. Consequently, while some relatively simple agreements could

essentially be automated, for more sophisticated agreements it is likely that only discrete elements will be automated in the foreseeable future. There will be limitations, however, in cases where complex contracts are subject to smart contracts. In this context it is necessary to link the legal aspects of contract law with the technical aspects of smart contracts.

Bridging this gap between developers and legal professionals will determine how easy it is to implement smart contracts. After all, technology also has limitations and there are factors that must also be taken into account in the ethical replacement of traditional contracts with smart contracts based on the blockchain network. In any case, there could be a future where the two types, traditional contracts and smart contracts, coexist, taking advantage of each and forming a more secure process of drawing up contracts and operating transactions.

References

1. It should be noted that even in smart contracts there are some costs. Gas is vital to the Ethereum network. Gas refers to the unit of computation required to perform a specific operation on the Ethereum network. Running transactions on Ethereum requires computing resources in order to ensure that Ethereum is not vulnerable to spams. Payment for calculations takes the form of gas fees. Fees are the amount of gas used to perform an operation over the cost per unit of gas, and are paid regardless of the success or failure of the transaction. see : <https://ethereum.org/en/developers/docs/gas/>
2. Delmolino K., Arnett M., Kosba A., Miller A. and Shi E., -“Step by Step Towards Creating a Safe Smart Contract: Lessons and Insights from a Cryptocurrency Lab” (18 Nov. 2015) University of Maryland. p.1. Available at: <https://eprint.iacr.org/2015/460.pdf>
3. Giancaspro M., Is a “Smart Contract” Really a Smart Idea? Insights from a Legal Perspective, 2017. <https://www.sciencedirect.com/science/article/pii/S026736491730167X>
4. A digital wallet is an electronic device that enables electronic transactions. Digital wallets can take many forms, with the most common example being contactless payment technology built into smartphones.
5. Law 4961/2022 (Government Gazette 146/A' / 27-07-2022) "Emerging IT and communications technologies, strengthening digital governance and other provisions".
6. Law 4961/2022 Article 28.
7. DIRECTIVE (EU) 2019/770 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 20 May 2019 on certain aspects relating to contracts for the supply of digital content and digital services.
8. DIRECTIVE (EU) 2019/771 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 20 May 2019 on certain aspects relating to contracts

- for the sale of goods, amending Regulation (EU) 2017/2394 and Directive 2009/22/EC, and the repeal of Directive 1999/44/EC,
9. Explanatory Memorandum, Hellenic Parliament,
file:///C:/Users/User/Downloads/%CE%91%CE%99%CE%A4%CE%99%CE%9F%CE%9B%CE%9F%CE%93%CE%99%CE%9A%CE%97%20%CE%95%CE%9A%CE%98%CE%95%CE%A3%CE%97%20(1).pdf
 10. As stated in the Public Consultation Report of Law 4961/2022, this possibility refers to the cases where it is possible to exercise a central administrator control of the origin of the digital certificate, i.e. in private or joint blockchain networks, in order to equate the electronic signature with the private signature (Annex II of the eIDAS Regulation, and Article 15 of Law 4727/2020), while in open public networks there is no such possibility and therefore it is a simple electronic signature (Article 16 of Law 4727/2020) with the evidentiary force of Article 25 of Regulation 910/2014.
file:///C:/Users/User/Downloads/%CE%91%CE%99%CE%A4%CE%99%CE%9F%CE%9B%CE%9F%CE%93%CE%99%CE%9A%CE%97%20%CE%95%CE%9A%CE%98%CE%95%CE%A3%CE%97%20(1).pdf
 11. EUROPEAN COMMISSION - Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on harmonized rules on fair access to and use of data (Data Act), as they are analyzed in article 30.
 12. Szabo, N.: Smart contracts: Building Blocks for Digital Markets 18(2), 28 (1996).
 13. According to article 49 par.1 sec. a' of Law 4961/2022.
 14. Fulbright R.N., "Can Smart Contracts be Legally Binding Contracts?", R3 and Norton Rose Fullbright White Paper (2016), σελ. 22.
<https://www.nortonrosefulbright.com/-/media/files/nrf/nrfweb/imported/norton-rose-fulbright-r3-smart-contracts-white-paper-key-findings-nov-2016.pdf>
 15. Giancaspro M., Is a "Smart Contract" Really a Smart Idea? Insights from a Legal Perspective, 2017. <file:///C:/Users/User/Downloads/ArticleFinal-Giancaspro.pdf>
 16. Szczerbowski J.(2017), Place of Smart Contracts in Civil Law. A few Comments on Form and Interpretation. :
https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3095933
 17. Raskin, M. The Law and Legality of Smart Contracts. Georget. Law Technol. Rev. 2017, 1:2, 305–341. <http://dx.doi.org/10.2139/ssrn.2842258>
 18. Papadimopoulos I. (2020), "The doctrinal inclusion of smart contracts in contract law", Chronicles of Private Law, June-July 2020, Sakkoulas.
 19. Spyridonos, A. (2019), "Smart contracts and freedom of contracts", University of Piraeus/Audit Court.

Deciphering the Use of Disclosure Tone through AI-based Decision Aids: Do Reliance and Experience Moderate AI Relevance in Investor Decision Making?

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Abstract

Emerging research on disclosure tone highlights the impact that tone can induce on retail investors' perceptions. Previous literature suggests that the effect of decision-aiding technology on investors' willingness to invest flows through investors' resulting perceptions of disclosure credibility. We extend the core theoretical model to account for the roles of reliance and investment experience on the relationships. More precisely, we predict that the effect of decision aiding technology on investors' willingness to invest is mediated by disclosure credibility, but the mediation is moderated by reliance on the AI-based decision aid, and that the effect of reliance on the mediation is moderated by investment experience.

Keywords: Artificial Intelligence, Algorithm Aversion, Decision Aids, Reliance, Investment Experience, Disclosure Credibility, Willingness to Invest.

Introduction

Bassyouny et al. (2022) express the importance of increasing our understanding of how disclosure tone influences investment decision making. A growing body of research establishes the prevalence of tone deviations and the relationship between tone and potential impression management practices. For instance, use of positive language in disclosure tone has been shown to be effective in creating a positive outlook among retail investors (Triki et al. 2015; Bassyouny et al. 2022).

While disclosure tone has the potential to sway investor decisions, advances in Artificial Intelligence (AI) provide the potential to mitigate these effects by analyzing the nature of language used in disclosures. With AI, it is possible to uncover 'hidden themes' through analysis of textual content (Moffitt and Vasarhelyi 2013). Yet, getting retail (non- professional) investors, to use these tools has been challenging at best. The challenge for individual investors to gain an understanding of the changing finance landscape and the available AI tools to better analyze corporate reporting is daunting. As these tools filter down into the retail investor marketplace, can we expect retail investors to make use of these AI- decision aids?

The provision of a decision aid (DA), by itself, does not necessarily lead to the inclusion of the DA's output in the users' decision-making process. Unless the user relies on the DA, the analysis will not become an integral part of the decision-making process (Arnold and Sutton 1998). As stated by Parkes (2017, p.165), -Use is a necessary but not sufficient precursor to reliance. We extend research on the effects of disclosure tone by building and testing a theoretical model that accounts for the mediating role of disclosure credibility on investors' willingness to invest and the moderating role of reliance and investors' experience. First, we posit that the effect of a DA (analyzing disclosure tone) on investors' willingness to invest flows through investors' resulting perception of disclosure credibility. Second, we apply the Theory of Technology Dominance (TTD) to argue that the mediated effect of DA output on investors' willingness to invest depends on reliance on the DA such that the more investors rely, the more impact the DA will have on their willingness to invest (Arnold and Sutton 1998; Sutton, Arnold and Holt 2023). In other words, we test a mediation that is moderated by reliance. Third, we use TTD to argue that the moderated mediation depends on investors' experience such that the impact of reliance on the DA decreases when investment experience increases as experienced decision makers are reluctant to rely.

Hypotheses Development

One of the many channels that companies can use to communicate information to investors is corporate narratives. Li's (2010) analysis reveals that over 70% of annual reports consist of narrative disclosures. While additional information can benefit investors, it can also create other means for managers to behave opportunistically. Managers can adjust the disclosure tone to provide a more optimistic picture of performance (Bassyouni et al. 2022).

Using disclosure tone as an impression management tool would not be as much of a concern if investors were able to see through management's tactics on their own. While Quick and Sayer (2024) find some evidence that financial analysts are not affected by disclosure tone, findings reported in the literature suggest that retail investors are (Bassyouni et al. 2022). More precisely, investors make different decisions when presented with information that has the same content but framed differently (Riley et al. 2014; Triki et al. 2015).

To address this problem, Triki and Arnold (2016) suggested the use of DAs that can analyze narrative disclosures and detect linguistic manipulations. The empirics in their study indicated that the detection of linguistic manipulation by a DA impacted investors' perceptions of disclosure credibility and their willingness to invest. More precisely, when the DA output indicated the presence of linguistic manipulation, investors had significantly lower perceptions of disclosure credibility and lower willingness to invest than when the DA did not detect linguistic manipulations. We expand upon this prior research related to DA disclosure tone analysis by considering the conditions that may alter the effectiveness of such DAs for investor decision making; such DAs will only be effective if investors incorporate the DA analysis meaningfully into their decision-making processes.

Findings from Triki and Arnold (2016) indicate that DA output has an impact on investors' perceptions of disclosure credibility and on their willingness to invest. More precisely, investors have a lower perception of disclosure credibility and are less willing to invest when the DA output detects linguistic manipulations in disclosure tone. Triki (2019) tests the effect of a deception detection DA and reports that the effect of the DA on investors' willingness to invest is mediated by investors' perception of disclosure credibility. Our baseline hypothesis predicts a similar effect of DA output on investors' decision making.

H1: The effect of DA output on investors' willingness to invest is mediated by investors' perceptions of disclosure credibility.

Arnold and Sutton (1998) define reliance as "...the degree to which the user of a decision aid applies the aid and incorporates the recommendations of the aid during judgment formulation..." (p. 180). The provision of a DA is one step that can lead to reliance but does not guarantee it. When provided with a DA, users are free to ignore the output and rely on other factors. Based on TTD, investors' assessment of the credibility of the disclosures and their willingness to invest depends on how much of the DA output they have incorporated in their decision-making process (i.e., reliance). We expect that the more investors rely on the DA output, the greater the effect the DA output will have on their decision making.

H2: The mediated effect of DA output on investors willingness to invest (hypothesized in H1) is moderated by their reliance on the DA.

We argue that the effect of reliance on investors' decisions will be diluted by investors' investment experience; the more experience the less likely reliance will impact their decision making. Most studies classify investors into homogeneous groups belonging to a specific class of investors rather than heterogeneous groups (Elliott et al. 2008). We begin to fill this gap by investigating the effect of experience within a specific class of investors: retail investors. An individual investor with one year of experience may process information differently from an investor with ten years of experience. Elliott et al. 2008 explored the effect of experience on retail investors decisions and conclude that "...as investors gain experience, they are better able to use unfiltered information to increase their portfolio return" (p. 475).

Based on TTD (Arnold and Sutton, 1998; Sutton et al. 2023), an individuals degree of reliance on a DA is heavily influenced by their task experience. In TTD, task experience is defined as "...the level of experience a decision maker has with respect to completion of a given decision task and the degree to which the decision maker has formed strategies for completing or solving the task" (Arnold and Sutton, 1998, p. 180). Retail investors who spent more years reading corporate reports and making investment decisions are expected to have a different degree of reliance on the DA than those who have less investing experience (Sutton et al. 2023). Experienced investors have gathered specific strategies and ways to make investment decisions and may consider many other pieces of information when determining the extent to which an investment is appealing. The more experience an investor has, the less importance the DA output may be to the decision-making process.

H3: The moderated-mediated effect of DA output on investors' willingness to invest(hypothesized in H2) is moderated by investment experience.

Research Methods

To test the theoretical model proposed above, we experimentally examine the impact of DA output (linguistic manipulation not detected vs. linguistic manipulation detected) on perceptions of disclosure credibility and willingness to invest. Additionally, we collect data for two measured moderating variables—extent of reliance and participants' investment experience.

Participants were told that they have accumulated \$50,000 of personal savings and that they could invest \$10,000 of their savings in buying stocks of an international confectionery manufacturer and retail operator company named -Chcolato|. Then, participants were provided with a brief overview of the company, followed by analysts' forecast (the forecast indicated revenue growth), a business journal article that described Chcolato's environmental performance positively, an income statement, and the environmental matters section of the management commentary section of the annual report. Then, participants were provided with the output of a DA analyzing the management commentary section for linguistic manipulation. Participants were then presented with questions to make sure that they paid attention to the manipulation and materials provided, and to capture the measured variables. Responses from 236 Amazon Mechanical Turk participants were used to test our theoretical model. All participants had investment experience.

Investors' perceptions of disclosure credibility were measured using participants' perceptions of whether the information in the management commentary section was believable, accurate, trustworthy, unbiased, and complete. The average score of these five measures was used to measure investors' perceptions of disclosure credibility. Investors' willingness to invest was measured by using a sliding bar through which participants indicated how much of their \$10,000 they wanted to invest in the company. Reliance was measured with six items adapted from Hampton (2005). Similarly to Elliott et al. (2008), we use self-reported numbers of years of investing as a measure of investors' investing experience.

Results

We use the fourth model in PROCESS V3.3 (Hayes, 2018) to test the effect of DA output on investors' willingness to invest through investors' perceptions of disclosure credibility. Results from the mediation analysis show that the direct effect of DA output on investors' willingness to invest is not statistically significant (one-tailed $p = 0.122$) and that the indirect effect of DA output on investors' willingness to invest through investors' perception of disclosure credibility is statistically significant and negative. The results indicate investors' perception of disclosure credibility fully mediates the effect of DA output on investors' willingness to invest, thus providing strong support for H1 and validating previous findings.

To test H2, the moderating role of reliance, we examine whether the indirect effect of DA output on investors' willingness to invest is altered by reliance. We use the eighth model in PROCESS V3.3 (Hayes, 2018). Results from the analyses suggest that when reliance is low DA output has a significant direct effect on investors' willingness to invest (one-tailed $p = 0.010$). However, when reliance is moderate or high, the direct effect is no longer significant (one-tailed $p = 0.364$ and 0.189 , respectively). The results show that the indirect effect of DA output on investors' willingness to invest is significant across all three levels of reliance. These results provide strong support to the predictions made in H2.

To test the moderating role of investment experience on the moderated mediation tested above, we use the 12th model in PROCESS V3.3 (Hayes, 2018). Results show that when reliance is low, DA output has a direct effect on investors' willingness to invest only when experience is low or moderate. When experience was high, DA output did not have a direct effect on investors' willingness to invest. When reliance was moderate, regardless of the level of experience, DA output did not have a direct effect on investors' willingness to invest. When reliance was high, DA output had a direct effect on investors' willingness to invest

only when experience was low. Overall, the results provide support to the predictions made in H3.

Conclusions

AI holds great potential to assist investors of all types in analyzing the complex data embedded in corporate annual reports. There are multiple challenges, however, as investors need to gain an appreciation for AI, they need to understand how the AI works and the inherent limitations in models, and they need to understand how to effectively integrate AI into their overall decision-making processes (Arnold and Sutton 1998; Sutton et al. 2023). In this study, we begin to explore these effects of AI-based DAs on retail investor decision making processes.

The study is conducted in the context of disclosure tone where AI has the potential to assess and interpret (Humphries et al. 2011; Moffitt and Vasarhelyi 2013). In examining AI within this context, we also begin to address the call for research by Bassyouny et al. (2022) to explore the underlying psychological processes that determine how much disclosure tone impacts decision making. In this study, we theorize that the effect of DA output on users' judgment and decision-making is not only dependent on the degree of reliance on the DA, but also the experience of the user. The results suggest that the greater the reliance on the DA, the more it impacts users' decisions. The results also show that users' investment experience diluted that effect. More precisely, the more investing experience the users had, the less influence reliance had on their decisions.

References

- Arnold V, and S. Sutton. 1998. The theory of technology dominance: understanding the impact of intelligent aids on decision maker's judgments. *Advances in Accounting Behavioral Research* Vol. 1, No.3, pp. 175–94.
- Bassyouny, H., T. Abdelfattah, and L. Tao. 2022. Narrative disclosure tone: A review and areas for future research. *Journal of International Accounting, Auditing and Taxation* Vol. 49, 100511.
- Elliott, W. 2006. Are investors influenced by pro forma emphasis and reconciliations in earnings announcements? *The Accounting Review* Vol. 81, pp. 113-133.
- Elliott, W., F. Hodge, and K. Jackson. 2008. The association between nonprofessional investors' information choices and their portfolio returns: The importance of investing experience. *Contemporary Accounting Research* Vol. 25, No. 2, pp. 473-498.
- Hampton, C. 2005. Determinants of reliance: An empirical test of the theory of technology dominance. *International Journal of Accounting Information Systems* Vol. 6, No. 4, pp. 217-240.
- Hayes, A. 2018. *Introduction to Mediation, Moderation, and Conditional Process Analysis (2nd ed.)*. New York: Guilford Press.

- Humpherys, S., K. Moffitt, M. Burns, J. Burgoon, and W. Felix. 2011. Identification of fraudulent financial statements using linguistic credibility analysis. *Decision Support Systems* Vol. 50, pp. 585-594.
- Li, F. 2010. Textual analysis of corporate disclosure: A survey of the literature. *Journal of Accounting Literature* Vol. 29, pp. 143-165.
- Moffitt, K., and M. Vasarhelyi. 2013. AIS in an age of big data. *Journal of Information Systems* Vol. 27, No. 2, pp. 1-19.
- Parkes, A. 2017. The effect of individual and task characteristics on decision aid reliance. *Behaviour & Information Technology* Vol. 36, No. 2, pp. 165-177.
- Quick, R., and S. Sayar. 2024. The effect of tone, signature, and visual elements in compliance management systems disclosures on financial analysts' decisions. *Journal of International Accounting, Auditing and Taxation* Vol. 55, 1000619
- Riley, T., G. Semin, and A. Yen. 2014. Patterns of language use in accounting narratives and their impact on investment-related judgments and decisions. *Behavioral Research in Accounting* Vol. 26, No. 1, pp. 59-84.
- Sutton, S., V. Arnold, and M. Holt. 2023. An extension of the theory of technology dominance: Capturing the underlying causal complexity. *International Journal of Accounting Information Systems* Vol. 50, 100626.
- Triki, A., V. Arnold, and S. Sutton. 2015. Too good to be true! – The bifurcated effect of strong tone in management disclosures on investors' decisions. *Advances in Accounting Behavioral Research* Vol. 18, pp. 1-31.
- Triki, A., and V. Arnold. 2016. Getting Caught __Sugar Coating__: The Behavioral Implications of Using a Decision Aid That Detects Linguistic Manipulations in Financial Disclosures. *Journal of Emerging Technologies in Accounting* Vol. 13, No. 2, pp. 169- 184.
- Triki, A. 2019. Examining the effect of deception detection decision aids on investors' perceptions of disclosure credibility and willingness to invest. *International Journal of Accounting Information Systems* Vol. 33, pp. 1-15.

An Analysis of the Impact of ESG on Corporate Financial Performance

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Abstract

This study investigates the impact of total ESG and its individual dimensions (environmental, social and governance) on the corporation's financial performance of UK firms. With rapid changes in society and the environment, businesses are not expected to prioritise profitability; they are suggested to be sustainable and more competitive. Implementing ESG initiatives is prevailing, encouraged and expected. To examine the relationship between ESG and business financial performance, this paper takes the recent UK firms as the sample from the FTSE100 index from 2014 to 2018, five years in total. Stakeholder theory and Ecological Modernisation Theory have been used to analyse the ESG. A regression model is utilised to estimate the results to test the study's hypothesis. This paper uses Thomson Reuters DataStream ESG Scores and individual aspects of ESG scores as independent variables, and this paper uses ROA to measure a business's financial performance to investigate the relationships. As studied, it can be confirmed that the total ESG positively impacts financial performance. But the results of individual dimensions of ESG are mixed. To make the findings more comprehensive and reliable, the robustness test has been estimated in this study, which considers the ESG scores and individual parts of ESG scores during the pandemic. The results of robustness are the same as the regression results. These

findings further guide the business in allocating resources to which aspect in the future.

Keywords

Corporate ESG performance, ESG Scores, Financial performance, UK firms, ROA

Introduction

Nowadays, in a dynamic environment, there are chances for the world; meanwhile, the world also faces a lot of challenges (Li et al., 2021). For instance, with the spread of COVID-19, the plague of locusts in Africa, ESG issues are in ascendance (Li et al., 2021). More and more stakeholders focus on ESG actions; ESG reporting has become an approach to provide detailed information about the sustainable development strategies taken by companies. As Tsang et al. (2022) researched, more than 50% of companies invest in independent institutions to authenticate their ESG reporting. Such non-financial reporting improves the transparency of business actions on ESG and helps corporations to be sustainable and competitive, especially under an unstable and unforeseeable economic environment. For instance, as researched by Hoang et al. (2020), the UK-listed firms with higher ESG disclosure scores experienced lower negative impacts during the COVID-19 pandemic. Businesses are expected to provide their ESG reporting to their stakeholders and institutional investors, and ESG reporting is prevailing among stakeholders and investors, as they can understand how businesses implement their CSR initiatives, and the investors are able to determine the sustainability of corporations. Thus, ESG initiatives make a crucial impact on corporations in the long term, for instance, by improving firms' reputation and image, boosting stakeholders' engagement, becoming more competitive in unstable environments, and realising sustainable development.

ESG is an approach to estimate the non-financial performance of the corporations, but it is also going to impact the financial performance of firms. According to Ting et al. (2019), ESG provides a guideline for the business's future financial performance and estimates the firm's strategies for investors. 'E' stands for pollution, water resource and water shortage, climate changes and environmental management; 'S' represents the community involvement, employees' benefits, human rights, and business service; 'G' stands for the regulations and rules that are used by corporations to enhance firms' ability (Ting et al., 2019). In addition, according to the European Banking Authority (2021), ESG considerations can also play a significant role in assessing opportunities for both financial and non-financial entities in their pursuit of transitioning towards a more sustainable economy. ESG actions not only help businesses to be more competitive and sustainable under such a volatile social environment but also the value of firms can be improved when they integrate the ESG performance into their managerial strategies. Therefore, ESG is a comprehensive system to analyse business strategies from environmental, social and governance factors as a crucial motivator for corporations to realise sustainable development (Li et al., 2021).

Due to such a situation, this paper will estimate the impact of individual aspects of ESG and the total ESG on corporation financial performance by utilising the FTSE100

UK firms from 2014-2018. And to guarantee the robustness of such an investigation, it also utilises the data during the pandemic to test the robustness of the results.

The study is discussed as follows. First, the introduction, motivations and contributions are described in part one. Secondly, substantial existing literature has been reviewed in the second part. It includes the definition of ESG and CSR, followed by the theories that fit into ESG. This paper discusses stakeholder theory and ESG, ecological modernisation theory and ESG, and provides a contrary theory to analysis.

After that, this paper shows several kinds of literature on the topic of ESG and business financial performance. And in the end of this part, it ends with some literature about the ESG and financial performance in the UK and the hypothesis which are going to be tested. Thirdly, it is going to show the data and the methodology used in this study. Besides the results are going to be demonstrated and shown in the findings section. In the end, there is a conclusion to summarise the main findings and the contributions of this study. Last but not least, there is a recommendation for future researchers who are going to study similar topic.

CSR and ESG Score

Corporate Social Responsibility (CSR) has become an inevitable theme. Du et al. (2010) state that CSR is crucial in today's global corporate agenda. It could boost the stakeholder's purchasing ability in the short term and enhance the business image and reputation in the long term (Du et al., 2010). As stated by De Grosbois (2012), the public, governments, customers, and other stakeholders have become increasingly aware of the social and environmental consequences of human activities, particularly business operations, during the past two decades. Therefore, corporations must provide information on the scope and effectiveness of their CSR work (De Grosbois, 2012). A large number of corporations has reported their non-financial reporting to their stakeholders. For example, Gillan et al. (2021) reported that 86% of S&P 500 firms released sustainability or CSR reports in 2018. Many regions have adopted mandatory policies requiring companies to provide non-financial reports. For instance, the European Union (EU) has issued a new directive (2014/95/EU) recently, which requires Europe's large companies to enforce sustainable Disclosure (Hummel and Rötzel, 2019). Besides, all the EU member countries had to incorporate such a directive into their national legislation (Jackson et al., 2020). Moreover, according to Howard-Grenville (2021), the Environmental, Social, and Governance Score (ESG Score) is the most widely used index to measure the corporation's sustainability criteria. Business strategies changed from achieving maximum profitability to maintaining the Environment's social and governance performance in the long term (Min and Mentzer, 2004).

ESG was formally proposed in 2004, which is an acronym for Environment, Social, and Governance (Gillan et al., 2021; Li et al., 2021). And the terminology of ESG is more widely included than the CSR terminology, which includes Governance (Gillan et al., 2021). According to Jo and Harjoto (2012), corporation governance could be the pillar of CSR; besides, CSR could be one of the dimensions of a firm's governance (Baraibar-Diez and D. Odriozola, 2019), and they supplement each other. ESG score is regarded as the indicator of an organisation's sustainable development performance (Rajesh and Rajendran, 2020). They also state that many kinds of research illustrate that ESG could directly or indirectly impact a firm's financial performance and profitability, according to Hawn et al. (2018).

