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SPECIAL ISSUE

**CORPORATE STRATEGIES FOR SUSTAINABLE
DEVELOPMENT AND ADOPTION OF NEW
TECHNOLOGIES**



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Corporate Strategies for Sustainable Development and Adoption of New Technologies

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Introduction

Digital technologies and innovative solutions play a crucial role in promoting sustainable development. However, it is important to acknowledge that these technological advancements may positively and negatively impact sustainability (Gray, 1994; Al-Emran, Griffy-Brown, 2023). In 2015, the United Nations (UN) adopted the 2030 Agenda for Sustainable Development as a plan of action to end poverty, protect the planet, and ensure prosperity for all people worldwide (UN, 2015). The Agenda contains 17 integrated sustainable development goals (SDGs) and 169 specific measurable targets. It emphasizes the private sector's role in facilitating the advancement and achievement of the UN's sustainable development initiatives, working in partnership with governments, civil society, and other stakeholders (UN, 2015). Even before adoption of this agenda, several social, environmental, and technological developments have impacted the operations and functions of companies. One of these developments is the emergence of green sustainability (Gray, 1994; Abbas, 2019), which helped evaluate companies' overall performance and shaped the creation of customer value. The corporate (as well as institutional) responses to the emergence of green sustainability have provided an impetus for companies to develop relevant business models compatible with these developments and to share these models with shareholders and so-

ciety at large. This impetus, in turn, has made it possible to implement sustainable development practices coherently and nurtures a new culture consistent with a large-scale transition to a green, sustainable future.

Digital communications effectively eliminate the geographical boundaries for businesses and their customers, so the latter can quickly contact different suppliers worldwide, and locate substitute goods that fulfil their needs (Singh, 2020; Mather, 2020). This trend has thus made acquiring and maintaining competitive advantage a real challenge for companies. This challenge involves the task of achieving the UN Sustainable Development Goals (SDGs) and aligning business strategies with these SDGs. Hence, companies successfully adopt multiple strategies and generate knowledge to satisfy the needs of their customers and achieve their SDGs.

The private sector's contribution to the achievement of the SDGs can be realized through the integration of principles into corporate strategies and operations. In this context, given that the development and implementation of corporate strategy is the responsibility of the firm-level green sustainability model (including environmental, social, and governance aspects), it is essential to provide an understanding of whether and how, green sustainability models affect or influence the corporate sector's engagement with SDGs (Mangena, 2012; Pirzada et al., 2017).

Overview of the special issue papers

The papers in this special issue examine the corporate strategies for sustainable green development and knowledge generation on SDGs in the context of Asian and Eastern European countries. Summarising the insights from the eight papers included in this special issue we conclude the editorial by offering insights for future research in this area.

The first paper by Tosin Ekundayo, Amiya Bhaumik, Justine Chinoperekweyi, and Zafarullah Khan has assessed the effect of open data implementation as part of its data governance initiatives on entrepreneurial attitudes in Europe and Central Asia. The impact of open data implementation in transforming entrepreneurial attitudes in the mentioned world regions has never been determined or investigated in a measurable form. This study uses regression analysis of secondary data on the Open Data Barometer (ODB) and the Global Entrepreneurship Index (GEI). The paper establishes a causation of the 32% impact of open data implementation on entrepreneurship attitudes toward recognizing opportunities in Europe and Central Asia. This paper advocates for the establishment of a comprehensive national open data initiative as a catalyst for fostering entrepreneurial attitudes within the mentioned world regions. Moreover, it emphasizes the importance for entrepreneurs to cultivate the necessary attitude for achieving their business objectives successfully. The paper recommends further investigation using a recent dataset. The paper's findings improve the understanding of how to induce entrepreneurship attitudes in pursuit of SDGs.

The second paper by Kiet Hong Vo Tuan Truong, Anh Vu Thai Nguyen, Sang Minh Vo and An Thien Vo explores the sustainable consumption of consumers. This topic, and its multi-faceted aspects, have received a lot of attention in many regions and countries worldwide. This study elaborates the issue using data on Vietnamese population. Despite the growing importance of sustainable consumption, marketing managers still lack adequate information on how to promote it to consumers. Truong et al. addressed this gap by examining the impact of environmental knowledge, man-nature orientation, environmental advertising, and demographic factors such as income, major, degree, age, and gender on sustainable consumption intention. An online survey was used to collect data from 460 people in Vietnam. The data was collected, using multivariate linear regression analysis, and other methods. The results revealed that man-nature orientation and environmental advertising positively affect sustainable consumption intention. Furthermore, the study also showed a strong relationship between environmental advertising and male orientation - natural and environmental knowledge. In contrast, the study did not find a relationship between environmental knowledge and sustainable consumption intention. The results provided theoretical and practical implications for marketing managers in developing effective communi-

cation strategies to promote sustainable consumption and encourage environmentally friendly consumption intentions.

In the third paper, Juniati Gunawan, John CG Lee, Aghnia Nadhira Aliya Putri, and Se Tin examined the decarbonization efforts of corporations in Malaysia about the country's national net-zero emission targets. A qualitative approach was adopted, employing two focus group discussions. Thematic analysis was utilized to analyze the collected data. The study sheds light on key decarbonization practices in Malaysian companies, which place greater emphasis on environmental regulatory compliance and cost-saving measures. However, investment in decarbonization remains a small part of overall capital investment and receives little attention from corporate leadership. The importance of addressing the concerns raised by this study is key to realizing Malaysia's Determined National Commitment (NDC) to achieve net zero emissions by 2050. Utilizing novel digital technologies, good corporate governance can contribute toward achieving this goal through proper risk management, encouraging and supporting development, resource management, and management of company business risks.

The fourth paper by Mohd Zulkhairi Mustapha, Zarina Zakaria, Nurliana Md Rahin, and Noor Sakinah Abd Wahab undertook an exploratory study to gain insight among tax and ESG practitioners on the linkage between ESG and tax compliance. This study examines the perception among the parties involved to understand their views on the relationship. Mustapha et al. found a gap between firms and tax regulators and consultants' perception of the link between ESG and tax compliance. There is also an inconsistent perception among sustainability and tax personnel in firms. Interestingly, they found that only the government-linked companies perceived tax compliance as part of social components. Their study implies that there is evidence to support negative and no relationship between tax avoidance and ESG but no evidence to support corporate hypocrisy.

The fifth paper in the special issue is by Kazi Sohag, Rogneda Vasileva, and Shawkat Hammoudeh, unlocking fiscal decentralization's potential to narrow regional economic disparities and ensure sustainable regional development. Fiscal decentralization (FD) is widely regarded as a potent instrument for mitigating interregional economic disparities, yet its impact can be multifaceted, contingent on the unique economic landscapes of various regions. Sohag et al. delved into the ramifications of FD on the economic disparity among Russian regions. They revealed that FD tended to be more effective when regional disparities were relatively modest. Additionally, the efficacy of FD was closely linked to the political affiliations of regional leaders. Notably, their findings highlight stark differences in the effects of FD between developing and developed regions. To harness the full potential of FD in the former, a tailored set of policy measures is impera-

tive. Based on the empirical investigation, the authors provided several policy implications. The counterproductive role of fiscal decentralization in reducing disparity for the weak regions implies that those regions should find market solutions to boost their economic performance to catch up with the wealthy regions. Besides, fiscal support from the central government should be utilized for purely public goods and merit goods. Fiscal support should be tied to fair accountability, transparency, and a budget implementation plan. Moreover, the decrease in the equalization transfer from the central budget can motivate the regions to seek new economic opportunities for sustainable economic development. Since natural resources are the prime factor for a higher regional disparity, the federal government should revise the distribution policy of resource rents for holistic economic development. Finally, the distribution of the national budget among the regions should be free from political nepotism to ensure more inclusive economic development.

The sixth paper by Meiryani, Dezie Leonarda Warganegara, and Vidhiya Andini aims to reveal the development of research, author status, references, relationship networks, country status, research institutions regarding big data, artificial intelligence, machine learning, and blockchain in corporate governance. The authors combined qualitative analysis (interpretation only) and quantitative analysis (evaluation and interpretation) to conduct bibliometric network analysis of research on emerging technologies that showed growing research interest to the topic. The use and utility of big data, artificial intelligence, machine learning, and blockchain technologies applied to corporate governance can improve efficiency, transparency, and security in decision-making.