As Rajesh and Rajendran (2020) stated, the ESG score significantly impacts the investment decision of stakeholders and managers. Further, as argued by Li et al. (2021), ESG plays a significant role in measuring businesses' forthcoming financial performance and their social influence. Therefore, the ESG score has been an indicator that cannot be ignored when studying business. As argued by Gillan et al. (2010), institutional investors are very interested in a corporation's ESG score when they make investment decisions, ESG indices allow the investors to compare the

businesses along environmental, social, and governance dimensions. The ESG score is given by specialised rating agencies; these agencies use their professional approaches to evaluate the businesses' sustainable development performance and give the score (Escrig-Olmedo et al., 2019). They also argue that this expertise allows ESG agencies to reference investors, corporations, and financial markets regarding business sustainability assessments. Moreover, ESG is a whole dimension to advise businesses not only focus on their profitability. It allows corporations to focus on other stakeholders, which could help businesses to create a good image and reputation in a long way. Additionally, as argued by Eccles et al. (2014), such a strategy is an approach to account for many aspects, which is considered a long-term approach to realising profitability. As the initiatives of ESG are experiencing inevitable advances, there is a positive relationship between the sustainability performance of businesses and the ESG scores (Rajesh and Rajendran, 2020).

Thus, ESG scores are a way to evaluate how the corporation's CSR initiatives influence corporations. This paper is going to analyse the relevant theories in the following part.

Empirical Studies about the Association between ESG score and Firm's Financial Performance

This section reviews the existing literature that discusses the associations between ESG scores and corporate financial performance (CFP). The discussion of the relationship between ESG and the firm's financial performance began in the 1970s (Friede et al., 2015). There are more than 2000 scholars, and studies on this topic have been published since then (Friede et al., 2015). However, the results are various, and most of the literature focus on one or two aspects. Researchers have studied the positive, neutral, and negative results of the relationship between ESG performance and a firm's financial performance.

For example, Arlow and Gannon (1982) stated that they researched the relationship between social aspects and economic performance and found an inconclusive association. Such a study only focuses on an element of ESG, examining the social dimension's impact on financial performance. Arlow and Gannon (1982) find a neutral relation between them. Furthermore, from another perspective, the author gets different results, as argued by Albertini (2013), who investigates that there is a positive impact on a firm's financial performance from an environmental perspective. In this paper, the author used a specific method that was different from Arlow and Gannon (1982); Albertini (2013) utilised meta-analysis to investigate the relationship. Meta-analysis is a quantitative method and is a statistical technique which could be used to distinguish and quantify the association among published literature (Hunter and Schmidt, 2004). The author has collected and researched 52 studies for the period from 1975 to 2011 that are relevant to such a topic after applying the criteria. Albertini (2013) investigates the positive relationship between environmental performance and CFP, which has the opposite result of Arlow and Gannon (1982).

Despite the positive and neutral results illustrated above, some studies also show negative results. For instance, Duque-Grisales and Aguilera-Caracuel (2021) argued that there is a significant negative relationship between ESG scores and CFP. Duque-Grisales and Aguilera-Caracuel (2021) gathered 104 multinationals from Latin America from 2011 to 2015. Such a study is based on multinationals in emerging countries, and there is also evidence showing negative relations in the UK. As Brammer et al. (2006) investigated, collect the UK's corporations' data to measure such a relationship. They find that social performance would not make a positive impact on the business's financial performance; further, social performance is negatively related to a firm's value. In such a study, they use the disaggregate score to make an analysis, Brammer et al. (2006) utilise the social performance indicator to analyse the relations; such an indicator includes aspects of environment, employment, and community. As illustrated by Brammer et al. (2006), some firms have poor financial performance with good social practices in the environment. Therefore, they conclude that corporations perform good social practices, usually with lower returns.

Regardless of only one aspect of ESG evaluated mentioned above, sufficient articles investigate the whole dimension of ESG influences in corporations' financial performance. For instance, as researched by Kim and Kim (2014), use the publicly listed restaurant firms from Standard Industrial Classification (SIC) code in the Securities and Exchange Commission (SEC) files, and they collected data from the period 1991 to 2011 to examine the relationship between ESG and the CFP. They have evaluated if the ESG initiatives have improved the value of shareholders. Kim and Kim (2014) have argued that shareholders' value can be increased by implementing vital ESG initiatives; conversely, shareholders' value can be reduced if businesses weaken their ESG activities. Therefore, they analyse that there is a positive association between ESG and firms' financial performance. Furthermore, as researched by Gordon et al. (2015) collected a quantity of evidence showing that businesses with higher ESG scores usually have a more competitive advantage in terms of the firm's value and stock price compared to those with lower ESG scores. Besides, they also indicate that corporations experience hostile stock prices when they do not perform ESG initiatives.

In addition, as investigated by Tahmid et al. (2022), data was collected from 2008 to 2020 European companies. They researched 180 businesses to study the relationship between ESG initiatives and firms' financial performance. All the data are gathered from the Thomson Reuters database as described by Tahmid et al. (2022). After applying the regression model to test the result, they found a significant positive association between the total ESG scores and businesses' financial performance. This means the corporation's financial performance could improve when the business practices ESG relative initiatives. Tahmid et al. (2022) also investigate the influence of the individual dimension of ESG on finance; however, the results are mixed. Different aspects might have various effects on business finance regarding various business industries and areas.

ESG and Financial Performance in the UK

The non-financial performance (ESG performance) has become a significant aspect for corporations. According to Odriozola (2019), businesses in many countries have established corporate social responsibility (CSR) committees, for instance, in Spain and Germany, their Corporate Governance Code of listed corporations includes a rule to suggest businesses establish relevant committees. Odriozola (2019) also argues that the CSR committees are the fundamental tool to realise corporate sustainable

development, and further make a result in getting higher ESG scores. CSR committees could be understood as synonyms of public responsibility committees, which is a subcommittee of the board of directors, according to Eberhardt-Toth (2017). As argued by Odriozola (2019), the establishment of CSR committees cater to the statement of stakeholder theory, because such establishment means a governance agency has been exited to satisfy the needs of stakeholders. Although there is no mandatory regulation to create a CSR committee in the UK's Corporate Governance Code in 2018, an increasing number of boards in the UK are openly embracing their responsibility by establishing dedicated board committees focused on CSR (Odriozola, 2019). More and more companies are taking ESG initiatives, it is environmentally friendly, which could help corporations to build their images in the long term. Additionally, ESG initiatives also help companies to improve their financial results.

The UK has concentrated on promoting business sustainable development for a long time. Becoming sustainable development is not a new topic for corporations anymore. Corporations are operating in an environmentally friendly way to become sustainable. According to Alkaraan et al. (2022), the UK government is driving sustainable guidelines for Industry 4.0 (I4.0) mechanisms implementation, which contains minimising material inputs, reducing waste, little carbon usage technologies, and energy efficiency (Foresight, 2013). Such a guideline aims to make UK firms more sustainable and comparable. Society is expected to develop sustainably is the fixed aim of the United Nations Sustainable Development Goals (Awan et al., 2018). As argued by Alkaraan et al. (2022), the I4.0 mechanism can improve productivity, reducing waste and risks. Practising ESG initiatives is a way to achieve such I4.0 implementation, which would help corporations be environmentally friendly, reduce operating waste, and contribute more to society.

In 2018, the UK government revised the corporate governance criteria which resulted in boosting the consciousness of the board for the benefit of their main stakeholders (Alkaraan et al., 2022). Additionally, Alkaraan et al. (2022) illustrate that such a criterion also suggests that UK firms are expected to make long-term strategies instead of making short-term strategies to maximise profits. Based on the stakeholder theory, businesses could enhance their relations with the stakeholders by practising ESG activities as ESG considers the environmental, society, and governance factors. It not only focuses on maximising the firm's profitability but also considers other factors and helps businesses to be more comparable and sustainable in the future. Moreover, as tested by Alkaraan et al. (2022), they find that firms with higher ESG performance usually report and implement more I4.0 mechanisms and have better financial performance.

There is adequate existing literature proving a positive relationship between ESG scores and the firm's financial performance. Ahmad et al. (2023) used 351 UK firms from 2002 to 2018 as their research data and found that ESG moderates the global financial crisis and business financial performance. Further, they study that ESG could improve corporations' performance, especially during the financial crisis period. More studies also illustrate that ESG scores indicate increasing businesses' financial performance. For instance, another study by Ahmad et al. (2021) stated to use the most recent 351 firms from the FTSE350 from 2002 to 2018 as their sample data. They use static and dynamic panel data techniques to investigate whether ESG scores affect corporate financial performance. The results show that the total ESG performance positively impacts the firm's financial performance.

Moreover, they also state that the business has higher financial performance with higher ESG scores. Besides, Ahmad et al. (2021) also investigates the other three dimensions of ESG, which are the environmental aspect, social aspect, and corporate governance factor. They find the results of the relationship between the three individual factors and the financial performance are mixed. Furthermore, not every analyst takes every dimension of ESG into account; some of them may only take one or two dimensions into consideration and make the study about the relationship between the factor and financial performance. For instance, as argued by Qiu et al. (2016) observed the environmental and social scores of the FTSE350 index from 2005 to 2009, which was disclosed by Bloomberg, to investigate the impact between environmental and social scores and the market prices. Qiu et al. (2016) applied their specific model based on Nelling and Webb's (2009) application of Granger causality to get the results. Based on the test of Qiu et al. (2016), they find that the disclosure of total environmental and social scores are positive and significant with firms' stock value; further, the current social scores have a positive relationship with the firm's lagged profitability. In addition, they also illustrate that the business is willing to invest in practices that are related to stakeholders. The example of Qiu et al. (2016) uses two factors of ESG to make an analysis.

Additionally, according to Adegbite et al. (2019), they collected data from 314 listed companies in the UK for the period from 2002 to 2015 provided by Thomson Reuters DataStream to estimate the correlation between corporate social performance (CSP) and corporate financial performance (CFP). The result of their research shows that the current corporate social performance has a positive impact on return on assets. In such an article, they only consider one dimension of ESG: corporate social performance. In many existing articles, the authors find that a firm's social performance positively correlates with business financial performance. For instance, as research by Waddock and Graves (1997), not only investigate the positive relation between CSP and CFP but also find that the current CSP also plays a positive role in the firm's upcoming CFP.

Furthermore, as analysed by McGuire et al. (1988), also found the same correlation association between CSP and CFP. Moreover, Elsayed & Paton (2005), collected 227 UK firms' data for the period from 1994 to 2000, all the data they used from Management Today. Their research also investigates environmental performance and finds a neutral association between environmental performance and the firm's performance. This paper will test the relationship between total ESG scores and the CFP and the individual dimensions of ESG association with the CFP by using the FTSE 100 index.

Hypothesis Development

As illustrated above, most literature only takes one factor into consideration, they do not estimate the correlation of other factors of ESG on the impact of CFP, which may not be analysed comprehensively. But they have provided sufficient evidence and analysis relevant to this topic. In this study, it is going to study deeper, which is going to evaluate the total ESG score impact on the FTSE100 firms' profitability. Moreover, it is going to estimate its individual dimensions' impact on business financial performance and discuss which factor is the most significant impact on the financial performance. Therefore, there are two hypotheses that are going to be investigated.

Hypothesis 1:

The overall ESG performance has a positive impact on the financial performance of the corporations.

Hypothesis 2:

The individual ESG element also has a positive impact on the firm's financial performance.

Therefore, two models are going to be applied to verify such two Hypotheses. And it is going to use ROA to measure CFP in this paper. In much existing reliable literature, the authors also utilise ROA as the dependent variable of CFP (e.g., Velte, 2017; Tien et al., 2013; Adegbite et al., 2019). To measure the relevance between ESG and the CFP, regression models will be adopted. The way how models are run, what data are going to be adopted, and how to measure ESG is going to be discussed in detail in the methodology part.

Data Collection

The sample consists of the constituents of the FTSE100 index of the United Kingdom covering the years 2014-2018, 5 years in total. The constituents of the FTSE100 index of the UK can be chosen because the FTSE100 is the largest listed corporation in the United Kingdom, which is representative. Additionally, it is a trend for corporations to publish their non-financial ESG reports; according to Hummel and Rötzel (2019), the European Union (EU) Directive 2014/95/EU mandates that large corporations disclose their sustainability in annual reports. This essay has used balanced panel data, excluding the companies that are not balanced. So, this reduces the selected sample from 100 firms to 58 firms each year. So, observe 290 firm years in total. All the firm's data is collected from the Thomson Reuters DataStream database. The ESG scores and rates of corporations are updated annually by DataStream after applying standard data filtering, such as deleting firms if they are missing data, to make the appropriate analysis. Therefore, after filtering data, five years of data for the 58 companies remaining, and this paper uses those data to make a relevant analysis.

Variables

This paper adopts eight variables: ROA, ESG scores, EnvironmentPillarScore, SocialPillarScore, GovernancePillarScore, Capital expenditures as a percentage of sales (CAPS), and leverage and size.

The ratio of return on assets (ROA) is the dependent variable, which is a variable that is closely related to financial performance.

The total Environmental Social and Governance scores (ESG scores), Environmental Scores (ENV scores), Social scores (SOC scores), and Corporate Governance scores (CGS) are the independent variables. As Tamimi and Sebastianelli (2017) state, 'The three ESG scores (each ranging from 0 indicating no disclosure to 100 demonstrating complete disclosure) are combined into a single score (ranging from 0 to 100) using a proprietary method.' Moreover, ESG is regarded as a standard and criteria for investors to estimate the corporation's future financial performance, as Li et al. (2021) stated. In other words, ESG helps investors to make appropriate investment decisions. According to the literature written by Ahmad et al. (2021), they find a positive

relationship between the total ESG and business financial performance, and they also use the total ESG scores as independent variables.

Further, this paper uses the firm's size as the control variable. As argued by Chen & Metcalf (1980), there is a positive relationship between the firm's size and the financial performance of the business because larger companies have greater familiarity and the ability to engage in more and better social performance than smaller companies with less familiarity.

Furthermore, capital expenditures as a percentage of sales (CAPS) and leverage are also control variables. As stated by Velte (2017), such controlled variables are widely used in this research area, according to Choi and Wang (2009); Fischer and Sawczyn (2013). Leverage is calculated by dividing total debt by total assets. And the formula of CAPS is capital expenditure/ total sales* 100.

Methodology

This paper applies regression analysis to evaluate the degrees of the total ESG and individual dimensions of ESG on the CFP by using balanced panel data. According to Greener (2008), regression analysis produces a percentage representing the variation in a dependent variable explained by an independent variable. Following Velte's (2017) research, he also applied a regression model to analyse whether there is a positive relationship between ESG scores and the firm's financial performance (which ROA represents). The following model (1) is applied to test Hypothesis 1.

Model (1):

$$FINP(ROA) = \beta_0 + \beta_1 ESG\text{scores} + \beta_2 \text{Leverage} + \beta_3 \text{Size} + \beta_4 \text{CAPS} + \varepsilon$$

Furthermore, in this paper, three more independent variables will estimate the relationship between each dimension and the CFP. The other three independent variables are the environmental, social, and governance scores. Therefore, four independent variables in total would be used in the regression model. As stated by Greener (2008), if there is more than one independent variable analysed in such a regression model, which is called a multiple regression model. The following multiple equations (2) are going to test Hypothesis 2, which is used to test the relationship between each ESG aspects score (ENV scores, SOC scores, and corporate governance score) and financial performance (ROA), respectively.

Model (2):

$$FINP(ROA) =$$

$$\beta_0 + \beta_1 \text{ENV scores} + \beta_2 \text{SOC scores} + \beta_3 \text{CGS} + \beta_4 \text{Leverage} + \beta_5 \text{Size} + \beta_6 \text{CAPS} + \varepsilon$$

All data of 58 firms from the FTSE100 index will come into such two models. As a result, the relationship between the total ESG scores and CFP and the relationship between the individual dimensions and CFP will be estimated.

Software Stata 17 is chosen to be used to apply such regression models, which is one of the most popular and common software that is used in data analysis. In addition, the panel data was selected for regression analysis using a fixed effects model after performing the Hausman test.

The Regression Result of the Aggregate ESG Scores and the CFP

Table 1. Regression result of ESG performance and corporate financial performance

VARIABLES	ROA
ESG score	0.054** (2.17)
Leverage	0.016 (0.84)
Size	-6.286*** (-10.37)
CAPS	-0.053*** (-4.84)
Constant	49.258*** (13.66)
Observations	290
Number of Years	5
R-squared	0.361
r2	0.361
F	39.61

Source: Author's calculation

Note: The numbers in parentheses are t-values; the symbols *** and ** indicate significance at the 1% and 5% levels, respectively. Leverage is the total debt divided by the total assets. Size represents firms' size; CAPS represents capital expenditures as a percentage of sales.

As shown above, this is the result after applying fixed effects models. The fixed effects models are selected by examining the Hausman test, and the Hausman test demonstrates that the fixed effects models are more appropriate than the random effects models. After applying the fixed effects models, the total ESG scores show a

positive correlation with the dependent variable ROA at the 5% significant level. As mentioned in the literature review section, some literature uses ROA as the dependent variable to measure the relationship between the independent variable (the total ESG scores). For example, as argued by Ahmad et al. (2023); Qiu et al. (2016), and Adegbite et al. (2019), they find a positive relationship between the firm's financial performance and ESG scores. Referring to the control variables, there is no relationship between the leverage and the firms' ROA. The result indicates that the companies' leverage might not impact the business's financial performance. And for the other two control variables, they have an impact on CFP at the significant level 1%. And for the R squared value (0.361), which means that 36.1% of the dependent variable is affected by the independent variable and the control variables. The R squared represents how well the regression model fits the data, therefore, in this study, there is remaining 63.9% of the variations of the dependent could be explored.

Overall, such a result shows there is a significant positive association between ESG performance and the CFP, this result agrees with Hypothesis 1. Such a result means that the business practice of ESG initiatives will help the business to improve its financial performance. This might be because businesses perform environmental, social, and governance practices, which are beneficial to their stakeholders. Although ESG practices would be a large expense in a short time, they will enhance the business reputation and image in the long term. Based on the stakeholder theory, businesses are desired to consider the benefits regarding their stakeholders. Shareholders prefer to invest their funds in a sustainable business; customers would be more loyal to a corporation that is friendly and responsible to their society and community when the business owns a considerable number of loyal customers their sales are expected an increase then they could earn more and when they earn more the shareholders could be assigned more dividends, which would result in a virtuous circle.

The Regression results of Individual ESG Dimensions and the CFP

Table 2. The Regression Results of Individual ESG aspects and the CFP

VARIABLES	ROA
EnvironmentPillarScore	-0.003 (-0.16)
ScoreSocialPillarScore	0.023 (0.85)
GovernancePillarScore	0.038** (2.32)

Leverage	0.014 (0.72)
Size	-6.376*** (-10.27)
CAPS	-0.048*** (-4.24)
Constant	49.767*** (13.67)
Observations	290
Number of Years	5
R-squared	0.368
r2	0.368
F	27.05

Source: Author's calculation

Note: The numbers in parentheses are t-values, the symbols *** and ** indicate significance at the 1% and 5% levels, respectively. EnvironmentPillarScore represents environmental dimension performance; SocreSocialPillarScore represents social aspect performance; GovernancePillarScore is the governance performance.

Table 2 illustrates Model 2, and it shows the results of the relationship between ESG elements and corporate financial performance. In the following sections, this paper is going to demonstrate each ESG element's performance relationship with CFP.

The Relationship between Environmental Performance and CFP

As demonstrated in Table 2, the regression result has shown a negative relationship between environmental performance and CFP, and it is not significant. This may be because most of the constituents of the FTSE100 index are financial and services sectors, which may not discharge much carbon emissions. Based on the characteristics of such industries, there will be a large expense for them if they invest in environmentally friendly activities. As investigated by Horváthová (2010), there is a negative relationship between environmental performance and corporate financial performance in general. Additionally, Ahmad et al. (2021) revisited the ESG elements' impact on the CFP of FTSE350 firms, and they also found a negative relationship between the environmental element and the CFP. Based on agreement of neoclassical school researchers, they believe that investing in environmental activities is an additional cost for corporations (Palmer et al., 1995).

Such corporations have little impact on the environment, which means such businesses will invest little in environment. Their environmental performance would decrease their financial performance; by contrast, firms with large impact on the environment will invest more. Since most of the samples are companies in the financial industry, the performance of those companies that have a great impact on the environment and invest in environmental governance may not be as good as the financial performance of financial companies, so such a result may be obtained. Thus, firms with negligible emissions to the environment when they invest in environmental performance would be an expense for such firms. Therefore, it might show a negative impact on business financial performance.

The Relationship between Social Performance and CFP

As seen in Table 2, there is a positive but not significant correlation between social performance and CFP. However, as Edmans (2011) investigated, the study randomly selected 250 employers from each 100 best companies to work for and made questionnaires to investigate employees' satisfaction. The questionnaires include four main aspects: the community with employees, chances and benefits, compensation and diversity, and teamwork (Edmans, 2011). The result shows a significant positive association between employer satisfaction and a firm's financial performance. Furthermore, as studied by Adegbite et al. (2019) utilise, 314 UK-listed companies examined the relationship between the social performance aspect and CFP. They also find that social performance has a significant positive impact on CFP. Social aspects typically include employee benefits, community, health and safety, and human rights. The reason why there is no significant result in this regression model might be because the selected sample size is too narrow, which is the limitation of this paper and will be discussed in detail later.

Thus, corporations investing more in social initiatives would have better CFP in theory. Based on the stakeholder theory, employees with higher satisfaction and employee turnover could be lower, which means businesses could save time and money in retaining new employees. Nonetheless, some evidence shows that the association between CFP and social performance is neutral. As researched by Sjöström (2011), reviewed 21 peer academic papers published between 2008 to 2010, 7 reviewed papers test the association between social performance and CPF as neutral. The results are mixed by different research.

The Relationship between Governance Performance and CFP

As shown in Table 2, governance performance is significantly positive with CFP at a 5% level. Such a result indicates that the higher the governance scores, the better CFP could make. This is the same result with a quantity of existing literature. For instance, as Brown and Caylor (2006) studied, the firm's value is positively and significantly related to business governance. They prove that effective business governance requires combined internal and external governance approaches and could make a better result on CFP. In addition, the governance aspect of ESG could also play a crucial role in managing the issues from the financial crisis made on the CFP, and further, it promotes the firm's CFP, according to Ahmad et al. (2023). Ahmad et al. (2023) utilise the FTSE350 index and make an analysis based on the UK companies, which is like this paper, British companies are selected as samples. And the result

tested in this paper is the same as theirs. Furthermore, most evidence has shown a positive relationship between governance performance and CFP (Love, 2011).

Investors are considerate about the governance of a company when they make investment decisions. Because those corporations with a good governance framework could minimise their scandals, as argued by Kyere and Ausloos (2021), businesses with scandals usually have poor governance. The scandals such as bankruptcy, for instance, if a firm with poor governance with their cash flows and budget management, the business might face fund issues which would result in fund shortage and then be broken. Once such a situation happens, investors' capital will evaporate, and unemployment will increase (Mallin, 2016). Therefore, investors must ensure their capital can be run and utilised in reliable corporations with good governance. From the other perspective of governance, if firms lack the practice of making appropriate strategies in bonding stakeholders, this would be a problem. According to Kyere and Ausloo (2021), the related community of the corporation could negatively affect the business if the community is not satisfied with the firm's operation. Thus, governance is crucial to the firm, and it is relevant to the firm's financial performance.

Robustness test

This paper does a robustness test; the results are presented below (Table 3). To do so, collected 3 more years of data, which are from 2019 to 2021, the data from the pandemic years, in order to test if the results are robust. Compared to the results displayed in Table 1 and Table 2, it can be seen that in general the results are similar and prove the robustness of this paper.

Table 3: Robustness Test Results

	(1)	(2)
	model 1	model 2
ESGscore	0.043** (2.18)	
Leverage	0.009 (0.61)	0.010 (0.66)
Size	-6.205*** (-13.20)	-6.246*** (-13.05)
CAPS	-0.035*** (-4.62)	-0.031*** (-4.02)
EnvironmentPillarScore		-0.016 (-1.07)
ScoreSocialPillarScore		0.022

		(1.06)
GovernancePillarScore		0.039***
		(2.82)
		(-0.53)
Constant	49.452***	49.581***
	(17.46)	(17.45)
Observations	290	290
	0.347	0.358

Source: Author's calculation

Note: The numbers in parentheses are t-values; the symbols *** and ** indicatesignificance at the 1% and 5% levels, respectively.

Discussion

As seen from the above tables, indicate the results of the whole ESG scores with the firm's financial performance and the relationship between individual dimensions of ESG and CFP. There is a positive significant relationship between total ESG scores and CFP, which is at the 5% significant level. These results explain that businesses with a higher ESG score generally have better financial performance. The results are mixed when it comes to the individual elements of the whole ESG. For the governance dimension, there is a significant positive association between the governance element and financial performance. However, there is no significant positive relationship found for the social aspect; and environment aspect negatively impact CFP. There is a negative but not significant association between the environmental aspect and CFP, and the relationship between the social aspect and financial performance is positive but not significant.