The seventh paper by Helena Knyazeva, Marina Boykova, and Mikhail Salazkin argued that the challenges future researchers would face are particularly complex, interconnected, contradictory, and cannot be resolved by linear approaches. Forecasting science needs tools that match the new contextual complexity, allowing it to capture a much more comprehensive range of drivers and their potential effects in a non-linear perspective to improve the accuracy of forecasts and the quality of strategies. Knyazeva et al., through a retrospective analysis of predictive science and foresight, revealed the prerequisites for their enrichment with the concepts of complexity science. Current foresight competencies were described. Cases were presented that could become a practical guide in mastering the creative potential of complexity in particularly unstable periods. Attention was paid to the emerging megatrend – the growth of deglobalization processes that could radically affect the implementation of strategies developed in previous years. The key conclusion that followed from the presented analysis could be formulated in a promising message: when skillfully working with complexity, great potential for creative development was revealed.

The eighth and final paper by Diana Koroleva, Tatiana Khavenson, Daria Tomasova focuses on the genesis and predictive ability of ecosystem approach. In recent decades, the education landscape has been progressively diversifying worldwide, including an influx of various new participants and the emergence of new products, technologies, and institutional configurations. This global trend triggers a debate on the emergence of comprehensive education ecosystems; however, the understanding of the latter remains fragmented and unstructured. This hinders the scholarly discourse and impedes the predictive potential of the ecosystem approach. This paper aimed to identify education ecosystems' attributes, characteristics, and patterns, and proposed an ecosystem approach to studying and modelling both transformation processes in education, and the shift towards sustainable development in this domain. Koroleva et al. contributed to the conceptualization of education ecosystems based on the principles of open and dynamic social systems. It emphasizes stakeholders' coevolution, a high degree of resource and competency complementarity, participation, and collaborative competition in the creation of innovative educational products. To accomplish the paper's objectives, Koroleva et al. have analysed the genesis of the education ecosystem concept, traced its continuity with the triple, quadruple, and quintuple helix models and with the innovation ecosystem concept. Consequently, a methodology for applying the ecosystem approach in foresight studies was proposed, as well as for co-designing strategies to accomplish the sustainable development goals in the education domain. Among other things, the ecosystem approach can be applied to identify data sources, interpret future signals, and describe the subject of a foresight study. Thus, Koroleva et al. affirmed the validity of the ecosystem approach for modelling novel stakeholder interaction formats, delineating the coevolution of social, economic, technological, and cultural trends, and setting fair and socially important priorities for advancing the education domain.

Conclusion

Technological advancements might have positive or negative impacts on sustainability. It's essential to understand the adoption of these technologies to achieve better sustainability. The United Nations 2030 Agenda and the associated SDGs have been promoted as tools suitable to alleviate poverty, protect Planet Earth, and contribute to worldwide prosperity (UN, 2015; Tsalis, 2020). But governments alone cannot achieve sustainable development; they must be supported by the private sector, which plays a colossal role in advancing and achieving the SDGs. Specifically, the private sector can integrate the 'green' principles into their corporate strategies. This integration depends on, and requires, an effective approach to green development and the knowledge generation of SDGs as embedded in the

companies' functions, values, and day-to-day operations. The papers in this special issue investigate the role of corporate strategies for sustainable green development and knowledge generation in the implementation of the SDGs or principles by Asian and Eastern European companies from Malaysia, Vietnam, Indonesia, Emirates, Zimbabwe and Russia. Hence, there is a need to expand the research in further studies to gauge the contribution of corporate strategies towards the achievement of the SDGs in a wider group of countries. These further studies could also focus on a comparative cross-country analysis to provide insights into how institutional differences among countries influence the implementation and achievement of the SDGs. In addition, there is also a need to understand the role of other corporate strategies, including integrated reporting and long-term value, in the achievement of the SDGs. It is a matter of great importance for companies to explain how businesses create value for their key stakeholders in the long term by implementing the SDGs.