Compared to the previous literature, the main results of this study are like Ahmad et al. (2023)'s research. But they utilise a more significant number of samples to analyse, which are 351 companies from the FTSE350 index and cross ten industries. This study only contains 58 firms after filtering, a narrow database compared to Ahmad et al. (2023)'s literature. In addition, the research of Adegbite et al. (2019) finds there is a lagged relationship between a firm's financial performance and its social performance. They also collected many companies' data but only examine one dimension of ESG's impact on the CFP. Furthermore, many existing articles only analyse one aspect's relationship with the firm's financial performance (for instance, Golicic and Smith, 2013; Love, 2011; Orlitzky, 2011). Those authors only investigate one aspect of ESG's influence on corporation financial performance.

However, the dimensions in this paper are more comprehensive, including all the individual aspects of ESG. And it further analyses how and the reasons why the individual elements would make an effect on a firm's financial performance. And based on several theories to study the whole ESG and its elements. Moreover, to be

tested reliable, this literature enlarges the sample years from 5 years to 8 years, which considers the influence made during the pandemic periods and examines the same results with the previous regression model. This is robust to the regression results.

The Summary of Main Findings

To conclude, there is an impact on the corporation's financial performance for ESG performance, which is positive and significant. Although this paper only considers one economic entity, the UK, it is examined with the same results as the other developed companies. For instance, by examining the EU firms, Tahmid et al. (2022) find a positive relationship between ESG initiatives and financial performance.

Besides this paper also investigates the relationship between other elements of ESG and CFP. From the perspective of the environmental aspect, the result indicates a negative but not significant relationship between the environmental aspect and CFP. The potential reason is that the environmental performance might not show its influence in a short time; it takes time to implement and play its role.

From the other perspective of ESG elements, there is a positive but no significant correlation between social performance and CFP. Based on the stakeholder theory, businesses are expected to consider stakeholders' benefits, not only prioritising maximising profits but they are also suggested to be environmentally and socially friendly.

And from the governance perspective, there is a significant positive influence on CFP. There are many governance mechanisms that could improve business financial performance. For instance, the management compensation is an effective governance approach to increase a firm's profitability, according to Guay et al. (2002) management compensation can attract, incentive and retain management, and further create value in the long term. Businesses could operate in an efficient way with good governance, governance is crucial for corporations. Business governance is regarded as a bridge between the management performance and the points focused by stakeholders (Malik and Makhdoom, 2016). Employees could be motivated when the management makes clear and good strategies, and the businesses can operate effectively and be responsible to their board members and stakeholders. Therefore, governance is crucial to a company and cannot be underestimated.

This paper focuses on the FTSE100 index UK firms, and only 58 firms are used after filtering, the sample size is narrow, and this paper's results are appropriate to the UK firms. In addition, this study only uses ROA as a measurement of financial performance. Therefore, it is recommended that further research can take more measurements into consideration for instance, the ROE and Tobin's Q. Besides, analysis can use a larger sample size, for example, investigating all listed UK firms in future and making the analysis more comprehensive and convictive.

References

- Adegbite, E., Guney, Y., Kwabi, F. and Tahir, S (2019), Financial and corporate social performance in the UK listed firms: the relevance of non-linearity and lag effects. *Review of Quantitative Finance and Accounting*, 52, pp.105-158.
- Ahmadi, H.B., Kusi-Sarpong, S. and Rezaei, J. (2017), Assessing the social sustainability of supply chains using Best Worst Method. *Resources, Conservation and Recycling*, 126, pp.99-106.
- Ahmad, N., Mobarek, A. and Roni, N.N. (2021), Revisiting the impact of ESG on financial performance of FTSE350 UK firms: Static and dynamic panel data analysis. *Cogent Business & Management*, 8(1), p.1900500.
- Ahmad, N., Mobarek, A. and Raid, M. (2023), Impact of global financial crisis on firm performance in UK: Moderating role of ESG, corporate governance and firm size. *Cogent Business & Management*, 10(1), p.2167548.
- Alareeni, B.A. and Hamdan, A. (2020), ESG impact on performance of US S&P 500-listed firms. *Corporate Governance: The International Journal of Business in Society*, 20(7), pp.1409-1428.
- Albertini, E. (2013), "Does Environmental Management Improve Financial Performance? A Meta-Analytical Review", *Organization & environment*, vol. 26, no. 4, pp. 431-457.
- Alkaraan, F., Albitar, K., Hussainey, K. and Venkatesh, V.G. (2022), Corporate transformation toward Industry 4.0 and financial performance: The influence of environmental, social, and governance (ESG). *Technological Forecasting and Social Change*, 175, p.121423.
- Aluchna, M., Roszkowska-Menkes, M., Kamiński, B. and Bosek-Rak, D. (2022), Do institutional investors encourage firm to social disclosure? The stakeholder salience perspective. *Journal of Business Research*, 142, pp.674-682.
- Ameer, R. and Othman, R. (2012), Sustainability practices and corporate financial performance: A study based on the top global corporations. *Journal of business ethics*, 108, pp.61-79.
- Arlow, P. and Gannon, M.J. (1982), Social responsiveness, corporate structure, and economic performance. *Academy of Management review*, 7(2), pp.235-241.
- Awan, U., Kraslawski, A. and Huiskonen, J. (2018), Governing interfirm relationships for social sustainability: the relationship between governance mechanisms, sustainable collaboration, and cultural intelligence. *Sustainability*, 10(12), p.4473.
- Ayres, R.U. (Ed.) (1998), *Eco-Restructuring*. United Nations University Press, New York.
- Baraibar-Diez, E. and D. Odriozola, M. (2019), CSR committees and their effect on ESG performance in UK, France, Germany, and Spain. *Sustainability*, 11(18), p.5077.

- Barnett, M.L. and Salomon, R.M. (2006), Beyond dichotomy: The curvilinear relationship between social responsibility and financial performance. *Strategic management journal*, 27(11), pp.1101-1122.
- BlackRock (2018), Sense of purpose. Larry Fink's Annual Letter to CEOs. <https://corpgov.law.harvard.edu/2018/01/17/a-sense-of-purpose/>.
- Brammer, S., Brooks, C., & Pavelin, S. (2006), Corporate social performance and stock returns: UK evidence from disaggregate measures. *Financial Management*, 35(3), 97–116.
- Brogi, M. and Lagasio, V. (2019), Environmental, social, and governance and company profitability: Are financial intermediaries different?. *Corporate Social Responsibility and Environmental Management*, 26(3), pp.576-587.
- Brown, L.D. and Caylor, M.L. (2006), Corporate governance and firm valuation. *Journal of accounting and public policy*, 25(4), pp.409-434.
- Buallay, A. (2019), Is sustainability reporting (ESG) associated with performance? Evidence from the European banking sector. *Management of Environmental Quality: An International Journal*, 30(1), pp.98-115.
- Buttel, F.H. (2000), Ecological modernization as social theory. *Geoforum*, 31(1), pp.57-65.
- Chelawat, H., Trivedi, I.V. (2016), The business value of ESG performance: The Indian context. *Asian Journal of Business Ethics*, 5, 195–210.
- Chen, K. H., & Metcalf, R. W. (1980), The relationship between pollution control record and financial indicators revisited. *The Accounting Review*, 55(1), 168–177.
- Choi, J. and Wang, H. (2009), Stakeholder relations and the persistence of corporate financial performance. *Strategic management journal*, 30(8), pp.895-907.
- Gordon L. C., Feiner, A., Viehs, M. (2015), "From the Stockholder to the Stakeholder: How Sustainability Can Drive Financial Outperformance." [Online]. [Accessed 10 August 2023]. Available from: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2508281.
- Clarkson, M.E. (1995), A stakeholder framework for analyzing and evaluating corporate social performance. *Academy of management review*, 20(1), pp.92-117.
- De Grosbois, D. (2012), Corporate social responsibility reporting by the global hotel industry: Commitment, initiatives and performance. *International Journal of Hospitality Management*, 31(3), pp.896-905.
- Dorfleitner, G., Halbritter, G. and Nguyen, M. (2015), Measuring the level and risk of corporate responsibility—An empirical comparison of different ESG rating approaches. *Journal of Asset Management*, 16, pp.450-466.
- Duque-Grisales, E. and Aguilera-Caracuel, J. (2021), Environmental, social and governance (ESG) scores and financial performance of multilatinas: Moderating effects of geographic international diversification and financial slack. *Journal of Business Ethics*, 168(2), pp.315-334.

- Du, S., Bhattacharya, C.B. and Sen, S. (2010), Maximizing business returns to corporate social responsibility (CSR): The role of CSR communication. *International journal of management reviews*, 12(1), pp.8-19.
- EBA (2021), EBA Report on Management and Supervision of ESG Risks for Credit Institutions and Investment Firms. [Online]. [Accessed 10 August 2023]. Available from: https://www.eba.europa.eu/sites/default/documents/files/document_library/Publications/Repos/2021/1015656/EBA%20Report%20on%20ESG%20risks%20management%20and%20supervision.pdf
- Eberhardt-Toth, E. (2017), Who should be on a board corporate social responsibility committee?. *Journal of Cleaner Production*, 140, pp.1926-1935.
- Eccles, R.G., Ioannou, I. and Serafeim, G. (2014), The impact of corporate sustainability on organizational processes and performance. *Management science*, 60(11), pp.2835-2857.
- Edmans, A. (2011), Does the stock market fully value intangibles? Employee satisfaction and equity prices. *Journal of Financial economics*, 101(3), pp.621-640.
- Elsayed, K., & Paton, D. (2005), The impact of environmental performance on firm performance: Static and dynamic panel data evidence. *Structural Change and Economic Dynamics*, 16(3), 395–412.
- Escrig-Olmedo, E., Fernández-Izquierdo, M.Á., Ferrero-Ferrero, I., Rivera-Lirio, J.M. and Muñoz-Torres, M.J. (2019), Rating the raters: Evaluating how ESG rating agencies integrate sustainability principles. *Sustainability*, 11(3), p.915.
- Fischer, T.M. and Sawczyn, A.A. (2013), The relationship between corporate social performance and corporate financial performance and the role of innovation: Evidence from German listed firms. *Journal of management control*, 24, pp.27-52.
- Freeman, R.E. (1984), *Strategic management: A stakeholder approach*. Marshfield, MA.
- Friedrichs, Jürgen (1990): *Methoden empirischer Sozialforschung*, Opladen.
- Freeman, R.E. and Dmytriiev, S. (2017), Corporate social responsibility and stakeholder theory: Learning from each other. *Symphonya. Emerging Issues in Management*, (1), pp.7-15.
- Freeman, R.E., Harrison, J.S. and Wicks, A.C. (2007). *Managing for stakeholders: Survival, reputation, and success*. Yale University Press.
- Friedman, A.L. and Miles, S. (2006), *Stakeholders: Theory and practice*. OUP oxford.
- Friedman, M. (1970), A Friedman doctrine: The social responsibility of business is to increase its profits. *The New York Times Magazine*, 13(1970), 32–33.
- Freeman, R.E., Harrison, J.S., Wicks, A.C., Parmar, B.L. and De Colle, S. (2010), *Stakeholder theory: The state of the art*. (Cambridge University Press, Cambridge, UK)
- Friede, G., Busch, T. and Bassen, A. (2015), ESG and financial performance: aggregated evidence from more than 2000 empirical studies. *Journal of sustainable finance & investment*, 5(4), pp.210-233.

- Foresight, U.K. (2013), The future of manufacturing: a new era of opportunity and challenge for the UK. Summary Report, The Government Office for Science, London, 20.
- Gillan, S., Hartzell, J.C., Koch, A. and Starks, L.T. (2010), Firms' environmental, social and governance (ESG) choices, performance and managerial motivation. Unpublished working paper, 10.
- Gillan, S.L., Koch, A. and Starks, L.T. (2021), Firms and social responsibility: A review of ESG and CSR research in corporate finance. *Journal of Corporate Finance*, 66, p.101889.
- Golicic, S.L. and Smith, C.D. (2013), A meta-analysis of environmentally sustainable supply chain management practices and firm performance. *Journal of supply chain management*, 49(2), pp.78-95. [Online]. [Accessed 7 August 2023]. Available from: https://onlinelibrary.wiley.com/doi/full/10.1111/jscm.12006?casa_token=cUNapqfPljsAAAAA%3AEX5qabm9DzzGs8vmlKFW9NL0ggpdoH50elwCBR5S5IoAwk9TUehP_AtUokxqreFQPwt3xEfgN5AQuChP.
- Goodland, R. and Ledec, G. (1987), Neoclassical economics and principles of sustainable development. *Ecological modelling*, 38(1-2), pp.19-46.
- Greener, S. (2008), *Business research methods*. BookBoon, p.62.
- Greening, D.W. and Turban, D.B. (2000), Corporate social performance as a competitive advantage in attracting a quality workforce. *Business & society*, 39(3), pp.254-280.
- Guay, W.R., Core, J.E. and Larcker, D.F. (2002), Executive equity compensation and incentives: A survey. [Online]. [Assessed 5th Aug 2023]. Available from: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=276425. [Assessed 5th Aug 2023].
- Hang, M., Geyer-Klingenberg, J. and Rathgeber, A.W. (2019), It is merely a matter of time: A meta-analysis of the causality between environmental performance and financial performance. *Business Strategy and the Environment*, 28(2), pp.257-273.
- Harrison, J.S., Phillips, R.A. and Freeman, R.E. (2020), On the 2019 business roundtable "statement on the purpose of a corporation". *Journal of Management*, 46(7), pp.1223-1237.
- Hawn, O., Chatterji, A.K. and Mitchell, W. (2018), Do investors actually value sustainability? New evidence from investor reactions to the Dow Jones Sustainability Index (DJSI). *Strategic Management Journal*, 39(4), pp.949-976.
- Hajer, M.A. (1995), *The politics of environmental discourse: ecological modernization and the policy process*. Clarendon Press, New York; Oxford.
- Hoang, T.H.V., Segbotangni, E.A. and Lahiani, A. (2020), Does ESG disclosure transparency help mitigate the COVID-19 pandemic shock? An empirical analysis of listed firms in the UK. *An Empirical Analysis of Listed Firms in the UK* (November 26, 2020).
- Horváthová, E. (2010), Does environmental performance affect financial performance? A meta-analysis. *Ecological economics*, 70(1), pp.52-59.
- Horváthová, E. (2012), The impact of environmental performance on firm performance: Short-term costs and long-term benefits?. *Ecological Economics*, 84, pp.91-97.

Howard-Grenville, J. (2021), ESG impact is hard to measure-but it's not impossible. [Online]. [Accessed 10 August 2023]. Available from: doi:10.17863/CAM.64207.

Hummel, K. and Rötzel, P. (2019), Mandating the sustainability disclosure in annual reports—evidence from the United Kingdom. *Schmalenbach Business Review*, 71(2), pp.205-247.

Hunter, J.E. and Schmidt, F.L. (2004), *Methods of meta-analysis: Correcting error and bias in research findings*. Sage.

Jackson, G., Bartosch, J., Avetisyan, E., Kinderman, D. and Knudsen, J.S. (2020), Mandatory non-financial disclosure and its influence on CSR: An international comparison. *Journal of Business Ethics*, 162, pp.323-342.

Jo, H. and Harjoto, M.A. (2012), The causal effect of corporate governance on corporate social responsibility. *Journal of business ethics*, 106, pp.53-72.

Karnani, A. (2010), The case against corporate social responsibility. *Wall Street Journal*, 23(14), pp.1-5.

Kim, M. and Kim, Y. (2014), Corporate social responsibility and shareholder value of restaurant firms. *International Journal of Hospitality Management*, 40, pp.120-129.

Kyere, M. and Ausloos, M. (2021), Corporate governance and firms financial performance in the United Kingdom. *International Journal of Finance & Economics*, 26(2), pp.1871-1885.

Lam, J.S.L. and Lai, K.H. (2015), Developing environmental sustainability by ANP-QFD approach: the case of shipping operations. *Journal of Cleaner Production*, 105, pp.275-284.

Li, T.T., Wang, K., Sueyoshi, T. and Wang, D.D. (2021), ESG: Research progress and future prospects. *Sustainability*, 13(21), p.11663.

Love, I. (2011), "Corporate Governance and Performance around the World: What We Know and What We Don't", *The World Bank research observer*, 26(1), pp. 42-70.

Malik, M.S. and Makhdoom, D.D. (2016). Does corporate governance beget firm performance in fortune global 500 companies?. *Corporate Governance*, 16(4), pp.747-764.

Mallin, C.A. (2016), *Corporate governance*. Oxford university press.

McGuire, J.B., Sundgren, A. and Schneeweis, T. (1988), Corporate social responsibility and firm financial performance. *Academy of management Journal*, 31(4), pp.854-872.

Mellahi, K. and Wood, G. (2003), The role and potential of stakeholders in “hollow participation”: Conventional stakeholder theory and institutional alternatives. *Business and Society Review*, 108(2), pp.183-202.

Min, S. and Mentzer, J.T. (2004), Developing and measuring supply chain management concepts. *Journal of business logistics*, 25(1), pp.63-99.

Nakao, Y., Amano, A., Matsumura, K., Genba, K. and Nakano, M. (2007), Relationship between environmental performance and financial performance: an empirical analysis of Japanese corporations. *Business Strategy and the Environment*, 16(2), pp.106-118.

Nelling, E. and Webb, E. (2009), Corporate social responsibility and financial performance: The “virtuous circle” revisited. *Review of Quantitative finance and accounting*, 32, pp.197-209.

Nirino, N., Santoro, G., Miglietta, N. and Quaglia, R. (2021), Corporate controversies and company's financial performance: Exploring the moderating role of ESG practices. *Technological Forecasting and Social Change*, 162, p.120341.

Odriozola, M.D. (2019), "CSR Committees and Their Effect on ESG Performance in UK, France, Germany, and Spain", *Sustainability (Basel, Switzerland)*, vol. 11, no. 18, pp. 5077.

OECD (2004), *Principles of Corporate Governance, Corporate Governance in Japan: From the Viewpoints of Management, Accounting, and the Market*. [Online]. [Assessed 6 August 2023] Available from: doi: 10.1007/978-4-431-30920-8_10.

Orlitzky, M. (2011), Institutional logics in the study of organizations: The social construction of the relationship between corporate social and financial performance. *Business Ethics Quarterly*, 21(3), pp.409-444. [Online]. [Assessed 7 August 2023]. Available from: <https://www.cambridge.org/core/journals/business-ethics-quarterly/article/abs/institutional-logics-in-the-study-of-organizations-the-social-construction-of-the-relationship-between-corporate-social-and-financial-performance/D1CD6564C1FDEBC178E7D310B2E18EDE>.

Palmer, K., Oates, W.E. and Portney, P.R. (1995), Tightening environmental standards: the benefit-cost or the no-cost paradigm?. *Journal of economic perspectives*, 9(4), pp.119-132.

Porter M. and Kramer M., 2011. Creating shared value. *Harvard Bus. Rev.* 89(1/2):62–77.

Preston, L.E. and O'bannon, D.P. (1997), The corporate social-financial performance relationship: A typology and analysis. *Business & Society*, 36(4), pp.419-429.

Qiu, Y., Shaukat, A. and Tharyan, R. (2016), Environmental and social disclosures: Link with corporate financial performance. *The British Accounting Review*, 48(1), pp.102-116.

Rajesh, R. and Rajendran, C. (2020), Relating environmental, social, and governance scores and sustainability performances of firms: An empirical analysis. *Business Strategy and the Environment*, 29(3), pp.1247-1267.

Schnaiberg, A., Weinberg, A., Pellow, D. (1998), Ecological modernization in the internal periphery of the USA. Paper presented at the annual meeting of the American Sociological Association, San Francisco.

Signori, S., San-Jose, L., Retolaza, J.L. and Rusconi, G. (2021), Stakeholder value creation: Comparing ESG and value added in European companies. *Sustainability*, 13(3), p.1392

Sjöström, E. (2011), “The Performance of Socially Responsible Investment – A Review of Scholarly Studies Published 2008–2010.” *SSRN Electronic Journal*:1–19.[Online]. [Accessed 10 August 2023]. Available from: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1948169.

Tahmid, T., Hoque, M. N., Said, J., Saona, P., & Azad, Md. A. K. (2022), Does ESG initiatives yield greater firm value and performance? New evidence from European

firms. *Cogent Business & Management*, 9(1).

<https://doi.org/10.1080/23311975.2022.2144098>

Tamimi, N. and Sebastianelli, R. (2017), Transparency among S&P 500 companies: An analysis of ESG disclosure scores. *Management Decision*, 55(8), pp.1660-1680.

Tarmuji, I., Maelah, R. and Tarmuji, N.H. (2016), The impact of environmental, social and governance practices (ESG) on economic performance: Evidence from ESG score. *International Journal of Trade, Economics and Finance*, 7(3), p.67.

Tien, C., Chen, C.N. and Chuang, C.M. (2013), A study of CEO power, pay structure, and firm performance. *Journal of Management & Organization*, 19(4), pp.424-453.

Ting, I.W.K., Azizan, N.A., Bhaskaran, R.K. and Sukumaran, S.K. (2019), Corporate social performance and firm performance: Comparative study among developed and emerging market firms. *Sustainability*, 12(1), p.26.

Tsang, A., Frost, T. and Cao, H. (2022), Environmental, social, and governance (ESG) disclosure: A literature review. *The British Accounting Review*, p.101149.

Velte, P. (2017), Does ESG performance have an impact on financial performance? Evidence from Germany. *Journal of Global Responsibility*, 8(2), pp.169-178.

Velte, P. (2020), Does CEO power moderate the link between ESG performance and financial performance? A focus on the German two-tier system. *Management Research Review*, 43(5), pp.497-520.

Waddock, S.A. and Graves, S.B. (1997), The corporate social performance–financial performance link. *Strategic Management Journal*, 18(4), pp.303-319.

Yoon, B., Lee, J.H. and Byun, R. (2018), Does ESG performance enhance firm value? Evidence from Korea. *Sustainability*, 10 (10), 3635.

Yoo, S. and Managi, S. (2022), Disclosure or action: Evaluating ESG behavior towards financial performance. *Finance Research Letters*, 44, p.102108.

Zhao, C., Guo, Y., Yuan, J., Wu, M., Li, D., Zhou, Y. and Kang, J. (2018), ESG and corporate financial performance: Empirical evidence from China's listed power generation companies. *Sustainability*, 10(8), 2607.

Performance Impacts of Accounting/Finance Transformation – the Mediating Role of Analytics Systems Quality

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Abstract

Our research investigates the trending topic accounting/finance transformation (AFT), how AFT projects impact on business intelligence and analytics (BI/A) systems and whether such impacts result in higher accounting information service levels. Using survey data collected from accounting and finance executives, the results of our SEM-PLS analysis indicate that AFT projects lead to higher BI/A systems quality via two mediators: system/data integration and adoption of BI/A tools in management accounting. We also find that the use of ERP systems in management accounting has a complementary effect on those relationships and that AFT projects indirectly lead to higher accounting information service levels and performance.

Keywords: Accounting/Finance transformation, systems quality, management accounting, business intelligence, business analytics

Introduction

In an era in which digital transformation has become a paradigm (Chang, Kauffman et al. 2014), a similar term has (re-)entered the list of priorities of C-level executives, consultants and professional accounting bodies alike: accounting/finance transformation¹ (AFT). AFT is in vogue (Driscoll 2016), as evidenced by search trends in Google, reports published by professional accounting and finance bodies (Lytton and Kops 2014) and the Big Four accounting firms, who all have specialised consulting sections for AFT support. In the absence of an academic definition of the term, practitioners offer a wide range of descriptions, such as a process “to align Finance with the overall company strategy in order to become more efficient and provide better service to internal customers” (Lau 2014); or: “aiming at better service and more insight. Second, articulating the role of the function to drive more effective analysis through partnering” (Arnold 2017). Effectively, AFT projects (AFTP) typically aim at better financial services, delivered more efficiently, providing better insights to internal information customers or business partners and becoming more strategic (Bhimani and Willcocks 2014, Lau 2014, Arnold 2017).

AFTPs are certainly not a new phenomenon: Attempts to reform, improve or re-engineer the accounting and finance (A&F) function have been undertaken frequently over the past decades, either under the same heading or using different labels or project names, such as reengineering finance and accounting (Robbins and Drory 1995) and with varying objectives or approaches. Accounting scandals and large corporate collapses are typical examples of triggers, but also technology innovations, global economic crises or simply internal pressures for higher efficiency and better service quality.