The insights drawn from this special issue contribute to the existing literature and provide valuable practical information for practitioners, policymakers, and developers. Practitioners can rely on the insights provided in this special issue to make informed decisions that consider both the short-term and long-term impacts of technology solutions and their adoption in organizations. They need to consider the opportunities and challenges associated with technology adoption and develop plans to mitigate the negative impacts and maximize the positive effects of technology adoption. Additionally, policymakers can use the findings of the eight papers to establish policies and regulations that encourage the adoption of sustainable technologies that serve society while minimizing the negative impacts on the environment, economy, and the general public. Further, developers can consider the barriers identified in the analysis to develop more effective solutions. They can also incorporate sustainable practices into the development process to ensure their technologies align with sustainable development principles.

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SUSTAINABLE DEVELOPMENT



The Impact of Open Data Implementation on Entrepreneurial Attitude with Regard to Moving towards UN Sustainability Goals

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Abstract

This study aimed to investigate the impact of open data implementation as part of data governance initiatives on entrepreneurial attitudes in Europe and Central Asia. Such has never been determined or investigated in a measurable form. Using regression (OLS) analysis of secondary data on the open data implementation index from the Open Data Barometer (ODB) and the Entrepreneurial Attitude index from GEI, this study investigates the impact of open data implementation (as a national data governance strategy) on entrepreneurial attitudes in Europe and Central Asia. This study introduces a novel approach that advances our understanding of sustainable development goals. The study establishes a

causation of the 32% impact of open data implementation on entrepreneurship attitudes toward recognizing opportunities in Europe and Central Asia.

This study advocates for the establishment of a comprehensive national open data initiative as a catalyst for fostering entrepreneurial attitudes within Europe and Central Asia. Moreover, it emphasizes the importance for entrepreneurs to cultivate the necessary attitudes for achieving their business objectives successfully. The study recommends further investigation using a recent dataset. The study's findings improve the understanding of how to induce entrepreneurial attitudes in Europe and Central Asia in pursuit of post-pandemic economic development.

Keywords: data governance; open data implementation; open data; entrepreneurship attitude; entrepreneurship

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Introduction

This study aims to investigate and gauge the impact (in numerical measurements) of open data implementation as part of a data governance strategy on entrepreneurial attitudes in Europe and Central Asia. The findings will create an opportunity to leverage open data implementation as an inducing factor for entrepreneurs' attitudes toward economic progress in a particular region. Entrepreneurial attitude is defined as the general sense of a country's population toward recognizing entrepreneurial opportunities (Acs, Szerb, 2010). This is also significant in the wake of the asserted failure attributed to the EU's Lisbon strategy. The Lisbon strategy represented a planned course of action in March 2000 to achieve ambitious targets and more concerted action across different EU member states and institutions by 2010. Economic renewal as one of Lisbon's strategic objectives were not fulfilled, as expected, due to lack of implementation, a long implementation period, and lack of coordination (Nam et al., 2021).

Potential findings will be significant to economic policymakers, practitioners, and potential entrepreneurs in Europe and Central Asia, especially in pursuit of UN-SDG8 objectives 8.1 and 8.2. Economic policymakers will be able to develop and deploy an open data implementation framework, policy, and principles that stimulate economic renewal by inducing the required entrepreneurial attitude in pursuit of current and future objectives in the region. Practicing entrepreneurs will identify potential sources of motivation for creative and innovative attitudes in pursuit of entrepreneurial success. Existing entrepreneurs will identify the basis on which attitudes are formed in pursuit of entrepreneurial success, risk reduction, and avoiding business failure (Ekundayo et al., 2023). As key stakeholders of the UN-SDG8, developing the right entrepreneurial attitude in the region will help prime entrepreneurship and behavioral intent contained within the respective polities.