The current rise in AFTPs is to a large extent technology-driven, e.g. by the digital transformation /revolution and associated challenges for A&F (Bhimani and Willcocks 2014); the advent of robotics process automation, which increases pressure on core financial management in terms of service quality and cost (Driscoll 2016); and the emergence of data scientists as a profession (Davenport and Patil 2012) potentially competing with management accountants. But AFTPs are also the result of increased pressure – at least from the professional accounting bodies – to more service orientation and business partnering (Civichino 2013, Hagel 2015, Arnold 2017), also partly as a result of the rapid growth of the international outsourcing market and the corresponding emergence of service level agreements (SLA) between accounting and finance (A&F) and the rest of the organization – similar to the well-established

Transformation is about *fundamental* changes to processes, structures, people, etc. Therefore, AFTPs are usually very complex, challenging, costly, lengthy, intimidating – hence risky and failure-prone. This raises the question as to whether the potential benefits associated with AFTPs justify the cost and risks. While there is some case evidence of project successes, no systematic evidence has so far been presented, and academic research in accounting has been completely silent on the phenomenon. In our attempt to reduce this research gap, we first of all focus on the service role of management accountants (business partners) by asking (RQ1): *Do AFTPs lead to more detailed and timely management accounting information provision to business managers?*

We also acknowledge that any such effects will not be direct, but rather delivered along indirect effect chains. As today's management accounting information is gathered, stored, processed and often also distributed to managers using computerised information systems, we focus our attention on the mediating effects of those information systems on the delivery of potential AFTP-related benefits for managerial decision support. In today's systems architectures of medium to large firms, management accounting data and information is typically processed at two system levels:

- a) The *core information system* level, which is used to record and maintain actual financial and also non-financial transactions, but which is also used for basic planning (e.g. standard costs), for splitting such costs into variable and fixed components, etc. and to provide standardized reports on such data. Most medium to large organisations use primarily enterprise resource planning systems (ERPs) to cover the core system level requirements.
- b) The *ad-hoc information system* level, which largely – but not necessarily exclusively – relies on the data in the core system, to provide ad-hoc support for one-off problem-specific information requirements (e.g. a project budget or an optimisation problem), more advanced issues in budgeting (e.g. scenario analysis) and advanced reporting requirements (e.g. dashboard kind of visualisation tools). Such information processing and reporting requirements may be addressed by – ad hoc or more permanent – spreadsheet models, or more specialized and functionally sophisticated business intelligence (BI systems) (Chaudhuri, Dayal et al. 2011) and – more recently – business analytics tools or systems (Chen, Chiang et al. 2012, Holsapple, Lee-Post et al. 2014) (BI/A systems).

In line with Peters, Wieder et al. (2016) we expect the functional quality of the ad-hoc system level (hereinafter referred to as *BI/A systems quality*) to play a major role in conveying AFT efforts into the timely provision of relevant MA information to business managers. Accordingly, our second and third research questions are: *Do AFTPs improve the accounting BI/A systems quality, and if so, how?*

While we acknowledge that AFT in the broader sense has been subject to many previous academic studies, we are not aware of any research which investigated the impact of AFT *projects* on ERPs and business intelligence systems or BI/A (business analytics tools or systems) and managerial decision support provided by accounting. To answer our research questions, we collected survey responses (Hiebl and Richter 2018) from top financial managers of medium to large size private sector firms, 50% of which had finalised or were in advanced stages for AFTP, thereby providing a perfect sample for contrasting AFTP and non-AFTP organisations. We provide first-time systematic evidence of benefits associated with AFTPs and how they can be achieved (i.e. via system and data integration efforts and the adoption of analytic tools). In particular, we provide evidence for the crucial mediating role of BI/A systems in conveying such benefits.

The remainder of this paper is structured as follows: In the next section, we develop the hypotheses out of existing literature and practical observations. That section is followed by a detailed description of the research method, followed by results section and finally conclusions and limitation section.

Theory/Hypotheses Development

Finance transformation projects

As outlined in the introduction, AFT-initiatives or projects are not new, but for various reasons, they have moved up substantially in the top-priority list of many chief financial officers (CFOs). Such projects

typically aim at better financial services, delivered more efficiently, providing better insights to internal information customers or business partners and becoming more strategic (Bhimani and Willcocks 2014, Lau 2014, Arnold 2017). This requires investments into skills, process engineering and supporting Information Technology/Information Systems (IT/IS) platforms and tools, partly aiming at efficiency improvements (e.g. robotic process automation), partly for providing better insights (e.g. through advanced analytics), or both (Gullkvist 2013). Skill investment is about acquiring or improving skills within the accounting and finance (A&F) function, referring to soft skills in support of better business partnering, and technical skills in support of mastering new methods and technologies (Bhimani and Willcocks 2014). IT/IS related objectives of AFTPs are typically two-fold: On the one hand, they pursue *IT/IS infrastructure related objectives*, e.g. the integration of data and systems used within A&F and across the whole organisation; on the other hand, they strive for better IT/IS support for *process automation and intelligence provision* through the use of advanced BI and analytic tools.

System and data integration in support of BI/A system quality

In support of the first IT/IS related objective of AFTP, ERP systems (ERPS) have long become the standard integration solution for business and accounting and finance (A&F) operations and basic planning activities in both areas. By integrating information from other modules (e.g. production planning and control), they make the operation of large-scale MA systems feasible – even with several thousands of cost centres and other cost objects. Furthermore, ERPS can help develop the role of MA from “data entering (towards) data analysis and consulting” (Endenich, Trapp et al. 2017) and to reach broader acceptance and the desired influence on managerial decision-making (business partnering).

However, ERPS do not guarantee that A&F systems are well integrated with other business functions, because there may be selective use of ERPS modules across business functions, and some organisations even use multiple ERPS. Accordingly, even if organisations use ERPS, they do not necessarily use them for management accounting, either because the system does not provide management accounting functionality at all, or because ERP-users prefer other MA solutions – including islands of spreadsheets. It is therefore not surprising that management accounting functionality embedded in ERPS did not revolutionize MA practices in organizations (Granlund and Malmi 2002, Busco, Quattrone et al. 2007). The mid-1990s saw the second wave of digital revolution (Bhimani and Willcocks 2014) and the *data warehouse* emerged as an integration and aggregation infrastructure for increasing amounts of transactional data inside and outside of ERPS using increasingly automated extract-transform-load (ETL) procedures. Data warehouses became the core engines of business intelligence (BI) solutions, which were initially primarily reporting tools, e.g. for performance measurement, but were gradually extended with functionality for advanced forecasting and planning, strategy management and other functions in support of *business partnering* (Elbashir, Collier et al. 2013, Acito and Khatri 2014, Wieder and Ossimitz 2015, Peters, Wieder et al. 2016, Vukšić, Bach et al. 2013).

However, data warehouses did not provide an end to the quest for integration: With data available rapidly increasing in terms of volume, velocity, variety etc. (Big Data) (Davenport 2014) and the Internet-of-things (IoT) further adding to the data explosion (Moffitt and Vasarhelyi 2013), the integration of systems and data is fully back on the agenda. System and data integration support the quality of business analytics tools or systems (BI/A). AFTPs are therefore expected to address such disintegration issues (this is a lack of quality), aiming for more integrated architectures in support of their business intelligence and analytics (BI/A):

H1a: Finance transformation projects with information systems or process-efficiency related objectives lead to increased systems and data integration, which has an indirect positive impact on the quality of business intelligence/analytics (BI/A) systems used in accounting.

Analytical tools in support of management accounting

Despite the increased use of data warehouses and business intelligence (BI) solutions in management accounting (MA), they have rarely evolved beyond what Davenport (2014) refers to as *Analytics 1.0* – the era of business intelligence (BI) reporting (Peters, Wieder et al. 2018). With the emergence of data science as a discipline and profession, some academics emphasize that MA has used, or has at least proposed the use of advanced business analytics (BA) methods in the past (Sutton, Holt et al. 2016,

18th International Conference on Enterprise Systems, Accounting, Logistics & Management (ICESALM) Amani and Fadlalla 2017). Others follow the tradition of Ijiri (1965) and provide new recommendations for the innovative use of such methods in MA (Raval and Greteman 2015, Nielsen 2018, Rikhardsson and Yigitbasoglu 2018). Machine learning/data mining techniques are frequently suggested advanced business analytics (BA) methods, but advanced visualization techniques have also attracted significant attention. In general, many of the recommendations for using advanced BA methods in MA refer to the benefits of utilizing new non-financial and/or external data sources to support traditional and new tools and methods (e.g. balanced score card (BSC), forecasting, pricing and benchmarking) (Pickard and Cokins 2015, Sutton, Holt et al. 2016). In doing so, management accountants are advised to move away from just verifying data, towards modelling, simulation and scenario analysis, “giving a range of answers rather than one single answer” (Russell 2014). A considerable number of publications address new opportunities in inventory management, costing and asset valuation more broadly (e.g. Hülle, Kaspar et al. 2011, Moffitt and Vasarhelyi 2013, Amani and Fadlalla 2017), but the vast majority of advanced business analytics (BI/A) applications potentially usable in management accounting (MA) are *proposed* rather than empirically *validated*. As for the latter, the actual cases reported in the literature tend to be only very marginally related to MA. We therefore seek to *empirically confirm* that such applications are actually used in management accounting (MA) and that such use contributes positively to the quality of business analytics (BI/A) systems:

H1b: Finance transformation projects with information systems or process-efficiency related objectives lead to increased use of analytic software tools in accounting, which has an indirect positive impact on the quality of business intelligence/analytics systems used in accounting.

Overall impact of accounting/finance transformation projects on BI/A systems quality

It follows from the development of H1a and H1b that we expect an overall positive *indirect* impact of AFTPs on BI/A Systems Quality (via higher systems/data integration and the increased adoption of business analytics (BI/A) tools in management accounting (MA)). We thereby predict as follows:

H1: Finance transformation projects with information systems or process-efficiency related objectives have a positive indirect impact on the quality of business intelligence/analytics systems used in accounting, mediated by the use of analytic tools and system/data integration.

Synergies between ERPS and BI/A systems

ERPS are based on a single-database and single-transaction system paradigm, with an integrated, redundancy free data model and programming architecture. It is therefore well-established (and not hypothesised here) that companies using ERPS achieve higher system/data integration (e.g. by Volkoff, Strong et al. 2005). In line with H1a, we therefore expect that the use of ERPS in A&F has a *positive indirect* effect on BI/A systems quality. ERPS also typically contain modules designed for direct functional support of management accounting (e.g. SAP Controlling), and if used properly, these modules can provide MA intelligence in two ways: 1) directly through embedded planning and reporting functionality and 2) indirectly by providing real-time data as feeder into more specialised and advanced reporting, planning and analytic (e.g. data mining) tools, thereby leveraging these tools through high quality data provision (Chou, Tripuramallu et al. 2005, Appelbaum, Kogan et al. 2017). In fact, there is some evidence that the integration of BI-systems with ERPS are necessary for BI success (Işık, Jones et al. 2013) and that there are synergies between the core (ERP) and analysis (BI/A) system levels in terms of delivering value for MA (Rom and Rohde 2006, Gullkvist 2013). Considering such direct and indirect effects of ERPS use on BI/A systems, we predict as follows:

H2: The use of ERPS in management accounting has a positive impact on the quality of business intelligence/analytics systems used in management accounting.

BI/A systems and management accounting information service levels

Management accounting (MA) “refers to the processes and techniques that focus on the effective and efficient use of organizational resources to support managers in their task of enhancing both customer value and shareholder value” (Langfield-Smith, Thorne et al. 2015), or more generally, to “fulfil the

18th International Conference on Enterprise Systems, Accounting, Logistics & Management (ICESALM) goals of an organization” (Horngren, Foster et al. 2009). As a service function, MA is essentially about managerial decision support (Langfield-Smith, Thorne et al. 2015) – increasingly through business partnering (Burns, Warren et al. 2014, Hagel 2015, Lawson 2016, Arnold 2017). This increasing trend towards service provision – rather than control (Burns, Warren et al. 2014) – raises questions about MA quality, related metrics and quality/service standards.

Service level agreements (SLAs) have been very commonly used to formalise the services and service quality – including corresponding metrics – expected from internal or outsourced IT service providers, and IS research on SLAs is abundant (Paschke and Bichler 2008). In accounting, SLAs have become prominent, especially with outsourcing agreements, but there is also evidence of SLAs specifying the expected service-levels from internal accounting departments, in particular shared-service centres.² Irrespective of the existence of formal, semi-formal or no SLAs, the role of management accountants as managerial decision supporters suggests that such support services are subject to – reasonably objective – quality metrics.

Management accounting (MA) quality has been conceptualised along three dimensions (Fleischman, Johnson et al. 2017): Functional quality (based on SERVPERF as proposed by Cronin and Taylor 1992), technical quality and image quality. We focus on technical quality, as it covers the *information* quality aspects of management accounting (MA), which are the focus of our research. Information quality is a very well established concept in IS research, and MA researchers have largely drawn on IS literature when adopting scales for measuring MA information quality. Fleischman, Johnson et al. (2017) developed a comprehensive scale of 18 MA information quality items, many of which refer to the relevance of information, which is user specific and therefore relatively subjective. Hence, we focus on the logistics aspects of MA information quality, i.e. timeliness, accessibility/delivery and level of detail and conceptualise those dimensions as MA information service level. BI/A systems can improve such MA information service levels in various ways: Business intelligence (BI) systems have been found to have a positive impact on annual budgeting by providing faster base line information and enabling monthly rolling budgets (De Leon, Rafferty et al. 2012). It was also found that management support requires structured and unstructured data from BI systems (Baars and Kemper 2008), and that BI tools

² While we found no mentioning of internal A&F SLAs in the academic literature, there is substantial evidence of such internal agreements at least in the public sector (as per Google Search).

increase the efficiency of (modern) management accounting (Al-Zubi, Shaban et al. 2014). BI systems have already been used successfully in performance management (Vukšić, Bach et al. 2013), as they improve performance measurement capabilities (Peters, Wieder et al. 2016). There is also evidence that technological capabilities such as data quality, user access and the integration of BI with other systems improve managerial decision making regardless of the decision environment (Işık, Jones et al. 2013, Wieder and Ossimitz 2015). We conclude that fast, up-to-date, flexible and well-integrated BI/A systems assist in providing on-demand, real-time, detailed and timely information to business managers; hence we hypothesise:

H3: The quality of business intelligence/analytics (BI/A) systems used in accounting has a positive impact on management accounting (MA) information service levels.

Considering the logic of H1 to H3 and the resulting path model (Figure 1), we predict an overall, indirect impact of AFTP on MA information service levels:

H4: Finance transformation projects with information systems or process-efficiency related objectives lead to higher management accounting information service levels.

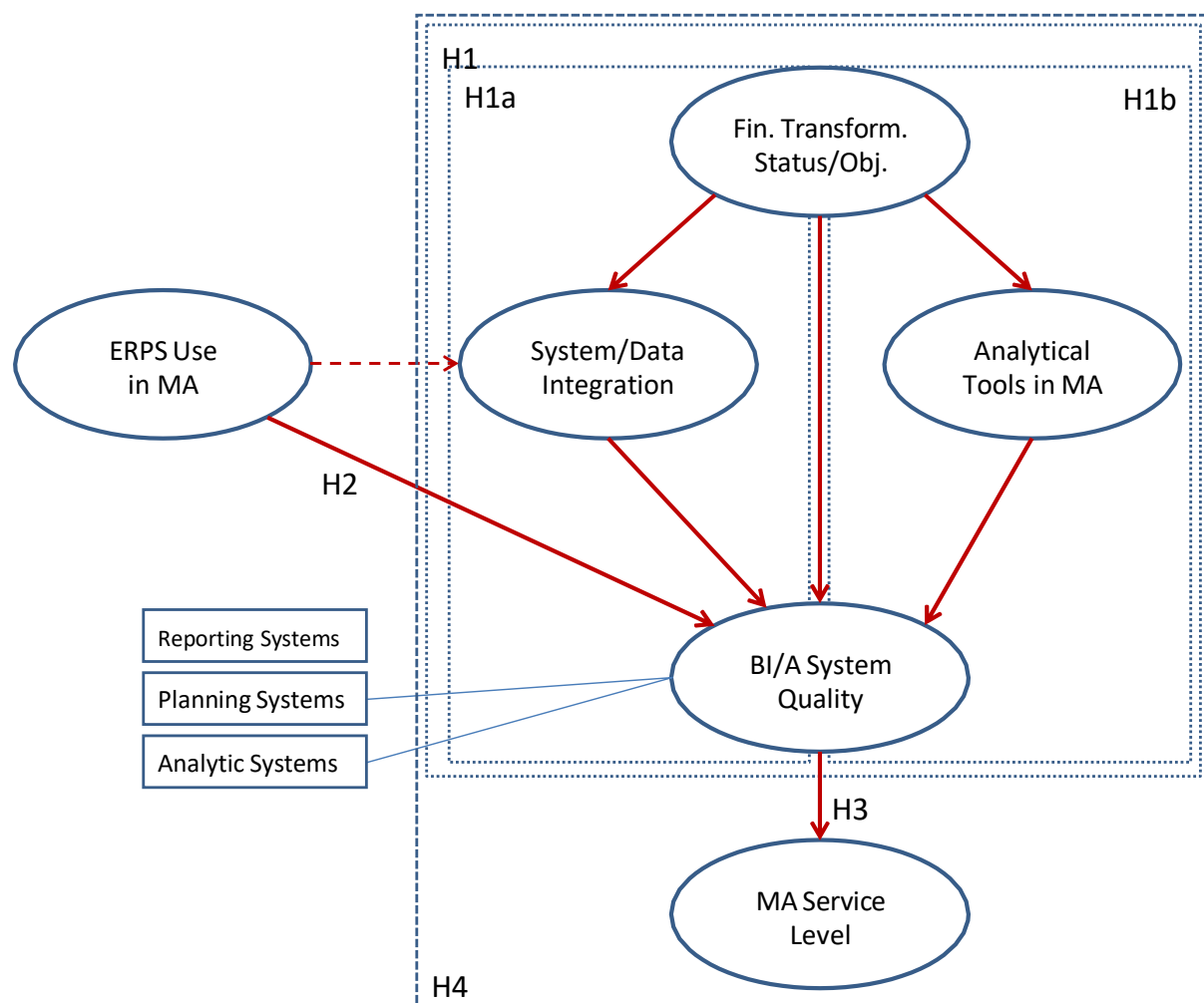


Figure 1: Research Model and Hypotheses Summary

Research Method

The research presented in this paper is based on a cross-sectional survey administered to top level financial managers of 925 Australian-based, medium to large (> 100 employees), private sector firms. The questionnaire relied partly on established (and slightly modified) constructs and measurement instruments and partly on new measurement scales (for the two new constructs accounting/finance transformation project and analytical tools used in management accounting (MA)). The development of the new scales relied heavily on practitioner literature, including vendor promotional materials and status reports (Dodson, Arnott et al. 2008). Conventional design and administration procedures were used, including pre-testing with four academics and two practitioners (Dillman 2007), to ensure face and content validity (Tourangeau, Rips et al. 2000), as well as the appropriateness of Likert-scale endpoints (Netemeyer, Bearden et al. 2003, p. 100).

The survey invitation email with a link to the online questionnaire was sent to the target respondents based on an email-list purchased from a commercial provider and targeted the following industry segments: Agriculture, mining, manufacturing, construction, retail, wholesale and distribution, transport, utilities and communications. Other industries, such as banking, insurance and business services, were excluded as they were considered too specific in terms of management accounting and information systems requirements and practices. Medium to large size (> 100 employees) companies were targeted to increase the likelihood that MA had been established as a separate sub-function within A&F.

The survey was conducted in three rounds spanning over a two-month period and generating 76 responses (9.95% response rate), 64 of which were complete and another 6 close-to-complete and

therefore usable (9.16% usable response rate). As targeted, the respondents were primarily CFOs or equivalents (e.g. director of finance) (7.0%), senior finance managers and financial controllers (24.3%) and less than 6% CEOs or commercial managers. In line with Australia's sectoral structure of the target sample, 18.6% were from the primary sector of the economy (7.1% agriculture and 11.4% mining), 37.1% were from manufacturing firms and 44.3% from services firms (18.6% wholesale/retail, 10% transportation, 5.7% communications, 5.7% diversified services and 4.3% construction).

Main construct measurement

Table 2 in the appendix provides a brief description of the survey measurement items. As for the AFTP construct, respondents were asked about their organisation's status regarding such projects (never considered, currently in plan, currently formally undertaking or formally completed in the past). Respondents in the latter two categories were classified as AFTP-organisations (AFTP = 1), the others as non-AFTP (0). AFTP-organisations were further asked to state the main objectives associated with their respective AFTPs by selecting one or more items from a list of objectives typically associated with AFTPs (e.g. Lau 2014), including a free text answer option (other). The list provided examples from three broad categories of objectives: accounting and finance (A&F) systems related, A&F processes/efficiency related and A&F skills related objectives. Respondents were classified accordingly (AFTP_IT = 1 or 0, AFTP_EFFI = 1 or 0, AFTP_SKILL = 1 or 0), with most AFTP-organisations pursuing multiple objectives. In line with the wording of H1, only the first two indicators were used to – reflectively – measure the AFTP-status in our study. A&F System/Data Integration (INTEG) was measured using an established scale developed by Peters et al. (2016). The reflective items were phrased as extreme endpoints (disintegration vs integration) on a 1-5 point scale (see Table 2 in the appendix). For the measurement of Analytic Tools used by A&F (A-TOOL), we relied on empirical studies about the use of accounting information systems in (management) accounting (Chen, Huang et al. 2012, Gullkvist 2013, Al-Zubi, Shaban et al. 2014, Amani and Fadlalla 2017), but we also incorporated articles which are more predictive in nature (Appelbaum, Kogan et al. 2017, Rikhardsson and Yigitbasioglu 2018). In addition, we also used practitioner literature, including software vendor marketing sites. Based on these analyses, the following business software categories were identified as analytic: Spreadsheets/Excel, BI reporting and visualisation systems/tools, statistical suites, specialised decision support systems and specialised data mining suites. Respondents were asked to rate on a scale of 1 (never) to 5 (very frequently) how often such tools were used by A&F in their organisation. The spreadsheets/Excel variable was eventually eliminated from the reflective measurement model, as it scored 5 in almost all respondent organisations (4.85 on average), thereby not only showing very little variance, but also not aligning with the other tools which were used relatively infrequently.

The *use of ERPS accounting functionality* in management accounting (ERP-MA) was a simple dummy variable (Y/N) based on the respondent's response to one single question. To measure the quality of business intelligence/analytic systems (BI/A QUAL) (2nd order) we primarily relied on a 2nd order scale developed for BI planning and reporting systems functionality (Peters, Wieder et al. 2016, Peters, Wieder et al. 2018), but extended it with corresponding questions about business analytics. The resulting variable is a three-dimensional emergent construct, formatively measured by the first order, reflective constructs BI-planning, BI-reporting and BI-analytics functionality. Latent variable scores for each dimension were generated in a separate hierarchical PLS model as per Wetzels et al. (2009). Scores were coded from 1 to 5, with 5 representing high functionality. Finally, the scale for management accounting

service level (MA-SERV) was adopted from Abdel-Kader and Luther (2006). Surprisingly, the first of four items in the reference study did not load convincingly on our INTEG construct and was therefore removed. Sensitivity analysis was performed using an alternative model which contained four additional variables for control purposes: an industry dummy (manufacturing vs. others), a dummy for the legal status of the organisation (public vs. private), a dummy for domestic vs. international ownership and a size variable. Firm size was measured with predefined intervals for full-time equivalent employees. All these controls have been used in previous studies and have occasionally been found to systematically influence organizational practices (such as management accounting) (Baum and Wally 2003) and information systems architectures and usage pattern.

Biases

To mitigate the potential of method bias, following Podsakoff, MacKenzie et al. (2012), several procedural remedies were applied. To increase participants motivations to respond accurately, they were invited to register on a separate website for a findings report. Motivational factors, ability factors and task factors were considered by targeting only top-level managers. The survey invitation email and the introduction message in the online questionnaire avoided hints of our research questions and hypotheses, and the ordering of the questions was designed to mitigate the risk of respondents guessing the research relationships. Finally, different anchor labels were used for related constructs (Podsakoff, MacKenzie et al. 2012). Non-response bias was assessed by splitting the dataset into two sub-groups that represented the early and late respondents. Independent sample tests (Mann-Whitney U) of all the test indicators showed no significant sub-group differences.

SEM-PLS

To determine the most appropriate analysis and testing techniques (parametric vs. non-parametric), all indicators and latent variables were tested for normality (Bollen and Stine 1990, Ringle, Sarstedt et al. 2012). As shown in Table 2 in the appendix, the absolute kurtosis/standard error scores exceed two for many of the data points, evidencing univariate non-normality (Cramer 1997). Consequently non-parametric test methods are required, with factor-analysis being inappropriate (Chin 1998). SEM-PLS is used, because it uses very general, soft distributional assumptions and non-parametric, prediction-oriented model evaluation measures (Wold 1982, Chin 1998). PLS is appropriate in exploratory research and when latent variable scores are used in higher order modelling. It is also suitable for indirect effect and moderator-mediator analysis (Gefen and Straub 2005, Hair, Hult et al. 2014). The significance of each effect is determined using bootstrapping with 5,000 samples (Henseler, Hubona et al. 2016), analysing both the bootstrapped t-statistic and the (bias corrected) bootstrapped percentiles. SmartPLS Version 3.00 M3 was used, as were recent guidelines about reporting the results (Ringle, Sarstedt et al. 2012, Henseler, Hubona et al. 2016).