The Sustainable Development Goals (SDGs)

The Sustainable Development Goals (SDGs) of the United Nations (UN) address some of the most important problems the world is currently experiencing. These challenges include poverty, gender inequality, environmental degradation, climate change, peace, and justice. Goal 8 of the UN-SDGs is about unprecedented work and economic growth. As declared by the UN, achieving this objective is not only a fundamental human right, but also a requirement for a world that is peaceful, prosperous, and sustainable (Kota et al., 2021). In pursuance of the UN-SDG8 objectives, the UN set relative targets. One of such targets is to maintain per capita economic growth in accordance with local conditions, with the least developed countries' GDP growth rate needing to be at least 7% annually (8.1). Another target is to increase economic productivity through innovation, technical advancement, and sector-specific attention to high value-added and labor-intensive industries (8.2). Thus, it is pertinent to investigate the variables that contribute to these targets relative to the UN-SDG8 (Fonseca et al., 2020). As a commitment to these global objectives, nations are identi-

fying comparative advantages, variables, and sub-economic elements that can be leveraged to boost their pursuit and achievement of these objectives (Fonseca et al., 2020). Biomass (Blair et al., 2021), renewable electricity (Swain, Karimu, 2020), circular economy framework (Schroeder et al., 2019), and the construction industry (Fei et al., 2021) are some of variables and sub-economic elements that have been leveraged in pursuit of SDG objectives and targets. This study argues that open data implementation is a valuable variable in Europe and Central Asia.

A key objective for this study is to validate the theory of planned behavior (TPB) (Ajzen, 1991) using an experimental strategy. Ajzen's (1991) Theory of Planned Behavior posits that behavioral intention is a function of a person's motivation and influences. It argues that motivations and influences over time are impacted by the attitudes, abilities, and subjective norms of individuals (Ajzen, 1991). According to this theory, attitude, ability, and subjective norms are often induced by background variables across various human endeavors.

Empirical review and analysis show that, while attitude is a construct that is generally complicated to measure, it represents a person's behavior toward compliance with a concept (Carmi, Bouhnik, 2020). Attitude, as a reflection of who we are, is an outcome of the integration of both internal and external variables within the context of a person's existence (Carmi, Bouhnik, 2020). Some of these factors are family, peer groups, and religion (Rosado-Cubero et al., 2022). Attitudes are expressed in terms of words, beliefs, and behaviors. However, differences in geographical location mean that internal and external factors that formulate entrepreneurial attitude, as indicated by the Theory of Planned Behavior (TPB), also differ. Thus, it is important for stakeholders to investigate the factors that influence entrepreneurship attitudes toward economic development in a particular region.

This study questions the role of open data implementation in shaping entrepreneurial attitudes towards establishing their own entities in Europe and Central Asia. According to the Open Data Barometer (ODB), Open Data Implementation is the extent to which accessible, timely, and open data are published by each country's government in the key 15 economic sectors (Likhacheva, 2020). According to the Global Entrepreneurship Development Index (GEDI), entrepreneurial attitude is the general sense of a country's population toward recognizing opportunities, knowing entrepreneurs personally, attaching high status to entrepreneurs, accepting the risks associated with a business start-up, and having the skills to successfully launch businesses (Inacio Junior et al., 2021). This study aims to ascertain the impact of open data on entrepreneurial attitudes. Investigating this nexus may help identify a key element in achieving the Sustainable Development Goals (SDGs), more specifically, SDG8.

Background Information

The categorization and focus on the countries of Europe and Central Asia is a broad approach—from Western, Northern, Eastern, and Southern Europe to Central Asia at various

levels in order to identify progress toward the Sustainable Development Goals, particularly SDG8. It also encompasses both EU and non-EU countries, offering insight into how open data implementation might impact entrepreneurial attitudes. This comprehensive approach will provide a nuanced understanding of the role of open data in fostering entrepreneurship infrastructure across these regions.

Entrepreneurship Attitude in Europe and Central Asia

Europe is considered a continent and subcontinent of Eurasia and is located in the Northern and Eastern Hemispheres. With a population of 446.8 million as of 2022 (according to Eurostat), it shares continental landmass of Afro-Eurasia with both Central Asia and Africa. According to the European Institute of Innovation and Technology (EIT), a body of the EU, Europe needs more entrepreneurs because the economic outlook is likely to undergo dynamic changes by 2030 (Leceta, Könnölä, 2021). Central Asia is a subregion of Asia. This region had a population of 77 million by 2022 (according to the UN). It encompasses several former Soviet republics. Only one-third of the entrepreneurs in Central Asia are women (Franzke et al., 2022). It is thus important that the region's female demography as much as other demography are recognized as the region's human capital capability relative to entrepreneurial impact. However, for entrepreneurship to increase in this region, it is important that entrepreneurial attitudes be consciously induced to create behavioral intentions in pursuit of entrepreneurial opportunities and economic development (Ekundayo et al., 2023). In line with this, the Theory of Planned Behavior (TPB), inducing the behavior of persons in the region, would potentially provide a competitive edge in their pursuit of an updated Lisbon strategy and the current SDG 8 objectives.