Measurement model quality

All first-order constructs were measured reflectively and tested for convergent and discriminant validities (Chin 1998) accordingly. For convergent validity, as shown in Table 4 in the appendix, indicator reliability was assessed by examining the significance of the construct loadings and all were significant at $p < 0.001$. For construct reliability and validity, Table 3 indicates high internal consistency in terms of composite reliability (Dillon-Goldstein's $\rho \geq 0.6$ and Cronbach's $\alpha \geq 0.7$) (Nunnally 1978, Fornell and Larcker 1981, Bagozzi and Yi 1991, Chin 1998). Convergent validity is confirmed as all average variances extracted (AVE) clearly exceed 0.5 (Fornell and Larcker 1981). Discriminant validity of the construct indicators was examined by assessing the loading of each indicator on its first-order construct, relative to its loading on other constructs. Table 4 confirms that only two of the construct-specific loadings do not exceed 0.7 (Chin 1998, Hulland 1999) and that each indicator loading is highest for the relevant latent variable construct (Fornell and Larcker 1981). Discriminant validity of the constructs is evidenced by the fact that all square roots of the AVE in the diagonal in Table 5 exceed

the correlations with the other constructs (Barclay, Higgins et al. 1995, Chin 1998). Further to that, all heterotrait-monotrait ratios (HTMT) are < 0.6 , far below the required benchmark of 0.85 (Henseler, Ringle et al. 2015). The coefficients of the formative measures of BI/A system quality are 0.36 for BI planning, 0.28 for BI reporting and 0.50 for BI analytics – all significant at $p < 0.001$. In summary, all the standard measurement model quality requirements are met (Chin 1998). The test results for overall model fit (Henseler, Hubona et al. 2016) shown in Table 6 show that the SRMR, unweighted least squares discrepancy (d_{ULS}) and geodesic discrepancy (d_G) of the estimated model are all smaller than their 95% bootstrap quantile, indicating satisfactory overall model fit.

Results

Table 1 presents the results of hypotheses testing, whereas Table 7 in the appendix contains all other effects of the structural model tested. H1 was a total effect hypothesis (direct *and* indirect) about the overall effect of AFTP on BI/A system quality, which is rejected in terms of total effect ($\beta = 0.123$, $p > 0.05$), but confirmed in terms of total indirect effect ($\beta = 0.130$, $p < 0.01$) (see below). However, AFTPs impact on BI/A system quality only indirectly, as those indirect effects fully mediate the significant univariate correlation between AFTP and BI/A system quality (as shown in Table 5), reducing the direct effect between those constructs to a marginal $\beta = -0.007$ and $f^2 = 0.000$ (Table 1). The test results for the strengths of the indirect paths in that overall effect, i.e. the paths via system and data integration (H1a: $\beta = 0.043$, $p < 0.05$) and analytical tools in MA (H1b: $\beta = 0.087$, $p < 0.05$), confirm those two sub-hypotheses. H2, which predicted a positive effect of the use of ERPS in MA on BI/A system quality, was confirmed in all respects, i.e. as direct effect (H2: $\beta = 0.276$, $p < 0.05$, $f^2 = 0.083$), total effect (H2: $\beta = 0.425$, $p < 0.001$) and – not hypothesised – indirect effect ($\beta = 0.150$, $p < 0.05$; Table 7). As for H3, which predicated a positive relationship between BI/A system quality and MA information service levels, we find very strong support for our prediction (H3: $\beta = 0.499$, $p < 0.001$, $f^2 = 0.331$), both in terms of effect sizes and significance. Sensitivity analysis revealed that after adding a path from ERPS use in MA to MA service levels the effect of BI/A systems quality remained strong and significant, while the effect of ERPS use in MA was even marginally negative. Finally, we could also find a significant total indirect effect of AFTP on MA information service levels, thereby confirming H4 ($\beta = 0.061$, $p = 0.061$). However, the significance of the predicted effect is borderline, as it is only confirmed by the bootstrap confidence interval method (both regular and bias-corrected), but not by the bootstrapped *t*-statistic.

Table 1: Test Results for Hypotheses

Hypo.	Path:	Effect ¹⁾	Coefficient	f Square
H1 – p/reject.	AFTP $\rightarrow$ BI/A QUAL	D	-0.007	0.000
H1 – conf.	AFTP $\rightarrow$ BI/A QUAL	TI	0.130**	
H1 – p/reject.	AFTP $\rightarrow$ BI/A QUAL	T	0.123	
H1a – conf. ²⁾	AFTP $\rightarrow$ INTEG $\rightarrow$ BI/A QUAL	I	0.043 ²⁾	
H1b – conf.	AFTP $\rightarrow$ A-TOOL $\rightarrow$ BI/A QUAL	I	0.087*	
H2 – conf.	ERP-MA $\rightarrow$ BI/A QUAL	D	0.276*	0.083
H2 – conf.	ERP-MA $\rightarrow$ BI/A QUAL	T	0.425***	
H3 – conf.	BI/A QUAL $\rightarrow$ MA-SERV	D/T	0.499***	0.331* ²⁾
H4 – conf. ²⁾	AFTP $\rightarrow$ MA-SERV	TI=T	0.061 ²⁾	
R squares:				
H1, H2	BI/A QUAL		0.383***	
	INTEG		0.326***	
H3	MA-SERV		0.249**	
	A-TOOL		0.121* ²⁾	

¹⁾ D = direct effect, I = indirect effect, TI = total indirect effect, T = total effect; ²⁾ significant only when applying bias corrected confidence interval method; ³⁾ refers to impact on BI/A QUAL only. Significance

1-tailed: $p < 0.05^*$; $p < 0.01^{**}$; $p < 0.001^{***}$

Discussion and Limitations

The aim of this study was to investigate if and how AFTPs impact on the quality of BI/A systems and whether variations in such quality have an impact on information service levels provided by MA. Our results confirm that formally established AFTPs, which have IT/IS and/or accounting efficiency related objectives, have an overall positive effect on the quality of BI/A systems. The results further suggest that this positive effect is fully mediated by the positive effect of AFTPs on a) system and data integration and b) the adoption and use of analytic software tools in MA, both of which impact positively to the quality of BI/A systems. However, we also find that diffusion rates of analytic tools in MA are still very low.

To eliminate the well-documented effect of ERPS on system and data integration, we control for the presence of such systems, which does not change the above-mentioned indirect effect between AFTP and BI/A systems quality. We also confirm a direct effect of ERPS on BI/A systems quality, which suggests there are synergies between those two types of systems – beyond the integration benefits offered by the former. We also find very strong support for the predicted impact of BI/A systems quality on information service levels provided by MA, which partly confirms the benefits previously associated high quality BI systems – but now extended by BA systems. Finally, the results for our path model also reveal that the indirect effects between AFTP and BI/A systems quality also translate into an overall indirect effect of AFTP on information service levels provided by MA, suggesting that IT/IS and/or efficiency centric AFTPs also have an effect on the timeliness and detail of information delivery or accessibility to/for managers.

Our study has several noteworthy implications for academia and practice: So far, AFTPs have been promoted primarily by professional accounting bodies and consulting service providers – usually without strong evidence of real benefits. To the best of our knowledge, this is the first cross-sectional research study which investigates AFTPs and which empirically confirms benefits associated with AFTPs and how they can be achieved (i.e. via system and data integration efforts and the adoption of analytic tools). We also provide valuable evidence that investments into high quality BI/A systems do actually lead to better provision of management accounting information to managers. In terms of measurement, we extend previously established scales for BI-quality by adding a new dimension for BA-quality, and we introduce the concept of and measurement for accounting information service level. The finding that there are substantial synergies between the use of ERPS for MA purposes and the quality of BI/A systems may create an incentive for the large portion (60%) of firms in our sample which have an ERPS, but do not use it for MA purposes at all. Finally, we add to the academic ERPS literature by finding that the use of ERPS in MA does not directly improve MA service levels, but only indirect via high quality BI/A systems.

Like with all empirical research, we have to acknowledge several *limitations*: Due to the constraints imposed by the survey method, we were not able to collect MA quality perceptions of information consumers, i.e. business managers outside accounting and finance (A&F). This required us to reduce our MA quality concept to only selected aspects of information quality. Another limitation – mentioned and explained earlier – is the small response rate and relatively small sample size. Finally, three of our latent variables have not been used in empirical research before and further research may be required to increase their robustness (esp. for A-tools).

Appendix

Table 2: Descriptive Statistics (Questionnaire Items/Indicators)

Indicator	Question (short version)	Scale	Mean/ Median	Std. Dev.	Kurt/ SE	Skew/ SE
AFTP_YES	AFTP ongoing or completed	Y/N	5.0%	0.50	-3.64	-0.00
AFTP_IT	AFTP with IT/IS related objectives (out of AFTP_YES)	Y/N	48.6%	0.50	-3.63	0.20
AFTP_Effi	AFTP with efficiency related objectives (out of AFTP_YES)	Y/N	31.4%	0.46	-2.42	2.85
ERP_MA	ERP-system with MA functionality, latter used	Y/N	35.4%	0.48	-2.83	2.11
ERP_Use	A&F use of ERP-system	Likert 1-5	3.94	1.50	-0.22	-1.16
MA_info2	Detailed MA info. available to business managers immediately upon request	1-5	3.67	1.01	0.17	-2.70
MA_info3	Detailed MA info. can be accessed on a real-time basis	1-5	2.90	1.15	-1.26	0.72
MA_info4	Detailed MA info. is reported directly to line managers	1-5	3.63	1.01	0.02	-2.45
INTEG_1	A&F systems integrated by a common, shared database	1-5	3.39	1.08	-0.23	-2.28
INTEG_2	A&F systems: one single enterprise system (ERPS)	1-5	3.39	1.26	-1.35	-1.48
INTEG_3	A&F systems: all data in a single enterprise database	1-5	3.03	1.16	-1.37	-0.61
Tool_BIRep	A&F use of reporting and visualisation systems/tools	1-5	2.54	1.63	-2.32	1.83
Tool_Stat	A&F frequency of use of statistical suites	1-5	1.34	0.71	8.87	7.84
Tool_DSS	A&F use of specialised decision support systems	1-5	1.40	0.86	9.87	8.18
Tool_MIN	A&F use of specialised data mining suites	1-5	1.40	0.89	9.36	8.24
Qual_rep1	Sophisticated formats and presentation features	1-5	2.97	1.15	-1.29	-0.63
Qual_rep2	Highly interactive reporting features	1-5	2.72	1.21	-1.97	-0.11
Qual_rep3	Very easy to use and navigate by all users	1-5	3.06	1.04	-0.34	-0.71
Qual_rep4	Rapid response and refresh times	1-5	3.00	1.15	-1.64	-0.00
Qual_plan1	Rapid response and refresh times	1-5	2.69	1.29	-1.88	0.68
Qual_plan2	Very quickly updated with actual and base-level info.	1-5	2.71	1.30	-2.02	0.74
Qual_plan3	Allows forecasts /budgets to be quickly created/revised	1-5	2.66	1.24	-1.75	0.79
Qual_plan4	Sophisticated models: easily implemented/changed	1-5	2.28	1.14	-1.32	1.49
Qual_ba1	Rapid response and refresh times	1-5	2.63	1.25	-1.88	0.36
Qual_ba2	Provide solutions for a broad range of business problems	1-5	2.63	1.13	-1.35	0.42
Qual_ba3	Easy to use	1-5	2.65	1.10	-1.91	-0.10
Qual_ba4	Presents output in an appealing & easy to understand way	1-5	2.54	1.15	-1.74	0.41
Qual_ba5	Sophisticated models: easily implemented/changed	1-5	2.45	0.98	-1.73	-0.33
Empl	Full-time equivalent range of employees (median)	Range	100-499	1.14	-0.55	1.52

Table 3: Latent Variables

Latent Variable – 2 nd Order Model	Cronbach's Alpha	Composite Reliability	Rho_A	AVE
Finance Transformation Project (AFTP)	0.821	0.912	1.015	0.839
A&F System/Data Integration (INTEG)	0.819	0.892	0.827	0.733
Analytic Tools used by A&F (A-TOOL)	0.755	0.847	0.788	0.587
ERP System used for A&F (ERP MA)	0.497	0.799	0.500	0.665
Full-Time Equivalent Employees (EMP)	1.000	1.000	1.000	1.000
Quality of Business Intelligence/Analytic Systems (BI/A QUAL) (2 nd order)	0.843	0.905	0.849	0.760
Management Accounting Service Level (MA SERV)	0.759	0.856	0.816	0.668

All significant at $p < 0.001$ (based on 5,000 sample-bootstrap)

Table 4: Discriminant Validity (Indicator Cross-Loadings)

	AFTP	INTEG	A-TOOL	ERP MA	EMP	BI/A QUAL	MA SERV
AFTP_EFFI	0.870	0.226	0.138	0.225	0.171	0.168	0.021
AFTP_IT	0.960	0.302	0.359	0.295	0.006	0.271	0.217
INTEG_1	0.233	0.882	0.113	0.530	0.053	0.420	0.171
INTEG_2	0.255	0.866	0.163	0.500	-0.140	0.443	0.207
INTEG_3	0.277	0.821	0.109	0.377	-0.062	0.388	0.099
TOOL_BIREP	0.076	0.047	0.551[^]	0.041	0.105	0.250	0.116
TOOL_DSS	0.291	0.069	0.737	0.065	0.365	0.199	0.059
TOOL_MIN	0.215	0.170	0.829	0.054	0.015	0.383	0.320
TOOL_STAT	0.288	0.158	0.901	0.106	0.093	0.316	0.247
ERP_MA_YES	0.184	0.394	0.052	0.820	-0.027	0.455	0.190
TOOL_ERP	0.291	0.509	0.094	0.811	-0.017	0.298	0.107
D_EMPL	0.071	-0.057	0.195	-0.027	1.00	0.056	0.089
1ALV_PLANQUAL_V2	0.133	0.411	0.190	0.496	0.005	0.844	0.362
1BLV_A_LYTICQUAL_V2	0.310	0.385	0.378	0.359	0.068	0.894	0.509
1CLV_REPQUAL_V2	0.205	0.481	0.391	0.369	0.067	0.877	0.424
MA_INFO2	0.229	0.199	0.233	0.284	0.123	0.464	0.867
MA_INFO3	0.129	0.218	0.251	0.128	0.037	0.461	0.876
MA_INFO4	-0.053	-0.038	0.062	-0.058	0.051	0.238	0.696[^]

All outer loadings significant at $p < 0.001$; all outer weights significant at $p < 0.001$, except for those marked with [^], where $p < 0.05$; all outer VIF scores < 3.0 .

Table 5: Discriminant Validity (Latent Variables)

	A-TOOL	BI/A QUAL	EMP	ERP MA	AFTP	INTEG	MA SERV
A-TOOL	0.766						
BI/A QUAL	0.373*** 0.465	0.872					
EMP	0.195 0.219	0.056 0.058	1.00				
ERP MA	0.089 0.182	0.462*** 0.722	-0.027 0.038	0.816			
AFTP	0.301** 0.327	0.252* 0.281	0.071 0.106	0.291** 0.443	0.916		
INTEG	0.151 0.185	0.488*** 0.586	-0.057 0.110	0.553*** 0.860	0.296** 0.351	0.856	
MA SERV	0.246** 0.343	0.499*** 0.586	0.089 0.099	0.182 0.310	0.157 0.193	0.189 0.230	0.817

- a) Fornell-Larcker Criterion: AVE-squared in diagonal (bold) compared with latent variable correlations (first value underneath diagonal);
- b) Heterotrait-Monotrait Ratio (HTMT) (second value underneath diagonal); all HTMT values significant at $p < 0.01$.

Table 6: Model Fit

	Saturate dModel	95%	99%	Estimated Model	95%	99%
SRMR	0.092	0.084	0.092	0.094	0.112	0.127
d_{ULS}	1.433	1.195	1.442	1.509	2.140	2.777
d_G	0.621	0.844	1.012	0.622	0.923	1.253

Table 7: Structural Model – Other Effects

Path:	Effect	Coefficient	f Square
AFTP → INTEG	D/T	0.148	0.030
AFTP → A-TOOL	D/T	0.288**	0.094
INTEG → BI/A QUAL	D/T	0.293*	0.093
A-TOOL → BI/A QUAL	D/T	0.302**	0.129
ERP-MA → INTEG	D/T	0.510***	0.354*
ERP-MA → INTEG → BI/A QUAL	I	0.150*	
INTEG → BI/A QUAL → MA-SERV	Ti=T	0.146*	
A-TOOL → BI/A QUAL → MA-SERV	Ti=T	0.151*	
ERP-MA → BI/A QUAL → MA-SERV	I	0.138*	
ERP-MA → INTEG → BI/A QUAL → MA-SERV	I	0.075*	
ERP-MA → MA-SERV	Ti=T	0.212**	
AFTP → BI/A QUAL → MA-SERV	I	-0.004	
AFTP → INTEG → BI/A QUAL → MA-SERV	I	0.022	
AFTP → A-TOOL → BI/A QUAL → MA-SERV	I	0.043*	
R squares:			
BI/A QUAL		0.383***	
INTEG		0.326***	
MA-SERV		0.249**	
A-TOOL		0.121* ⁽¹⁾	

Significance 1-tailed: $p < 0.05^*$; $p < 0.01^{**}$; $p < 0.001^{***}$

References

- Abdel-Kader, M. and R. Luther (2006). "Management accounting practices in the British food and drinks industry." *British Food Journal* **108**(5): 336-357.
- Acito, F. and V. Khatri (2014). "Business analytics: Why now and what next?" *Business Horizons* **57**(5): 565-570.
- Al-Zubi, Z., O. Shaban and N. Alnaser (2014). "The effect of Business Intelligence Tools on Raising the Efficiency of Modern Management Accounting." *International Review of Management and Business Research* **3**, 68-77.
- Amani, F. A. and A. M. Fadlalla (2017). "Data mining applications in accounting: A review of the literature and organizing framework." *International Journal of Accounting Information Systems* **24**: 32-58.
- Appelbaum, D., A. Kogan, M. Vasarhelyi and Z. Yan (2017). "Impact of business analytics and enterprise systems on managerial accounting." *International Journal of Accounting Information Systems* **25**: 29-44.
- Arnold, S. (2017). The 3 Pillars of Finance Transformation, BlackLine Magazine.
- Baars, H. and H.-G. Kemper (2008). "Management Support with Structured and Unstructured Data—An Integrated Business Intelligence Framework." *Information Systems Management* **25**(2): 132-148.
- Bagozzi, R. P. and Y. Yi (1991). "Multitrait-Multimethod Matrices in Consumer Research." *Journal of Consumer Research* **17**(4 (March)): 426-439.
- Barclay, D., C. Higgins and R. Thompson (1995). "The Partial Least Squares (PLS) Approach to Causal Modeling: Personal Computer Adoption and Use as an Illustration." *Technology Studies* **2**(2): 285-309.
- Baum, J. R. and S. Wally (2003). "Strategic Decision Speed and Firm Performance." *Strategic Management Journal* **24**(11): 1107-1129.
- Bhimani, A. and L. Willcocks (2014). "Digitisation, 'Big Data' and the transformation of accounting information." *Accounting and Business Research* **44**(4): 469.
- Bollen, K. A. and R. Stine (1990). "Direct and Indirect Effects: Classical and Bootstrap Estimates of Variability." *Sociological Methodology* **20**(1): 115-140.
- Burns, J., L. Warren and J. Oliveira (2014). "Business Partnering: Is It All That Good?" *Controlling & Management Review* **58**(2): 36-41.
- Busco, C., P. Quattrone and A. Riccaboni (2007). "Management Accounting: Issues in interpreting its nature and change." *Management Accounting Research* **18**(2): 125-149.
- Chang, R. M., R. J. Kauffman and Y. Kwon (2014). "Understanding the Paradigm Shift to Computational Social Science in the Presence of Big Data." *Decision Support Systems* **63**: 67-80.
- Chaudhuri, S., U. Dayal and V. Narasayya (2011). "An Overview of Business Intelligence Technology." *Communications of the ACM* **54**(8): 88-98.
- Chen, H., R. H. L. Chiang and V. C. Storey (2012). "BUSINESS INTELLIGENCE AND ANALYTICS: FROM BIG DATA TO BIG IMPACT." *MIS Quarterly* **36**(4): 1165-1188.
- Chen, H. J., S. Y. Huang, A. A. Chiu and F. C. Pai (2012). "The ERP system impact on the role of accountants." *Industrial Management & Data Systems* **112**(1): 83-101.
- Chin, W. W. (1998). "Issues and Opinion on Structural Equation Modeling." *MIS Quarterly* **22**(1): 7-16.

- Chou, D. C., H. B. Tripuramallu and A. Y. Chou (2005). "BI and ERP integration." Information Management & Computer Security **13**(5): 340.
- Civichino, A. (2013). "Financial steward or business partner?" CMA Magazine (1926-4550) **87**(2): 16-17.
- Cramer, D. (1997). Basic Statistics for Social Research: Step-by-Step Calculations and Computer Techniques Using Minitab. London, Psychology Press.
- Cronin, J. J. and S. A. Taylor (1992). Measuring service quality: A re-examination and extension. Journal of Marketing. **56**: 55-68.
- Davenport, T. H. (2014). Big Data @ Work: Dispelling the Myths, Uncovering the Opportunities. Boston, Harvard Business Review Press.
- Davenport, T. H. and D. J. Patil (2012). "Data Scientist: The Sexiest Job of the 21st Century." Harvard Business Review **90**(10): 70-76.
- De Leon, L., P. D. Rafferty and R. Herschel (2012). "Replacing the Annual Budget with Business Intelligence Driver-Based Forecasts." Intelligent Information Management **4**(1): 6.
- Dillman, D. A. (2007). Mail and Internet Surveys: The Tailored Design Method. New York, Wiley.
- Dodson, G., D. Arnott and G. Pervan (2008). The Use of Business Intelligence Systems in Australia. The Australasian Conference on Information Systems Christchurch, New Zealand, ACIS 2008 Proceedings.
- Driscoll, M. (2016). Three Reasons Why Finance Transformation is Back in Vogue, American Productivity and Quality Center (APQC).
- Elbashir, M. Z., P. A. Collier, S. G. Sutton, M. J. Davern and S. A. Leech (2013). "Enhancing the business value of business intelligence: The role of shared knowledge and assimilation." Journal of Information Systems **27**(2): 87-105.
- Endenich, C., R. Trapp and M. Brandau (2017). "Management accounting networks in corporate processes - a cross-national study." Journal of Accounting & Organizational Change **13**(1): 25-43.
- Fleischman, G. M., E. N. Johnson and K. B. Walker (2017). "An Exploratory Examination of Management Accounting Service and Information Quality." Journal of Management Accounting Research **29**(2): 11-31.
- Fornell, C. and D. F. Larcker (1981). "Evaluating Structural Equation Models with Unobservable Variables and Measurement Error." Journal of Marketing Research **18**(1): 39-50.
- Gefen, D. and D. Straub (2005). "A Practical Guide to Factorial Validity Using PLS-Graph: Tutorial and Annotated Example." Communications of the Association for Information Systems **16**(1): 5.
- Granlund, M. and T. Malmi (2002). "Moderate impact of ERPs on management accounting: A lag or permanent outcome?" Management Accounting Research **13**(3): 299-321.
- Gullkvist, B. M. (2013). "Drivers of change in management accounting practices in an ERP environment." International Journal of Economic Sciences & Applied Research **6**(2): 149-174.
- Hagel, J. (2015). Are you a scorekeeper or a business partner?, American Institute of Certified Public Accountants. **220**: 22-23.
- Hair, J. F., G. T. M. Hult, C. Ringle and M. Sarstedt (2014). A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM). Thousand Oaks, US, Sage Publications.
- Henseler, J., G. Hubona and A. Ray (2016). "Using PLS path modelling in new technology research: updated guidelines." Industrial Management & Data Systems **116**(1): 2-20.
- Henseler, J., C. M. Ringle and M. Sarstedt (2015). "A New Criterion for Assessing Discriminant Validity in Variance-Based Structural Equation Modeling." Journal of the Academy of Marketing Science **43**(1): 115-135.
- Hiebl, M. R. W. and J. F. Richter (2018). "Response Rates in Management Accounting Survey Research." Journal of Management Accounting Research **30**(2): 59-79.
- Holsapple, C., A. Lee-Post and R. Pakath (2014). "A Unified Foundation for Business Analytics." Decision Support Systems **64**: 130-141.
- Hornigren, C. T., G. Foster, S. M. Datar and M. Rajan (2009). Cost Accounting: A Managerial Emphasis. New Jersey, Prentice Hall.
- Hulland, J. (1999). Use of partial least squares (PLS) in strategic management research: a review of four recent studies. Strategic Management Journal. **20**: 195-204.
- Hülle, J., R. Kaspar and K. Möller (2011). "Multiple Criteria Decision-Making in Management Accounting and Control - State of the Art and Research Perspectives Based on a Bibliometric Study." Journal of Multi-Criteria Decision Analysis **18**(5/6): 253-265.
- Ijiri, Y. (1965). Management goals and accounting for control. Amsterdam, North Holland Pub. Co.
- Işık, Ö., M. C. Jones and A. Sidorova (2013). "Business intelligence success: The role of BI capabilities and decision environment." Information & Management **50**(1): 13-23.
- Langfield-Smith, K., H. Thorne, D. Smith and R. Hilton (2015). Management Accounting: Information for Creating and Managing Value. North Ryde, NSW Australia, McGraw Hill.
- Lau, A. (2014). Finance Transformation: The Art of Getting More from Your Finance Team, Openview. Lawson, R. (2016). How controllers become business partners: it takes strategic vision and a new application of business skills and analysis. Strategic Finance. **98**: 24+.

- Lyton, J. and D. Kops (2014). Finance transformation roles: pathways to CFO, The Association of Chartered Certified Accountants (ACCA).
- Moffitt, K. C. and M. A. Vasarhelyi (2013). "AIS in an Age of Big Data." Journal of Information Systems **27**(2): 1-19.
- Netemeyer, R. G., W. O. Bearden and S. Sharma (2003). Scaling Procedures: Issues and Applications. Thousand Oaks, Sage.
- Nielsen, S. (2018). "Reflections on the applicability of business analytics for management accounting – and future perspectives for the accountant." Journal of Accounting & Organizational Change **14**(2): 167-187.
- Nunally, J. C. (1978). Psychometric Theory B2 - Psychometric Theory. New York, NY, McGraw-Hill. **2nd**.
- Paschke, A. and M. Bichler (2008). "Knowledge representation concepts for automated SLA management." Decision Support Systems **46**(1): 187-205.
- Peters, M. D., B. Wieder and S. G. Sutton (2018). "Organizational improvisation and the reduced usefulness of performance measurement BI functionalities." International Journal of Accounting Information Systems **29**: 1-15.
- Peters, M. D., B. Wieder, S. G. Sutton and J. Wakefield (2016). "Business intelligence systems use in performance measurement capabilities: Implications for enhanced competitive advantage." International Journal of Accounting Information Systems **21**: 1-17.
- Pickard, M. D. and G. Cokins (2015). "From Bean Counters to Bean Growers: Accountants as Data Analysts--A Customer Profitability Example." Journal of Information Systems **29**(3): 151-164.
- Podsakoff, P. M., S. B. MacKenzie and N. P. Podsakoff (2012). "Sources of Method Bias in Social Science Research and Recommendations on How to Control It." Annual Review of Psychology **63**(1): 539-569.
- Raval, V. and M. J. Greteman (2015). "Big Data in Management Accounting." Management Accountant **50**(9): 102.
- Rikhardsson, P. and O. Yigitbasoglu (2018). "Business intelligence & analytics in management accounting research: Status and future focus." International Journal of Accounting Information Systems **29**: 37-58.
- Ringle, C. M., M. Sarstedt and D. W. Straub (2012). "Editor's comments: A critical look at the use of PLS-SEM in MIS Quarterly." MIS Quarterly **36**(1): iii-xiv.
- Robbins, C. and A. Drory (1995). Re-Engineering the Financial Function. CMA - the Management Accounting Magazine.
- Rom, A. and C. Rohde (2006). "Enterprise resource planning systems, strategic enterprise management systems and management accounting: A Danish study." Journal of Enterprise Information Management **19**(1): 50-66.
- Russell, G. W. (2014). "The Importance of Management Accounting for Professional Accountants in Business." GAA Accounting.
- Sutton, S. G., M. Holt and V. Arnold (2016). ""The reports of my death are greatly exaggerated"—Artificial intelligence research in accounting." International Journal of Accounting Information Systems **22**(September): 60-73.
- Tourangeau, R., L. J. Rips and K. Rasinski (2000). The psychology of survey response. Cambridge, Cambridge University Press.
- Volkoff, O., D. M. Strong and M. B. Elmes (2005). "Understanding enterprise systems-enabled integration." European Journal of Information Systems **14**(2): 110-120.
- Vukšić, V. B., M. P. Bach and A. Popović (2013). "Supporting performance management with business process management and business intelligence: A case analysis of integration and orchestration." International Journal of Information Management **33**(4): 613-619.
- Wetzels, M., G. Odekerken-Schröder and C. van Oppen (2009). "Using PLS Path Modeling for assessing hierarchical construct models: guidelines and empirical illustration." MIS Quarterly **33**(1): 177-195.
- Wieder, B. and M.-L. Ossimitz (2015). "The Impact of Business Intelligence on the Quality of Decision Making – A Mediation Model." Procedia Computer Science **64**: 1163-1171.
- Wold, H. (1982). Systems under indirect observation using PLS. A second generation of multivariate analysis B2 - A second generation of multivariate analysis. C. Fornell. New York, Praeger: 325-347.

Guests' perceptions on eco-tourism: The case of hotels in Greece

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Abstract

The increase of eco-tourism in Greece can be attributed to the growing consciousness among tourists regarding the environmental consequences of their journeys. Consequently, the aim of this research is to investigate guests' perceptions of eco-tourism in Greece and identify the strategies employed by hotels to attract eco-conscious travelers. It is crucial to recognize the factors that motivate tourists to opt for eco-tourism and comprehend the mindset of eco-tourists, as this knowledge would facilitate the development of effective marketing strategies for hotels. The study also examines the distinctive characteristics of eco-tourists and their willingness to pay for staying in eco-friendly hotels. The data were collected between May 2023 and July 2023 using a structured questionnaire. The research results show that there is a significant percentage of guest who choose eco-friendly hotels when they travel. Moreover, based on the respondents' views, there are also many hotels in Greece adopting practices to preserve the environment. Based on the research results it is proposed that mostly young people should be the target for hotels that are environmentally friendly. Moreover, the need to educate people on environmental sustainability and the concept of ecotourism become evident.

Keywords: Eco-tourism, tourism, environmental sustainability, green hotels

1. Introduction

Ecotourism is an industry that has shown significant growth in recent years, and this growth appears to be driven by a rising concern for the environment (do Paço, Alves and Nunes, 2012); (Drosos and Skordoulis, 2018). This concern is increasing and is becoming evident year-by-year due to the negative impacts of climate crisis (Ntanos *et al.*, 2018);(Skordoulis, Ntanos and Arabatzis, 2020). The official definition about ecotourism that was given from the International Ecotourism Society is *“responsible travel to natural areas that conserves the environment, sustains the well-being of the local people, and involves interpretation and education* (TIES, 2015). Tourism industry is one of the most vulnerable sectors to environmental degradation and climate change, and it is a significant contributor to greenhouse gas emissions, particularly through transportation (Diakakis, Skordoulis and Savvidou, 2021). However, the industry also suffers significantly from the effects of global warming, including sea level rise, changing weather patterns, and increased frequency and severity of natural disasters (Merli *et al.*, 2019). In response to these challenges, hotels and tourism operators are incorporating eco-friendly features into their services and rebranding their establishments as "green hotels" or "environmentally friendly hotels". While ecotourism is often associated with environmental benefits, it also provides opportunities for cultural exchange and economic benefits for local communities (Boley and Green, 2016).

By choosing to travel in a way that is eco-friendly, travelers can enjoy all the benefits of traveling while also minimizing their negative impact on the planet (Doran and Larsen, 2016); (Skordoulis *et al.*, 2020). A tourist who is eco-conscious is known as an ecotourist. It is a person who travels to a location and invests time, money, and other resources into pleasure, business, health, and other endeavors before returning home with a deeper understanding of its inhabitants. Women are more likely than men to hold pro-environmental objectives, attitudes, and beliefs that may be the cause of agreeableness which is a personality trait that is most commonly found in women (Bilynets and Knezevic Cvelbar, 2022). Also, females are more socialized to be outward-looking and socially responsible than males, and this may have an impact on their pro-environmental behavior (Gifford and Nilsson, 2014). Furthermore, age can be a significant factor in the way individuals engage with environmental issues (Ntanos *et al.*, 2019); (Thapa *et al.*, 2024); (Lampropoulos *et al.*, 2024). As children and young adults develop cognitively, their capacity to sustainably manage resources grows, with boys tending to perform better as they age, while girls exhibit superior management skills when they are younger. While some early studies have reported that older individuals tend to behave in a more pro-environmental way than younger people, it is important to consider that events that may have had a stronger influence on one age group than the other would generate a group effect, rather than aging itself (Gifford and Nilsson, 2014).

The hospitality industry is becoming increasingly aware of the importance of sustainability in recent years, and hotels are adopting eco-friendly practices to

enhance their competitive advantage in the market (Skordoulis, Ntanos and Arabatzis, 2020); (Skordoulis *et al.*, 2020). As Merli *et al.* (2019) pointed out, going green has become a winning strategy for hotels to attract customers who are environmentally conscious. The discussion on sustainability is ongoing and continually evolving. It extends beyond ecological matters and strategies, it also involves economic viability and social fairness (Malheiro *et al.*, 2020). Thus, it is essential to involve in this research the ESG framework. The ESG principle is a framework system including environmental (E), social (S), and governance (G) factors. The integration of the Environmental component of the ESG within the hotel sector begins with a strong commitment to environmental responsibility (Kalantonis *et al.*, 2020); (Kalantonis, Schoina and Kallandranis, 2021);(Delegkos *et al.*, 2022); (Abazaj, 2024). The environmental dimension of ESG is considered as the impact of a company's operations on the natural environment and the long-term sustainability of natural resources (Meagher, 2023). These environmental considerations include implementing sustainable practices that reduce ecological impact. This strategic alignment with sustainable practices is not only a path to corporate responsibility, but also a major driver of long-term success and relevance in the dynamic hotel sector (Legrand and Matthew-Bolofinde, 2022).

Therefore, it is crucial for hotels to prioritize environmental and social sustainability and communicate their efforts transparently to guests (Sakellari, 2019). This can lead to higher guest satisfaction, loyalty, and even willingness to pay more for stays at "green hotels" (Kang *et al.*, 2012); (Skordoulis, Andreopoulou and Drosos, 2022). Willingness to pay is a critical factor in determining consumer behavior and preferences when it comes to sustainable choices because it represents the maximum amount that customers are willing to spend on environmentally friendly products and services. This consumer behavior is becoming increasingly important in today's market, as more and more people are becoming aware of the significance of sustainability and its impact on the environment (Boronat-Navarro and Pérez-Aranda, 2020). According to estimates, there are around 140 eco-labels that focus on green hotel certifications and only 6.2% of hotels globally have been certified. The low number of hotels with green certification may be a reflection of the fact that, despite the numerous efforts to advance green hotel sector initiatives, the value of green certification to consumers is still not sufficiently recognized across contexts (Nelson *et al.*, 2021). Furthermore, third-party certification processes can serve as a reliable and trustworthy source of information for guests about a hotel's sustainability efforts (Drosos, Chalikias, *et al.*, 2017); (Drosos, Skordoulis, *et al.*, 2017) (Merli *et al.*, 2019).

The study aims to explore tourists' perceptions of ecotourism and how it is implemented by hotels in Greece. The first objective is to identify the factors that motivate tourists to choose eco-tourism. Another objective of the study is to examine the strategies implemented by hotels in Greece. The findings of the study would provide insight into the challenges and opportunities for hotels to adopt eco-friendly practices.

2. Research methodology

To achieve the aim and the objectives of the present study, a primary research was carried out between May and July, 2023. A total of 352 hotels' guests responses in a questionnaire designed for the present study were statistically analyzed using descriptive and inferential statistics. In order to ensure that the participants fully comprehend the aim of the study and the terms used in the questionnaire, an introduction to ecotourism is included, providing a brief explanation of what it entails. The questionnaire was designed in a structured manner, beginning with more general inquiries such as age, gender, and knowledge about ecotourism. Subsequently, specific questions aligned with the research objectives are presented. All the respondents were assured confidentiality about the responses provided by them.

Before the final data collection, a pilot study was carried out. No issued refereeing to the validity and the reliability of the research tool were recorded.

3. Research results

In investigating the multifaceted realm of ecotourism, understanding the demographic characteristics, such as age and gender, provides crucial insights into the diverse motivations, preferences, and behaviors of participants engaging with sustainable travel practices (Kim and Han, 2010).

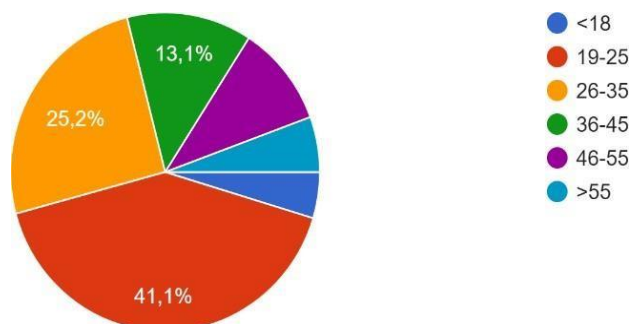


Figure 1: Respondents' age.

Referring to respondents' age, a substantial majority, with a notable percentage of 41.1%, reported their ages falling within the range of 19 to 25 years old. Further analysis of the data reveals that the next largest segment of participants belonged to the age group of 26 to 35 years old, accounting for 25.2% of the total respondents. Interestingly, the third-largest group consisted of individuals aged 36 to 45, representing 13.1% of the participants. Delving deeper into the survey results, it becomes apparent that individuals falling within the age range of 46 to 55 comprised a modest percentage of 10.3%. In contrast, the youngest and oldest age groups had relatively smaller proportions. Those below the age of 18 constituted merely 4.7% of the respondents. On the other end of the spectrum, individuals above 55 years old accounted for 5.6% of the participants.

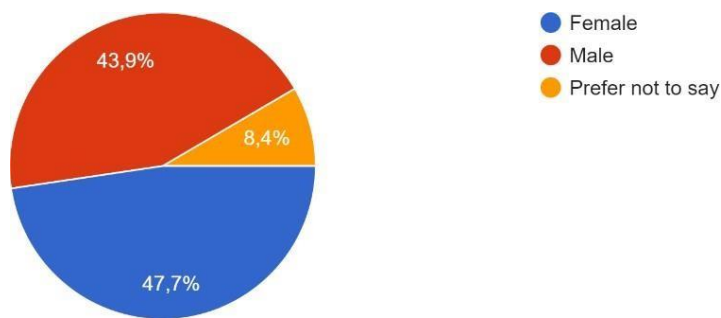


Figure 1: Respondents' gender.

Referring to respondents' gender, it becomes readily apparent that participant responses were notably distinct. A relatively small proportion, amounting to 8.4% of the survey respondents, opted not to disclose their gender, while the remaining participants were divided between two primary categories, females, constituting 47.7%, and males, comprising 43.9%.

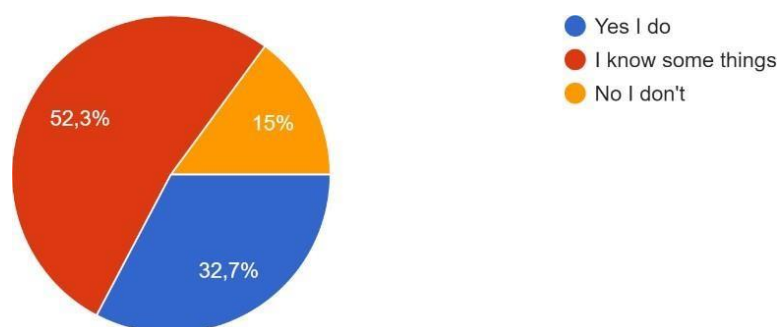


Figure 2: Respondents' level of knowledge and awareness regarding ecotourism.

Regarding respondents' knowledge of ecotourism, the analysis reveals interesting insights into the participants' level of knowledge and awareness regarding this particular form of travel. The results demonstrate that a significant majority of participants, comprising 52.3% of the respondents, possessed a certain degree of familiarity with the concept of ecotourism. The second-largest segment of participants consists of those who were familiar with the concept and amounts to 32.7% of respondents. Conversely, the remaining group of participants, comprising 15% of the respondents, admitted to having limited or no knowledge about ecotourism.

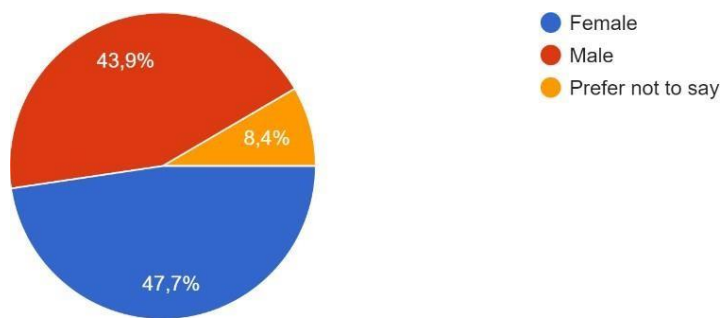


Figure 3: Respondents' preference for eco-friendly hotels when travelling.

When it comes to choosing eco-friendly hotels when travelling, a noteworthy percentage of 15% of participants expressed a strong inclination towards eco-friendly hotels, indicating their wholehearted agreement with the idea. Furthermore, a significant proportion of 38.3% of participants agreed with the notion of preferring eco-friendly hotels when traveling. Conversely, a considerable percentage of participants, accounting for 42.1%, adopted a neutral stance on the topic, indicating that they did not possess a firm opinion regarding their preference for eco-friendly hotels. Additionally, a notable portion of respondents, comprising 3.7%, expressed their disagreement with the idea of choosing eco-friendly hotels when traveling. Lastly, a small percentage of 0.9% of participants outright disagreed with the notion of preferring eco-friendly hotels when traveling.

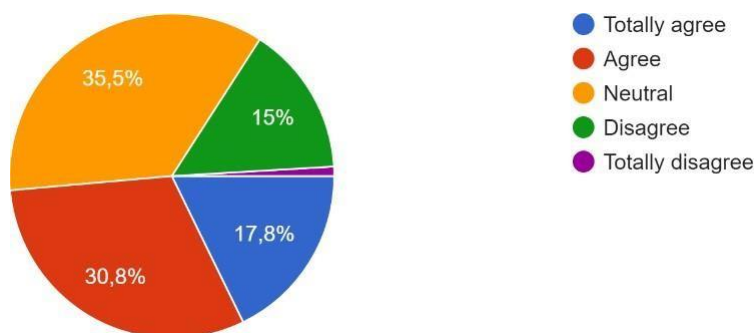


Figure 4: Opinion of respondents on the compliance of eco-friendly Greek hotels with ecotourism protocols.

Regarding the belief about whether eco-friendly hotels in Greece follow the protocols of ecotourism, it can be understood that the 17,8% of the participants of the questionnaire totally agree that the hotels in Greece follow the eco-tourism protocols. After that, it is easily understood that a much larger amount of people, a 30,8% agree with that idea. An even larger amount of participants, a 35,5%, didn't have a formed opinion on the topic so they answered as neutral. Next there was a 15% of participants that disagreed with the statement of the question and lastly after that one with the smallest percentage of the chart were the participants who totally disagreed with the

statement of the question at a 0.9% and thought that eco-friendly hotels do not follow the eco-tourism protocols.

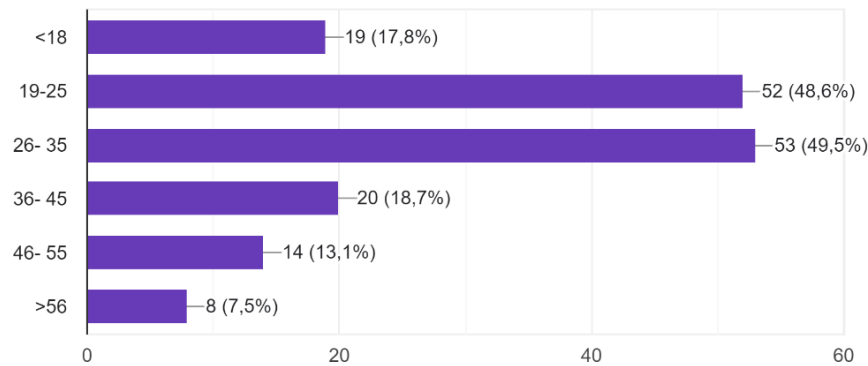


Figure 7: Age when respondents adopt an eco-friendly lifestyle.

Pondering the pivotal question of when individuals begin to embrace an eco-friendly lifestyle, provides valuable insights into the perspectives of the participants. Upon closer examination of the data, it is evident that a notable percentage of 17.8% of the participants believe that individuals begin to embrace an eco-friendly lifestyle before the age of 18. Moving forward, the majority of participants, specifically 48.6%, expressed the belief that individuals are more likely to adopt an eco-friendly lifestyle between the ages of 19 and 25. Interestingly, the age group between 26 and 35 garnered the highest percentage of participants, with a substantial majority of 49.5% associating this period of life with the adoption of an eco-friendly lifestyle. Furthermore, a noteworthy percentage of 18.7% of participants believe that the age range of 36 to 45 is a significant period when individuals are likely to embrace an eco-friendly lifestyle. Lastly, there are two age groups, namely 46 to 55 and over 56 years old, that were considered by the participants. Among the respondents, 13.1% believe that individuals between the ages of 46 and 55 are likely to follow an eco-friendly lifestyle. Additionally, 7.5% of the participants associate the age group of 56 and over with embracing environmentally conscious practices.

With the above, the research question arises as to whether age is correlated with following an eco-friendly way of life. To examine this relationship, Spearman's correlation coefficient is used. Based on the p-value obtained (sig. = 0.001), there is a statistically significant positive correlation ($Rho = 0.435$) between respondents' age and the adoption of an eco-friendly lifestyle. This means that as respondents' age increases, their likelihood of embracing eco-friendly practices also tends to increase. Overall, these results suggest that there is a statistically significant and positive association between age and the adoption of eco-friendly behaviors among the study participants. This is linked to the fact that 66.3% of respondents are in the 16 to 35 age range. Understanding this relationship can shed light on generational differences in environmental attitudes and behaviors. This exploration aims to unravel the complex

interplay between age demographics and the adoption of eco-conscious lifestyles, shaping future strategies for promoting sustainability across diverse age groups.

Referring to respondents' demographics, the focus shifts to a second research question which concerns whether there is a correlation between gender and the adoption of an eco-friendly lifestyle. This inquiry delves into the intersection of gender dynamics and environmental consciousness, exploring whether individuals' gender identities influence their commitment to sustainable living practices. The analysis of this relationship, aims to uncover valuable insights into the factors that shape attitudes and behaviors towards environmental responsibility. Understanding any potential gender disparities in eco-friendly behavior can inform targeted interventions and initiatives aimed at promoting sustainability across diverse demographic groups. To examine the abovementioned relationship, a Mann-Whitney U test is used. Based on the p-value obtained (sig. = 0.982), there is no statistically significant difference between gender and the adoption of a eco-friendly life style. Overall, these results suggest that gender is not a significant factor in determining the adoption of eco-friendly lifestyles among the study participants, according to the Mann-Whitney U test.

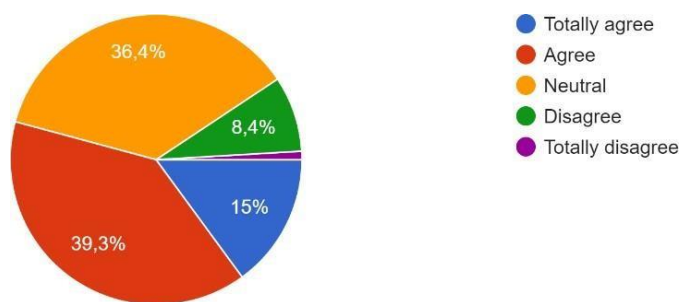


Figure 5: Respondents' preference for hotels with environmental certification.

Moving on to the subsequent inquiry in the survey, participants were asked about their preference for hotels with environmental certification. A meticulous analysis of the data reveals that a notable percentage, precisely 15%, of the participants expressed a strong agreement with the notion of preferring hotels with environmental certification. Following this group, a significant proportion of 39.3% of participants indicated their agreement with the statement, signifying that they do prefer hotels with environmental certification to some extent. Interestingly, a considerable portion of 36.4% of the participants selected the 'Neutral' option, indicating that they did not have a definitive opinion formed regarding their preference for hotels with environmental certification. Conversely, a smaller but notable percentage of 8.4% of participants expressed disagreement with the notion of preferring hotels with environmental certificates. Lastly, the smallest percentage of participants, at only 0.9%, strongly disagreed with the statement, indicating that they entirely oppose the idea of preferring hotels with environmental certificates.

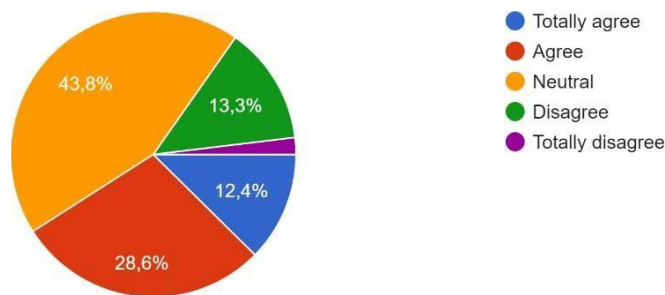


Figure 6: Respondents' willingness to pay more for an eco-friendly hotel.