Global entrepreneurship practices have been investigated, assessed, and indexed using the Global Entrepreneurial Development Index (GEDI). The GEDI 2018 (pre-pandemic) report posits that entrepreneurship practice in the EU's 26 of 28 member countries is lagging compared to that in the United States. The report cites the region's dwindling entrepreneurial attitudes in recent times as the root cause of this trend (Acs et al., 2018).

Understanding this regional variation in entrepreneurial attitudes in Europe forms the subject of a previous study (Bosma, Schutjens, 2011). Using data from the Global Entrepreneurship Monitor (GEM) for 127 regions across 17 European countries, the authors highlight that urban cities and regions in Europe tend to exhibit relatively high rates of early-stage entrepreneurship. The study further breaks down entrepreneurial attitudes into three dimensions in line with the GEM model, asserting that understanding these attitudes generally influences entrepreneurship. This underscores the need for varied instruments at different spatial scales and at different stages of entrepreneurship in order to foster the appropriate entrepreneurial attitudes for each stage and region. Nevertheless, Bosma & Schutjens (2011) do not identify the specific factors that contribute to the devel-

opment of entrepreneurial attitudes, despite acknowledging the significance of those attitudes in the early stages of entrepreneurial activity. In a different vein, Draghici et al. (2014) critique the EU's strategy for a knowledge-based economy aimed at fostering economic development. They argue that the strategy has not lived up to expectations, attributing this failure to the region's neglect of variables that stimulate entrepreneurial attitudes. The authors contend that the EU has not treated entrepreneurial attitude as a valuable asset or knowledge worth inducing or leveraging. Their position is substantiated by a regression analysis of entrepreneurial attitudes and activities indexing data sourced from the GEM. The findings reveal a positive correlation between entrepreneurial attitudes and activities within the EU. Consequently, the authors cite the disregard for entrepreneurial attitude as a key reason for the failure of the region's Lisbon strategy. However, similar to (Bosma, Schutjens, 2011), Draghici et al. (2014) do not identify the specific factors that can induce the appropriate attitudes for entrepreneurial activity.

Rusu and Roman (2017) make a compelling case that within the European Union, financial and economic aspects (such as access to credit, inflation rates, foreign direct investments, and total tax rates), significantly impact attitudes toward entrepreneurship. The emphasis on these factors has sparked a growing concern among stakeholders about the impact on existing and potential entrepreneurs. The quest to rekindle entrepreneurial attitudes in the face of these economic and financial determinants has therefore become a priority. However, while Rusu and Roman's research brings to light the economic and financial sub-elements that shape entrepreneurial behavior and attitudes, it does not delve into factors outside the financial sphere. This presents a void in comprehension, particularly because the Theory of Planned Behavior promotes a more encompassing perspective, proposing that the determinants of behavioral intentions span a wider variety of variables, not those strictly limited to economic or financial factors. Another important dimension comes to the fore in the work of (Bjerde, 2022), who argues that despite women constituting a significant proportion of human capital in Europe and Central Asia, they are considerably underrepresented in entrepreneurial activities. This raises critical implications about the need to effectively stimulate female entrepreneurial attitudes in order to contribute to economic revitalization in the region. Bjerde's findings further underscore the potential economic benefits of increased female participation in entrepreneurship, suggesting that such inclusion could potentially enhance GDP by 23%.

Overall, entrepreneurial attitudes have been identified as having an impact on entrepreneurship development, however factors inducing entrepreneurial attitudes have not been sufficiently investigated in the EU as it pursues its economic, Lisbon, and SDG8 objectives. This study investigated the impact of open data implementation as a leveraging element to induce entrepreneurial attitudes in Europe and Central Asia. If entrepreneurial attitudes can be effectively induced, Bosma and Schutjens (2011), Draghici et al. (2014), and the Theory of Planned Behavior can be validated accordingly.