Analyzing whether individuals are willing to pay more in an eco-friendly hotel provides valuable insights into the attitudes and beliefs of the participants regarding the willingness to invest additional funds for environmentally conscious accommodation. Upon careful analysis of the data, it is evident that a significant proportion, precisely 12.4%, of the participants expressed a strong agreement with the notion that individuals would indeed be willing to spend more for an eco-friendly hotel. Following this group, a substantial percentage of 28.6% of participants indicated their agreement with the statement, indicating their belief that individuals would be willing to allocate additional financial resources to stay at an eco-friendly hotel. Intriguingly, the largest percentage of the chart, accounting for 43.8%, was occupied by participants who chose the 'Neutral' option, indicating that they held no definitive opinion on whether individuals would be willing to spend more for an eco-friendly hotel. Conversely, a smaller yet notable proportion of 13.3% of participants expressed disagreement with the statement, indicating their belief that individuals would not be willing to spend more for an eco-friendly hotel. Lastly, the smallest percentage, comprising merely 1.9% of participants, strongly disagreed with the statement, firmly asserting their belief that individuals would not be willing to allocate additional funds to stay at an eco-friendly hotel.

The third research question emerges, focusing on the existence of a correlation between the adoption of an eco-friendly life style and willingness to pay more for an eco-friendly hotel. To examine this relationship, Spearman's correlation coefficient is used. Based on the p-value obtained (sig. = 0.000), there is a statistically significant positive correlation (Rho = 0.505) between the adoption of an eco-friendly lifestyle and willingness to pay more for an eco-friendly hotel. Therefore, the results suggest that there is a statistically significant and positive association between the adoption of an eco-friendly lifestyle and the willingness to pay more for an eco-friendly hotel. In simpler terms, individuals who embrace eco-friendly practices are also more likely to be willing to pay a premium for eco-friendly accommodations.

Delving into the question of how much additional expense an eco-tourist might bear for an eco-friendly hotel sets the stage for a deeper examination of the interplay between sustainable practices, consumer behavior, and economic considerations within the tourism sector. Notably, a significant percentage of 8.6% of participants

believed that eco-tourists would not be inclined to pay any additional amount for an eco-friendly hotel. Conversely, there was a substantial proportion of 24.8% of participants who estimated that eco-tourists might be willing to pay a modest premium ranging from 1% to 5% more for an eco-friendly hotel. Moreover, another notable percentage of 21% of participants estimated that eco-tourists could potentially be willing to pay a slightly higher premium, ranging from 6% to 10% more for an eco-friendly hotel. Further analysis of the data reveals that a considerable percentage of 22.9% of participants perceived eco-tourists as being potentially willing to pay an even greater premium, specifically between 11% and 15% more for an eco-friendly hotel. Additionally, a noteworthy proportion of 9.5% of participants estimated that eco-tourists might be willing to pay a higher premium ranging from 16% to 20% more for an eco-friendly hotel. Lastly, an equally significant percentage of 8.6% of participants believed that eco-tourists would be willing to pay an even higher premium, exceeding 20% more to stay at an eco-friendly hotel.

4. Discussion and conclusions

The study of the scientific literature in the context of this paper makes it clear that ecotourism is becoming a very big part of tourism all around the world. According to the findings of the above analysis, 90.7% of the sample is positively inclined towards choosing a green certified hotel. Furthermore, 45.7% of the sample is willing to pay at least 10% higher price to a hotel that makes efforts to be environmentally sustainable. In this direction, hotels need to act appropriately in order to take advantage of the opportunities created by environmental sustainability. Enhancing the above, the ESG compliance highlights the need to prioritize environmental duties alongside basic company operations (Ding and Tseng, 2023). Thus, it's a result that a hotel's holistic adoption of green principles is more than a moral obligation but stands as a strategic imperative. The target market, according to the question regarding the demographics of ecotourists, is the age group between 19 and 35 years old. Within this range, according to the steady-state analysis the as age increases, the likelihood of embracing eco-friendly practices also tends to increase. The statistical significance of age has also been pointed out in the other studies (Zhao *et al.*, 2014). Referring to gender, it is not found to be a significant factor in determining the adoption of eco-friendly lifestyles. This result is consistent with previous studies about gender differences in eco-friendly behaviors (Chen and Chai, 2010); (Pickett, Kangun and Grove, 1993); (Wiidegren, 1998). However, there are other studies showing that females are about to have a higher level of environmental consciousness (Chekima *et al.*, 2016); (Kalamas, Cleveland and Laroche, 2014). Women are more likely than men to hold pro-environmental objectives, attitudes, and beliefs (Bilynets and Knezevic Cvelbar, 2022) that may be the cause of agreeableness which is a personality trait that is most commonly found in women. Statistical significance, extended to the relationship between the adoption of an eco-friendly lifestyle and the willingness to pay more for an eco-friendly hotel. These results align with prior studies indicating that environmentally conscious consumers express a greater readiness to pay an additional price to lodge in eco-friendly hotels (Kang *et al.*, 2012).

Last but not least, education is of major importance for people who either do not know anything about ecotourism and what it stands for or for people who have limited knowledge of it and can learn more about it through traveling to Greece and around the world.

Our study findings underscore the importance of fostering sustainable development through the implementation of eco-friendly practices and ESG implementation. This can be achieved through close collaboration with research centers and universities. By working together, we can harness the expertise and resources available to drive meaningful change towards a more environmentally conscious future.

Referring to future research directions, exploring various demographic variables among guests would enhance the survey's comprehensiveness, shedding light on consumers' attitudes and behaviors towards eco-friendly practices. This comprehensive approach would provide clarity on consumer perspectives, enabling hoteliers to devise effective strategies.

References

- Abazaj, L. (2024) 'Exploring the path to Sustainable Hospitality and ESG integration. Case: Mainport Hotel, Rotterdam'.
- Bilynets, I. and Knezevic Cvelbar, L. (2022) 'Tourist pro-environmental behaviour: The role of environmental image of destination and daily behaviour', *Annals of Tourism Research Empirical Insights*, 3(2), p. 100070. Available at: <https://doi.org/10.1016/j.annale.2022.100070>.
- Boley, B.B. and Green, G.T. (2016) 'Ecotourism and natural resource conservation: the "potential" for a sustainable symbiotic relationship', *Journal of Ecotourism*, 15(1), pp. 36–50. Available at: <https://doi.org/10.1080/14724049.2015.1094080>.
- Boronat-Navarro, M. and Pérez-Aranda, J.A. (2020) 'Analyzing Willingness to Pay More to Stay in a Sustainable Hotel', *Sustainability*, 12(9), p. 3730. Available at: <https://doi.org/10.3390/su12093730>.
- Chekima, B. *et al.* (2016) 'Examining green consumerism motivational drivers: does premium price and demographics matter to green purchasing?', *Journal of Cleaner Production*, 112, pp. 3436–3450. Available at: <https://doi.org/10.1016/j.jclepro.2015.09.102>.
- Chen, T.B. and Chai, L.T. (2010) 'Attitude towards the Environment and Green Products':
- Delegkos, A.E. *et al.* (2022) 'Integrated Reporting and Value Relevance in the Energy Sector: The Case of European Listed Firms', *Energies*, 15(22), p. 8435. Available at: <https://doi.org/10.3390/en15228435>.
- Diakakis, M., Skordoulis, M. and Savvidou, E. (2021) 'The Relationships between Public Risk Perceptions of Climate Change, Environmental Sensitivity and Experience of

Ding, X. and Tseng, C.J. (2023) 'Relationship between ESG strategies and financial performance of hotel industry in China: An empirical study | Nurture'. Available at: <https://www.nurture.org.pk/index.php/NURTURE/article/view/366> (Accessed: 16 May 2024).

Doran, R. and Larsen, S. (2016) 'The Relative Importance of Social and Personal Norms in Explaining Intentions to Choose Eco-Friendly Travel Options', *International Journal of Tourism Research*, 18(2), pp. 159–166. Available at: <https://doi.org/10.1002/jtr.2042>.

Drosos, D., Skordoulis, M., *et al.* (2017) 'The Impact of ISO 9001 Quality Management System Implementation in Tourism SMEs', in V. Katsoni, A. Upadhya, and A. Stratigea (eds) *Tourism, Culture and Heritage in a Smart Economy*. Cham: Springer International Publishing, pp. 145–157. Available at: https://doi.org/10.1007/978-3-319-47732-9_10.

Drosos, D., Chalikias, M., *et al.* (2017) 'The Strategic Role of Information Technology in Tourism: The Case of Global Distribution Systems', in V. Katsoni, A. Upadhya, and A. Stratigea (eds) *Tourism, Culture and Heritage in a Smart Economy*. Cham: Springer International Publishing, pp. 207–219. Available at: https://doi.org/10.1007/978-3-319-47732-9_15.

Drosos, D. and Skordoulis, M. (2018) 'The role of environmental responsibility in tourism', *Journal for International Business and Entrepreneurship Development*, 11(1), pp. 30–39. Available at: <https://doi.org/10.1504/JIBED.2018.090019>.

Gifford, R. and Nilsson, A. (2014) 'Personal and social factors that influence pro-environmental concern and behaviour: A review', *International Journal of Psychology*, 49(3), pp. 141–157. Available at: <https://doi.org/10.1002/ijop.12034>.

Kalamas, M., Cleveland, M. and Laroche, M. (2014) 'Pro-environmental behaviors for thee but not for me: Green giants, green Gods, and external environmental locus of control', *Journal of Business Research*, 67(2), pp. 12–22. Available at: <https://doi.org/10.1016/j.jbusres.2013.03.007>.

Kalantonis, P. *et al.* (2020) 'The Impact of the Disclosed R & D Expenditure on the Value Relevance of the Accounting Information: Evidence from Greek Listed Firms', *Mathematics*, 8(5), p. 730. Available at: <https://doi.org/10.3390/math8050730>.

Kalantonis, P., Schoina, P. and Kallandranis, C. (2021) 'The impact of corporate governance on earnings management: Evidence from Greek listed firms', *Corporate Ownership and Control*, 18, pp. 140–153. Available at: <https://doi.org/10.22495/cocv18i2art11>.

Kang, K.H. *et al.* (2012) 'Consumers' willingness to pay for green initiatives of the hotel industry', *International Journal of Hospitality Management*, 31(2), pp. 564–572. Available at: <https://doi.org/10.1016/j.ijhm.2011.08.001>.

Kim, Y. and Han, H. (2010) 'Intention to pay conventional-hotel prices at a green hotel – a modification of the theory of planned behavior', *Journal of Sustainable Tourism*, 18(8), pp. 997–1014. Available at: <https://doi.org/10.1080/09669582.2010.490300>.

Lampropoulos, I. *et al.* (2024) 'The Contribution of Education and ICT Knowledge in Sustainable Development Perceptions: The Case of Higher Education Students in

Legrand, W. and Matthew-Bolofinde, A. (2022) 'ESG, SDGs, and Hospitality: Challenges and Opportunities in Activating Sustainability', in C. Nelly Berrones-Flemmig, F. Contreras, and U. Dornberger (eds) *Business in the 21st Century*. Emerald Publishing Limited, pp. 25–39. Available at: <https://doi.org/10.1108/978-1-80382-787-220221003>.

Malheiro, M. et al. (2020) *Sustainability In Tourism And Hospitality: Trends And Challenges*.

Meagher, P. (2023) 'The Environmental Dimension of ESG: How Companies Can Promote Sustainability and Protect the Natural World', *Learnsignal*, 9 January. Available at: <https://www.learnsignal.com/blog/esg-environmental-sustainability-natural-world-protection/> (Accessed: 12 May 2024).

Merli, R. et al. (2019) 'Why should hotels go green? Insights from guests experience in green hotels', *International Journal of Hospitality Management*, 81, pp. 169–179. Available at: <https://doi.org/10.1016/j.ijhm.2019.04.022>.

Nelson, K.M. et al. (2021) 'Tourist willingness to pay for local green hotel certification', *PLOS ONE*, 16(2), p. e0245953. Available at: <https://doi.org/10.1371/journal.pone.0245953>.

Ntanos, S. et al. (2018) 'Renewable Energy and Economic Growth: Evidence from European Countries', *Sustainability*, 10(8), p. 2626. Available at: <https://doi.org/10.3390/su10082626>.

Ntanos, S. et al. (2019) 'An Application of the New Environmental Paradigm (NEP) Scale in a Greek Context', *Energies*, 12(2), p. 239. Available at: <https://doi.org/10.3390/en12020239>.

do Paço, A., Alves, H. and Nunes, C. (2012) 'Ecotourism from Both Hotels and Tourists' Perspective', *Economics & Sociology*, 5(2), pp. 132–142,154.

Pickett, G.M., Kangun, N. and Grove, S.J. (1993) 'Is There a General Conserving Consumer? A Public Policy Concern', *Journal of Public Policy & Marketing*, 12(2), pp. 234–243. Available at: <https://doi.org/10.1177/074391569101200208>.

Sakellari, M. (2019) 'Ecotourism in the Greek islands: Lost in vagueness', *Diacronie. Studi di Storia Contemporanea* [Preprint], (N° 40, 4). Available at: <https://doi.org/10.4000/diacronie.12206>.

Skordoulis, M. et al. (2020) 'Environmental Innovation, Open Innovation Dynamics and Competitive Advantage of Medium and Large-Sized Firms', *Journal of Open Innovation: Technology, Market, and Complexity*, 6(4), p. 195. Available at: <https://doi.org/10.3390/joitmc6040195>.

Skordoulis, M., Andreopoulou, M.-I. and Drosos, D. (2022) 'Consumers' Willingness to Pay for Green Hotels: The Case of Millennials in Greece'.

Skordoulis, M., Ntanos, S. and Arabatzis, G. (2020) 'Socioeconomic evaluation of green energy investments: Analyzing citizens' willingness to invest in photovoltaics in Greece', *International Journal of Energy Sector Management*, 14(5), pp. 871–890.

Thapa, K. *et al.* (2024) 'Visitors' environmental attitudes and willingness to pay for nature conservation: the case of Langtang National Park in the Himalayas', *Global NEST Journal*, 26, pp. 1–13. Available at: <https://doi.org/10.30955/gnj.005717>.

TIES (2015) 'What Is Ecotourism', *The International Ecotourism Society*. Available at: <https://ecotourism.org/what-is-ecotourism/> (Accessed: 17 May 2024).

Wiidegren, Ö. (1998) 'The New Environmental Paradigm and Personal Norms', *Environment and Behavior*, 30(1), pp. 75–100. Available at: <https://doi.org/10.1177/0013916598301004>.

Zhao, H. *et al.* (2014) 'What affects green consumer behavior in China? A case study from Qingdao', *Journal of Cleaner Production*, 63, pp. 143–151. Available at: <https://doi.org/10.1016/j.jclepro.2013.05.021>.

SCOR Model: A literature review

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Abstract

Supply Chain Management involves the integration of key business processes from end users through suppliers, providing services, products, and information that add value for customers and stakeholders. A significant advantage of the Supply Chain Operations Reference (SCOR) model is its ability to establish a common language and framework for supply chain management across various industries and organizations. By utilizing standardized terminology and performance metrics, companies can benchmark their supply chain performance against industry standards, thereby identifying opportunities for collaboration and improvement. In today's rapidly evolving and globalizing world, intense competition exists among the supply chains of different companies. The SCOR model addresses this competition by providing a standardized process for supply chain management, encompassing five key steps: Plan, Source, Make, Deliver, and Return. This paper presents a research agenda on the SCOR model, aiming to explore its application and effectiveness in enhancing supply chain performance and fostering industry-wide collaboration and improvement.

Keywords: SCOR Model, Supply Chain, Literature review, Supply Chain Council

1. Introduction

The way a company manages its' supply chain, constitutes one of the most significant factors that plays an important role to win a business competition. To win the competition, the goods must arrive in the customer hands faster, cheaper in excellent quality. (Dana S.Saroso, 2023). The SCOR (Supply Chain Operations Reference) model is one of the relatively recent ways of measuring supply chain performance including suppliers, customers and their interactions (Jain et al., 2022). The creation of this particular model was aimed at improving the operation and performance of the supply chain (Rodríguez Manay, Guaita-Pradas & Marques-Perez, 2022). According to the Supply Chain Council, reliability in the measurement of supply chain performance refers to the ability of each company to perform its operations as expected from their design (Benkachcha, Benhra & El Hassani, 2014). The effective management of supply chain performance and its optimal management is judged in a number of studies as to be extremely important (Nguyen et al., 2021). Many researchers consider it a top priority issue and it becomes imperative to find a model that will meet case specific conditions, facing any new challenge as a single chain (Chehbi-Gamoura et al., 2020). This need was quickly met by some approaches that were developed and integrated into company processes, such as ABC Analysis which can be applied with different measures, Key Performance Indicators, Metrics, the Balanced Scorecard Targeting etc., which however cover a part of supply chain management (Abbaspour, 2019).

In 1996, the Supply Chain Council developed a supply chain operations reference (SCOR) model, as the cross-industry, de facto, standard diagnostic tool of supply chain management

(Ayyildiz & Taskin Gumus, 2021). The Council includes researchers, 70 leading managers and professionals in the field of supply chain management, whose companies come from a variety of industries. The 1st version of the SCOR model appeared in Europe in 1997 and since then, the versions have been getting better and better, the most recent being the 12.00 version. Supply Chain Council is an independent, non-profit, global corporation open to all businesses that wish to implement and promote supply chain management systems and practices as well as its members are organizations and businesses interested in implementing and promoting state-of-the-art supply chain systems and practices (Chehbi- Gamoura et al., 2020). The SCOR model has been developed to describe the business activities associated with all phases of satisfying customer demand, it can describe very simple or very complex supply chains using a common set of definitions. In addition, the model is able to describe and provide with success a basis for supply chain improvement for global projects as well as site-specific projects (www.apics.org).

2. Literature Review

2.1 Conceptual Approach to Supply Chain Operations Reference Model (SCOR)

The Supply Chain Operations Reference (SCOR) model is a broad, yet highly structured and systematic framework for supply chain improvement (Roque et al., 2021). It manages supply chains that extend from the "supplier of suppliers" to the "customer of customers" (Abbaspour, 2019). The assessment of the whole performance of supply chains includes distribution, order efficiency, production flexibility, warranty along with return costs, inventory and capital networks and other factors (Ayyildiz & Taskin Gumus, 2021). It is structured around five key processes - planning, procurement, production, delivery and return - and covers the key activities of the supply chain, from demand identification to product delivery and cash collection (Kamarudin & Nizam, 2022). The SCOR model essentially "breaks" the supply chain into five critical processes that are each articulated in even more components (Sundarakani, Abdul Razzak & Manikandan, 2018). This framework uses a widely accepted methodology, diagnostic and assessment tools for evaluating supply chain activities. Companies that have used the model include BP, Amazon, P&G, Coca Cola and Siemens. The model uses three well-known individual techniques which are transformed into an integrated approach (Rodríguez Manay, Guaita-Pradas & Marques-Perez, 2022; Slack, Chambers & Johnston, 2010). These are business process modeling, benchmark performance and analysis of best practices.

The SCOR model is globally recognized as a global standard that connects supply chain process, metrics, best practices and technology into a single structure (Nguyen et al., 2021). Since 1996, more than 5.000 companies around the world have used and implemented the SCOR model. It also defines a common set of supply chain processes to help companies better understand the relevant issues and set goals for its improvement. Furthermore, it is a powerful diagnostic tool that contributes decisively to the optimization of the size and complexity of the supply chain, to the objective evaluation of its performance and to the determination of its improvement objectives (Hammadi et al., 2018).

2.2 Detailed description of the structure of the SCOR model

The SCOR model is based on three pillars, the modeling of the processes, the performance measurements and the best practices (Ikatriinasari, Harianto & Yuslistyari, 2020). The framework of the SCOR model is designed to enable effective communication both internally and between supply chain members (Hammadi et al., 2018). It also suggests standard definitions and data needs for many metrics, which can then be used to compare

and benchmark performance within an organization (Ricardianto et al., 2022). The processes covered by the SCOR model include every action and interaction between customer and supplier, it provides a description of the supply chain processes, as well as a series of metrics to measure the performance of each process (Ikatinasari, Harianto & Yuslistyari, 2020). It extends two levels ahead and two levels behind, from the supplier's supplier to the customer's customer (Figure 1).

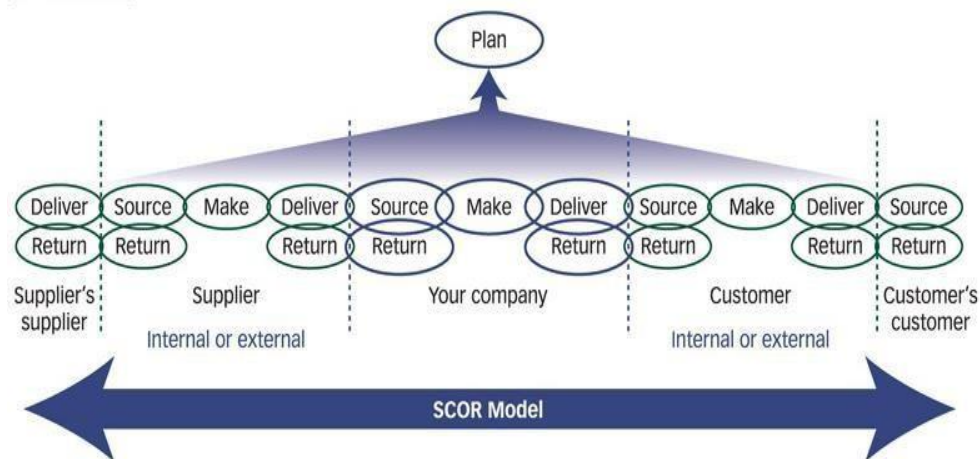


Figure 1. SCOR Model (Supply Chain Council: SCOR 9.0 Overview Booklet, 2008)

The SCOR model links processes, indicators, best practices and technologies to create a unified structure. For each process, SCOR provides information about the other processes connected to it, either at a higher or lower level, indicators that measure its performance, best practices related to it, and competencies that must be possessed by the employees involved in that process. The SCOR model combines the concepts of business process reengineering, benchmarking and best practices as well as it is different from other models since it is much more than just a tool for mapping supply chain processes and activities (Georgise et al., 2016).

According to the information provided by the SCOR model, the boundaries of any model must be defined carefully (SCOR Overview, Version 9.0). Specifically, SCOR for a company covers all interactions with its customers, from the entry of an order to the payment of the invoice, all transactions (physical materials or services) of products, from the supplier's supplier to its customer's customer, including transfers of equipment, supplies, spare parts, raw materials, defective products, software, etc. and all the interactions with the market, from ascertaining the level of overall demand to fulfilling each individual order.

The SCOR model does not attempt to describe every business process or activity and it does not include functions such as sales and marketing (demand generation), research and development of technology, product development and some post-distribution customer support procedures (Jain et al., 2022). However, the possibility of connecting the model to some processes that are not included in its scope is possible, such as e.g. product development, in accordance with all that is noted in the SCOR model. It also takes into account, but does not specifically refer to education, quality, information technology and management which is not related to the supply chain (Rodríguez Manay, Guaita-Pradas & Marques-Perez, 2022).

2.3 Basic principles of supply chain design

The SCOR model takes into account the following principles, according to which each key supply chain is a link of execution processes (eg. Procurement, Production and Distribution) (Nguyen et al., 2021). Specifically, execution processes convert or transfer materials and/or products; each process is the “customer” of the previous process and the “supplier” of the next process; planning processes manage supplier-customer linkages; planning processes bring “balance” to the supply chain; each link requires the existence of a design process (SCOR Overview, Version 9.0).

2.4 Evolution of the SCOR model over time & Advantages of its use

The first version of the model was followed by several in recent years, through which the Council refined and further developed the SCOR model. Feedback from business users of the model combined and its rapid market penetration increased interest around it, leading in successive improved versions. Today, after the improvements made in the 10th and 11th editions, the 12th edition went into effect where “Enable” added to Level 1 processes.

The SCOR model is so far the most comprehensive framework that has the potential to offer solutions to address most of the problems facing supply chains (Ramish & Aslam, 2016). In the past it has been compared with other supply chain management frameworks and specifically evaluated for its validity, strengths and potential weaknesses (Ayyildiz & Taskin Gumus, 2021). Slack, Chambers and Johnston (2010) indicate some of the benefits that a company can obtain from the use of the SCOR model. Specifically, they mention the better understanding of performance and processes; the improved supply chain performance; the increase in customer satisfaction and customer retention; the reduction of required funds; the improved profitability and return on investment and the increase in productivity.

The SCOR model methodology can be applied to many levels of supply chain management and gives companies an idea of their effectiveness (Sundarakani, Abdul Razzak & Manikandan, 2018). This methodology helps businesses understand how the six steps are constantly repeated between suppliers, business and customers. Each step is a connecting link in the supply chain and is an important component of the success of the respective product. This standard model has proven to help companies that use it to identify supply chain problems. The standard allows the creation of a "road map" of supply chain processes, the coordination of business processes and the increase of return on investment (Ikatinasari, Harianto & Yuslistyari, 2020).

Moreover, the Council of the Supply Chain mentions indicative organizational benefits provided by the adoption of the SCOR model (Supply Chain Operations Reference model Overview - Version 10.0) such as the rapid assessment of supply chain performance; the clear identification of performance gaps; the effective network redesign and supply chain optimization; the enhanced operational control based on standard core procedures; the improved management of the organizational structure; the alignment of supply chain team skills with strategic objectives; the detailed plan for launching new products and the systematic supply chain synergies that ensure projected savings (Rosyidah et al., 2022).

Adopting the SCOR model can also give to a business the ability to increase the speed of system applications, to support organizational learning objectives and having improved stockshooting (Abbaspour, 2019). Additionally, companies usually find significant benefits from the proper use of the SCOR model, since it helps in better management of the business by providing a detailed description of how to complete tasks (Rosyidah et al., 2022). The model also helps companies compete more effectively through the system of key performance measures linked to business processes and it promotes cooperation and

teamwork among employees (Ricardianto et al., 2022). The use of performance measures (KPIs) of the SCOR model usually improves cost, cycle time and reliability (Sundarakani, Abdul Razzak & Manikandan, 2018) and according to Abbaspour (2019) the use of SCOR metrics can bring positive results to the biggest challenges of the Supply Chain such as customer service, cost control, planning and risk management, management of relations with the supplier / partner and management of human resources.

Furthermore, the research of Lestari et al. (2013) show that the application of SCOR model found to be a very useful tool for the design and configuration of the supply chain, but also ensured the possibility of improving the existing system of the examined company through the application of best practices. Thus, a company using a hierarchical - interdepartmental model, achieves the description, measurement and evaluation of its supply chain, but also the possibility of direct communication between departments (Alimo, 2021). It also has the ability to use previous supply chain data to monitor its execution and growth, and by that way it defines five general attributes of performance and three levels of measures that analysts can use (Jain et al., 2022). Once a company has a better understanding of the strengths and weaknesses of the process as it is, it is in a better position to decide how it wants to move competitively and what it will need to do in order to implement such a plan, regardless of the supply chain strategy it uses (Zhou, 2022).

2.5 Levels of Supply Chain Management

The SCOR model enables the modeling of the supply chain in four levels, as follows (Alimo, 2021; Kamarudin & Nizam, 2022):

Level 1 is the highest level in which the six processes are detailed and at this level the company defines its objectives to make the supply chain competitive. At *level 2* the categorization of critical processes (eg production to stock, production to order, design to order) is formed. Companies implement their strategies through the parameters they choose. At the 2nd level, the six basic management processes are divided into categories that allow each company to describe the configuration of the chain. This level defines the relationship between the members of the chain and the interactions with the external environment. *Level 3* provides the breakdown of the process required to describe each element that makes up the Level 2 categories. At this level, the best practices, the capabilities of the system that will support them and the performance measures are defined in detail. Finally, *level 4* defines practices to achieve competitive advantage and the organization's ability to adapt to changes in the business environment. It is not within the SCOR model, as it is obvious that it is not possible for the considered model to provide standard procedures at this level due to the great variation of both business sectors and organizations within the same sector. This level focuses on the implementation of the model and is unique for each company. At this level, the details of the implementation of the model are designed according to the needs of each company.

2.6 Analysis of SCOR model processes

The SCOR model is an auxiliary management tool, used to direct, examine and improve management decisions concerning a company's supply chain and involving its suppliers and customers (Dissanayake & Cross, 2018). This tool describes the business processes required to satisfy a customer's requirements, while helping to understand and improve processes along the entire supply chain (Ayyildiz & Taskin Gumus, 2021). The SCOR model has been described as "the most promising model for strategic supply chain decision-making" (Janaki, 2019). The model incorporates business concepts such as redesign, evaluation and

measurement and focuses on six steps of the supply chain: planning, procurement, production, deliveries, returns and empowerment (Hammadi et al., 2018).

The framework that the model provides for process improvement is cross-departmental and hierarchically structured (Rosyidah et al., 2022). For each of the model's six core processes: Plan, Source, Make, Delivery, Return, and Enable and their subcategories provide a set of metrics and optimal practices for their proper management and the balancing of the planned demand with the actual one (Kamarudin & Nizam, 2022). In the SCOR model, each "link" of the supply chain is represented, which consists of the six aforementioned processes. Each process captures a "supplier-customer" relationship (Slack, Chambers & Johnston, 2010) and the measurements concern the management of the six processes based on which the supply chain is described, measured, and evaluated (Hammadi et al., 2018). An analysis of the model's processes follows.

I. Plan

The first phase to manage supply and demand is integrated into the planning process (Janaki, 2019). With the data collected, an attempt is made to balance resources and requirements, while at the same time pouring them into all links of the supply chain (Alshawabkeh et al., 2022). Planning also includes all those decisive business rules in order to improve and measure the efficiency of the supply chain, mainly the coordination and organization of transport and stocks in order to harmonize movements with the rest of the processes (Jain et al., 2022). Planning includes the effort to coordinate the objectives of the supply chain with the financial capabilities of the business (Subagyo et al., 2022). It consists of the processes that balance supply and demand by developing a strategy that will lead to the satisfaction of supply, production and delivery requirements. It includes the activities of gathering data about customer requirements, gathering information about available resources and balancing them with requirements. Also, production possibilities, deficiencies and the actions to be performed to cover them are determined. Demand and supply planning are thus integrated into a general planning system that covers activities such as long-term production capacity and resource planning. Planning processes manage supplier-customer linkages, which ensures the balance of supply chain activities (Dissanayake & Cross, 2018).

II. Source

"Source" relates to the processes of receiving, delivering and transporting goods or services necessary to create a specific product or service in order to satisfy demand (Ricardianto et al., 2022). At this stage, the necessary procedures are carried out for the acquisition of raw materials and the operation of the supply chain. Here the way of inventory management is described, methods of communication with suppliers are developed, their performance is measured and agreements with them are defined. This category includes payments to suppliers, certification of the supplier, entering into a contract with the supplier and agreements for the transport and receipt of the products. Describes the ordering, receipt of goods and use of the services provided. It is also related to issuing purchase orders, scheduling deliveries, receipts, validating and storing loads and accepting invoices from suppliers (Sundarakani, Abdul Razzak & Manikandan, 2018).

III. Make

The specific process is the one that adds value to the products and services with the help of additives in the production processes and functions (Ricardianto et al., 2022). Products are configured in their final form to satisfy planned or actual demand or to define the content of services. In this stage, the strategic planning of the production is done which can be "production according to the orders" or "production according to the stock level". This

process also includes activities related to the production and packaging of the products, as well as the management of the equipment, facilities and transportation of the products (Alshawabkeh et al., 2022). Each activity (e.g. repackaging materials in a distribution center, quality control in a production line) adds value to the process in question (Janaki, 2019).

IV. Deliver

Distribution includes the management of all customer-related issues, including outbound logistics (Sundarakani, Abdul Razzak & Manikandan, 2018). Specifically, it includes: order demand, storage, transportation and distribution of finished products and services that meet actual or planned demand. In addition, it includes the receipt and management of orders from customers as well as the pricing of products, as well as their life cycle.

V. Return

The return process takes care of reverse logistics, where products are "moved" backwards from the supply chain process by customers, due to product defects or customer support after delivery (Milambo & Phiri, 2019). In this process, actions are carried out for the return or receipt of returned products due to a possible defect or for maintenance and repair or for the replacement or recycling of materials which the customer no longer needs and includes customer support after delivery (Subagyo et al., 2022). Also, at this stage the planning, transport and receipt of the returned goods is carried out. Businesses must be able to manage the return of products that may be due to defects (Dissanayake & Cross, 2018). Return includes inventory management and claims settlement. It consists of processes associated with returning defective or surplus products from customers and includes customer support after delivery (Sundarakani, Abdul Razzak & Manikandan, 2018).

VI. Enable

This is a new process that prepares, maintains, or manages information or relationships on which planning and execution processes are based (Hammadi et al., 2018). Processes are associated with establishing, maintaining and monitoring the information, relationships, resources, assets, business rules, compliance and contracts required to operate the supply chain. "Enable" supports the implementation and management of planning and execution of supply chain processes (Lemghari, Okar & Sarsri, 2018). These processes interact with processes in other areas, e.g. financial processes, Human Resources, Information, Communication & Technology processes, facilities management processes, product & portfolio process management, product and service design processes, and sales and support processes (Milambo & Phiri, 2019).

2.7 Characteristics of the SCOR model and performance measurement

Performance is measured qualitatively with characteristics defined by the model (Attributes) and quantitatively with the help of indicators (Metrics) (Abbaspour, 2019). Attributes are a group of metrics that are used to define strategy while the indicators measure the ability of the chain to achieve its objectives (Abbaspour, 2019). The SCOR model identifies five key characteristics to determine supply chain performance where each process is evaluated using specific characteristics (Lemghari, Okar & Sarsri, 2018). In the first case, the proposed measures assess how well the company delivers products and services to its customers, while in the second case, how well the company operates internally. That is why the first three characteristics are considered customer-centric, while the last two characteristics focus on the internal environment of the company (Dissanayake & Cross, 2018).

Additionally, the SCOR model includes metrics and provides tools for graphically depicting and describing supply chain processes (Zhou, 2022). One of the key principles of the SCOR

model is that metrics should progress hierarchically from one level to the next. For that reason, the strategic performance metrics monitored by senior management should be supported by more detailed metrics that can be used to diagnose and control operations at the tactical level (Subagyo et al., 2022). Those metrics are related to fulfillment rates, on-time deliveries, loss ratios, etc. When issues are observed at the strategic level, for example, perfect order performance declines, operational metrics provide indications of the issues that actually exist (Ricardianto et al., 2022).

Measuring performance according to information provided by the Supply Chain Council states that (Supply Chain Operations Reference model Overview - Version 10.0) a metric is a standard for measuring process performance (Milambo & Phiri, 2019). SCOR model metrics are diagnostic metrics while it recognizes three levels of predefined metrics (Hammadi et al., 2018): *Level 1*: Metrics are diagnostic of the “overall health” of the supply chain. These metrics are also known as strategic metrics and key performance indicators (KPIs). Level 1 benchmarking against the aforementioned metrics helps establish realistic goals that support strategic goals. *Level 2*: Metrics serve as a diagnostic tool for Level 1 metrics. This diagnostic relationship exists to help determine the cause or causes of the performance gap for Level 1 metrics. *Level 3*: Measurements serve as a diagnostic tool for Level 2 measurements.

Analyzing the performance of metrics from level 1 to 3 is referred to as decomposition. The decomposition helps to identify the processes that need to be studied further (The processes associated with level 1 and the level 2 metrics) (Lemghari, Okar & Sarsri, 2018). Many metrics in the SCOR model are hierarchical, just like the process elements (Zhou, 2022). Level 1 metrics are generated from lower calculations. At Level 2, metrics are generally associated with a narrower subset of processes. More specifically, supply chain measurement is an important part of supply chain management (Milambo & Phiri, 2019). The SCOR model at Level 1 provides ten key performance indicators. Based on the latest data from the 12th edition SCOR model study, there are over 250 indicators described in the SCOR model. Specifically, they are organized based on a hierarchical and codified structure from organizational level 1, to process level 2, to diagnostic level 3 (Hammadi et al., 2018).

The SCOR model provides key performance indicators that evaluate the performance of the supply chain as well as the company's customers. Key performance indicators are classified by level, according to their position in the context of the process applied by the SCOR model (Lepori et al., 2013). The SCOR model helps to model Supply Chain processes. The breakdown of the SCOR model into processes related to key performance indicators and levels provides a framework for performance evaluation. The classification by level and by performance of the characteristics makes it possible to track the measures through this process (Milambo & Phiri, 2019). The SCOR model divides the indicators related to the relationship with the customer into three categories related to the extent of the company's response with an indicator of the order satisfaction time, those related to the reliability with a key indicator the perfect satisfaction of a customer's order and those related to the proficiency with indicators of flexibility and adaptability in both supply chain flows, from suppliers to customers (Lemghari, Okar & Sarsri, 2018). Moreover, financial indicators are divided into two categories, those that focus on costs such as cost of goods sold and cost of supply chain management and those related to assets such as the cash-to-cash cycle, the return on fixed resources of the supply chain and the return on working capital (Hammadi et al., 2018).

Table 1: SCOR Model across sectors

Sector	Study	Measures	Findings
Food & Beverages	Alimo, 2021	Reducing postharvest losses of fruits and vegetables through supply chain performance evaluation	SCOR Model is recommended as a SCP measurement.
	Nguyen et al., 2021	Measuring coffee Supply Chain Performance Measurement	The study proposes some recommendations to improve the coffee supply chain's efficiency. Most processes, including Source, Make, Deliver, and Return, have a small performance value.
	Rosyidah et al., 2022	Analyze activities related to Green Supply Chain Management and Supply Chain performance in the palm oil sector	Renewable energy has the most significant weight is performance measurement.
	Fauziyah, Ridwan & Muttaqin, 2020	Food production performance	15 metrics are divided into three performance attributes, reliability attribute (5 metrics), responsiveness (9 metrics), and cost (1 metric)
	Moazzam et al., 2018	Measuring agri-food supply chain performance	The detailed information required for measuring the level-3 SCOR metrics is not easily available in the industry
Automotive industry	Lemghari, Okar & Sarsri, 2018	Supply Chain Performance Measurement	The indicators measuring the performance of the SC depend on the strategic vision of the company
	Yahiaoui, Fedouaki & Mouchtachi, 2021	Measuring the impact of COVID-19 on Automotive Supply Chain	There is negative impact of the coronavirus pandemic on the four poles of the SC (import, production, sale, and export).
	Fauzia & Zamzamy, 2021	Designing a Performance Improvement Strategy	Processes are divided into several attributes that are included at level two of the SCOR model. Each of these attributes has a total of 49 performance indicators.
	Ganji Jamehshooran, Shaharoun & Norehan Haron, 2015	Assessing Supply Chain Performance	Four components of Business analytics affect Supply Chain Performance
	Yongan & Menghan, 2011	Green Supply Chain Design	GSCM is recommended
Port management	Subagyo et al., 2022	Supply Chain Performance Measurement of Logistic Businesses	Integration is fundamental in the use of all the equipment, resources, strategies and implementation of Supply Chain Management.
	Huang et al., 2021	Efficiency evaluation of key ports	Ports with low relative efficiency suffer from input redundancy and inefficiency output.
	Wang & Du, 2019	Access supply chain management to port operations	The suggested management model supports all port operations
Healthcare	Smith & Johnson, 2022	Parallels between industrial sector and health care services	SCM and SCOR Model recommended
	Chorfi, Benabbou, Berrado, 2018	Measurement system for pharmaceutical products supply chain for the Moroccan public sector	Balanced scorecard (BSC) and SCOR model to engineer an integrated performance measurement system for managing public healthcare supply chains.
	Anas, Sefiani, Reklouai, Azzouzi, 2018	Evaluation of Hospital Supply Chain using SCOR based performance	Improvement of practical performance and enhancement of management effectiveness

Generally, SCOR Model has been applied in several industries and sectors in order to access supply chain and operations performance. Literature-related papers for SCOR Model had also written for manufacturing industry, military industry, geographical information system (GIS) and Information Technology (IT), logistics operations and collaborative supply chain networks. The application of the model aims to determine specific performance indicators, to

generally assess the performance of the supply chain or to introduce new performance frameworks.

In this study we created the above table (Table 1), in order to cluster into categories measures and findings for the sectors that frequently use SCOR Model. Table 1 contains the application of SCOR Model on three different sectors (Food & Beverages, Automotive Industry, Port Management,) along with the aim – measurement of each case and some of the main findings. Overall, the use of SCOR Model ends up with positive outcomes and specific metrics which can be applied on every industry.

2.8 SCOR Model best practices

Once supply chain performance has been measured and its gaps identified, it is necessary to define and implement appropriate practices and take the necessary actions to close those gaps (Jain et al., 2022). Over 400 practices have been communicated by the Supply Chain Council to its members. Lemghari, Okar and Sarsri (2018) state that the SCOR model defines a best practice as a timely, structured, proven and repeatable method that affects business results. Specifically, the practice should be neither newly emerging nor outdated; it must be demonstrated and proven in a regular work environment; the practice must have been repeated and be repeatable in multiple independent settings; the business process, practices, organizational strategy, technology used, public relations of the business, the business model as well as the knowledge and information of the management must be seen; and the practice must be impactful, show operational improvements and reflect them in key performance indicators (KPIs). Impact should show both gains (increased speed, revenue, quality) and losses (poor resource utilization, high costs, non-returns).

3. Conclusions and discussion

Clearly defining the supply chain, SCOR Model enables a company to measure its performance and assess its effectiveness. This measurement reveals several deviations from the desired performance of the supply chain and, as a consequence, several opportunities to improve the existing situation. Maintaining the above approach, as far as the supply chain is concerned, leads to its continuous evolution and continuous improvement, so that it is able to meet the demands of the modern, dynamic and complex business environment. Therefore, the importance of the performance of the supply chain requires every company to take action in the direction of its continuous improvement. In fact, most large companies, recognizing this need, form groups of competent and qualified executives, who work to establish integrated supply chains. The difficulty of this attempt is revealed sooner or later as in practice many action plans run into various problems and become blocked or inactive and abandoned. The SCOR Model offers a step-by-step approach that facilitates the analysis, design and ultimately improvement of supply chain performance. The working framework of the model is rigorous and at the same time flexible so that on the one hand it provides full guidance during its implementation and on the other hand it can be implemented in every industry and for every issue in the supply chain.

After the extensive study of the bibliography of the SCOR model, observed that there are some sectors that do not extensively use the SCOR model, it might be interesting to categorize and further analyze them or to compare them for common elements. Healthcare, Education and Agriculture are some of the sectors that use the SCOR model less frequently according to bibliography. The literature on Hospital Supply Chain performance is limited and assessing the performance of the Hospital Supply Chain (HSC) is currently a key challenge (Anas et al., 2018).

References

- Abbaspour, A. (2019). "Supply chain analysis and improvement by using the SCOR model and Fuzzy AHP: A Case Study". *International Journal of Industrial Engineering and Management Science*, 6(2), pp. 51-73.
- Alimo, P. K. (2021). "Reducing postharvest losses of fruits and vegetables through supply chain performance evaluation: an illustration of the application of SCOR model". *International Journal of Logistics Systems and Management*, 38(3), pp. 384-407.
- Alshawabkeh, R., AL-Awamleh, H., Alkhawaldeh, M., Kanaan, R., Al-Hawary, S., Mohammad, A., & Alkhawalda, R. (2022). The mediating role of supply chain management on the relationship between big data and supply chain performance using SCOR model. *Uncertain Supply Chain Management*, 10(3), pp. 729-736.
- Anas, Z., Sefiani, N., Reklouli, K. and Azzouzi, H. (2018) "A SCOR based Performance evaluation system of the Hospital Supply chain," *International Colloquium on Logistics and Supply Chain Management (LOGISTIQUA)*, Tangier, Morocco, 2018, pp. 182-187.
- Andrais, A., & Kristina, S. (2019). Indonesia SME Supply Chain Performance from SCOR Model Perspective. *International Conference on Family Business and Entrepreneurship*, 9.
- Ayyildiz, E., & Taskin Gumus, A. (2021). Interval-valued Pythagorean fuzzy AHP method- based supply chain performance evaluation by a new extension of SCOR model: SCOR 4.0. *Complex & Intelligent Systems*, 7(1), pp. 559-576.
- Benkachcha, S., Benhra, J., & El Hassani, H. (2014). Demand forecasting in supply chain: comparing multiple linear regression and artificial neural networks approaches. *International Review on Modelling and Simulations*, 7(2), 279-286.
- Butturi, M.A., Lolli, F. and Gamberini, R., 2024. Set up a supply chain observatory through the comparison of multi-criteria parsimonious methods. *Benchmarking: An International Journal*.
- Chehbi-Gamoura, S., Derrouiche, R., Damand, D., & Barth, M. (2020). Insights from big Data Analytics in supply chain management: an all-inclusive literature review using the SCOR model. *Production Planning & Control*, 31(5), pp.355-382.
- Chorfi, Z., Benabbou, L. and Berrado, A. (2018) 'An integrated performance measurement framework for enhancing public health care supply chains', *Supply Chain Forum: An International Journal*, 19(3), pp. 191–203.
- Dana S.Saroso & Ivan Kristianto & Erry Rimawan, 2023. "A Framework of SCOR Model Based on Systematic Literature Review: Case Study in Micro and Small Industries in Indonesia," *International Journal of Research and Innovation in Social Science*, *International Journal of Research and Innovation in Social Science (IJRISS)*, vol. 7(5), pp 902-917.
- Dissanayake, C. K., & Cross, J. A. (2018). "Systematic mechanism for identifying the relative impact of supply chain performance areas on the overall supply chain performance using SCOR model and SEM", *International Journal of Production Economics*, 201, pp. 102-115.
- Douglas Smith, Anthony Vatterott & Wesley Boyce. (2022) Assessing Performance and Risk in Complex Supply Chains and Tying Performance Measures to Strategic Concepts. *Supply Chain Forum: An International Journal* 23:1, pp. 20-38.
- Georgise, F. B., Thoben, K. D., & Seifert, M. (2016). Application of the Adapted SCOR Model to the Leather Industry: An Ethiopian Case Study, In *Dynamics in Logistics*, Springer, Cham, pp. 441-451.
- Hammadi, L., de Cursi, E. S., Barbu, V. S., Ouahman, A. A., & Ibourk, A. (2018). "A SCOR model for customs supply chain process design", *World Customs Journal*, 12(2), pp. 95- 106.

- Ikatrinasari, Z., Harianto, N., & Yuslistyari, E. (2020). Improvement of supply chain performance of printing services company based on supply chain operation references (SCOR) model. *Uncertain Supply Chain Management*, 8(4), pp. 845-856.
- Jain, V., Kumar, S., Mostofi, A., & Momeni, M. A. (2022). Sustainability performance evaluation of the E-waste closed-loop supply chain with the SCOR model, *Waste Management*, 147, pp. 36-47.
- Janaki, D. (2019). "Adapting the SCOR model for supply chain network assessment and improvement in oil industry", *International Journal of Data and Network Science*, 3(4), pp. 331-338.
- Kamarudin, N., & Nizam, N. Z. (2022). "The mediating effect of JIT on the relationship between SCOR model and supply chain performance", *International Journal of Social Science Research*, 4(1), pp. 376-388.
- Lemghari, R., Okar, C., & Sarsri, D. (2018). Supply chain performance measurement: A case study about applicability of scor® model in automotive industry firm, In *MATEC Web of Conferences* (Vol. 200, p. 00016). EDP Sciences.
- Lepori, E., Damand, D., & Barth, B. (2013). Benefits and limitations of the SCOR model in warehousing. *IFAC Proceedings Volumes*, 46(9), pp. 424-429.
- Lestari, F., Ismail, K., Hamid, A. A., & Sutopo, W. (2013). Designing supply chain analysis tool using SCOR model (Case study in palm oil refinery), *IEEE International Conference on Industrial Engineering and Engineering Management*, pp. 919-923.
- Milambo, D., & Phiri, J. (2019). "Aircraft spares supply chain management for the aviation industry in Zambia based on the supply chain operations reference (SCOR) model", *Open Journal of Business and Management*, 7(3), pp. 1183-1195.
- Mochamad, A., & Moh, N. (2016). Application of Supply Chain Performance Measurement in SCOR Model at Building Project. *International Conference on Civil Engineering Research*, 5.
- Nguyen, T. T. H., Bekrar, A., Le, T. M., & Abed, M. (2021, May). Supply chain performance measurement using SCOR model: a case study of the coffee supply chain in Vietnam. *IEEE 1st International Conference On Cyber Management And Engineering (CyMaEn)* pp. 1-7.
- Ramish, A., & Aslam, H. (2016). "Measuring supply chain knowledge management (SCKM) performance based on double/triple loop learning principle". *International Journal of Productivity and Performance Management*.
- Ricardianto, P., Barata, F., Mardiyani, S., Setiawan, E., Subagyo, H., Saribanon, E., & Endri, E. (2022). Supply chain management evaluation in the oil and industry natural gas using SCOR model. *Uncertain Supply Chain Management*, 10(3), pp. 797-806.
- Rodríguez Mañay, L. O., Guaita-Pradas, I., & Marques-Perez, I. (2022). Measuring the supply chain performance of the floricultural sector using the SCOR model and a multicriteria decision-making method. *Horticulturae*, 8(2), pp.168.
- Roque, L. C., Da Silva, R. M., Gauer, G. F., Reis, G. G., & Frederico, G. F. (2021). The impact of COVID-19 on international supply chains looking through the SCOR model. In *2nd South American Conference on Industrial Engineering and Operations Management*, pp. 2413-2424.
- Rosyidah, M., Khoirunnisa, N., Rofiatin, U., Asnah, A., Andiyan, A., & Sari, D. (2022). Measurement of key performance indicator Green Supply Chain Management (GSCM) in palm industry with green SCOR model. *Materials Today: Proceedings*.
- Slack, N., Chambers, S., & Johnston, R. (2010). *Operations management*. Pearson education.
- Subagyo, H., Ricardianto, P., Setiawan, E. B., Simarmata, J., & Pratiwi, S. W. (2022). Supply Chain Performance Measurement of Logistic Business Using SCOR Model in the Indonesian Main Ports. *Engineering and Science*, 5(12), pp. 100-16.

- Sundarakani, B., Abdul Razzak, H., & Manikandan, S. (2018). "Creating a competitive advantage in the global flight catering supply chain: a case study using SCOR model". *International Journal of Logistics Research and Applications*, 21(5), pp. 481-501.
- Supply Chain Operations Reference (SCOR®) model Overview - Version 10.0
- Zhou, Z. (2022). Green Supply Chain Management Model of e-Commerce Enterprises Based on SCOR Model. *Mobile Information Systems*.



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