Technology, Data and Entrepreneurship in EU

The nexus between technology, data, and entrepreneurship is a matter of constant debate, relative to expectations. For entrepreneurial ventures to sustain their impact on economic advancement in the modern economy, there is a need to continuously use technology and the data it provides to shape the attitudes of entrepreneurial stakeholders relative to the matters at hand. As Europe is one of the most technologically advanced regions in the world, the role of technology in entrepreneurial sustainability cannot be overemphasized. A noticeable effort to shape entrepreneurial/business attitudes in the region is the EU's General Data Protection Regulation (GDPR). The EU's regulatory framework, the General Data Protection Regulation (GDPR), is a guide for the formulation of data attitudes (Aseri, 2020). The European Union enacted the GDPR in 2015 to assert the use of personal data for creative purposes. This has become a model for the rest of the world (Zaeem, Barber, 2021). This encourages transparency in data implementation processes (Aseri, 2020). It ensures the correct use and deployment of open data because there is the possibility of incorrect use (Rhahla et al., 2021; Zaeem, Barber, 2021). The government's interest in regulating data implementation for business uses is not only for security; it is also to harness the potential of its economic contributions, thereby validating its key role in business and economic development (Li et al., 2019). Coincidentally, it could provide an opportunity for the region to shape the entrepreneurial behavior (via data behavior route) toward other economic objectives, such as the entrepreneurial attitudes toward the foundation, success, and sustainability of ventures. Therefore, it is important to determine how emerging concepts such as open data implementation, a sub-element of technology and data attested to and governed by the EU's GDPR, play a crucial role in the formation and expression of entrepreneurial attitudes (Tamburri, 2020). Understanding echnology, data, and entrepreneurship in EU allows this study to explore how data and technology interface with entrepreneurship in the European context, informing potential mechanisms by which open data might impact entrepreneurship.

Open Data and Entrepreneurship in Central Asia

Kossow (2016) provides a comprehensive analysis of open data initiatives in Eastern Europe and Central Asia (EECA), particularly focusing on their role in promoting peaceful, just, and inclusive societies, as prescribed by the Sustainable Development Goal (SDG) 16. The analysis consists of over 40 interviews with experts in Albania, Georgia, and Moldova. The experts include representatives from government agencies, civil society organizations, and technical experts. The interviews focused on the availability and utility of open data, and its contribution to transparency and government accountability. Apart from expert interviews, the study also provides an overview of government data available in open formats and an evaluation of the impact of open data on transparency and accountability. The analysis provides policy recommendations for promoting open data initiatives in the region. Kossow's study stresses the significance of open data implementation in enhancing transparency and gov-

ernment accountability and in fostering citizen engagement in economic activities such as entrepreneurship (Kossow, 2016). The study's extension by further exploring the influence of open data on entrepreneurship is a connection noted by the authors, however it was not elaborated upon.

Another study by Bespalyy et al. (2021), explores the expansion of social entrepreneurship in Kazakhstan, pinpointing the factors that drive this growth. Their quantitative analysis delves into the primary reasons for the emergence of social enterprises, revealing how these factors interact. The methodology of this study, grounded in economic and mathematical principles, forms a comprehensive analysis of social entrepreneurship in Kazakhstan, a key country in the region. By employing several economic indicators such as unemployment rates, population income levels, social protection expenditure in GDP, per capita GDP, and the consumer price index, Bespalyy et al. bring to light the diverse factors influencing the evolution of social entrepreneurship in the wider region. This study's insights fill an existing gap in our understanding of entrepreneurship in Kazakhstan and contribute to the current research by exploring the role of open data implementation in transforming entrepreneurial attitudes.

Seitzhanov et al. (2020) scrutinized the influence of the state's innovation policies on the innovative behaviors of business entities in Kazakhstan, underscoring the scarcity of empirical studies focusing on the micro-level impact of public policy. The study established the groundwork for a deeper exploration into the effects of public policy (on open data) on entrepreneurial activities within the region. This present research builds upon this groundwork, focusing specifically on how open data implementation, as a distinct data governance strategy, molds entrepreneurial attitudes across Europe and Central Asia. The potential insights from this study could provide valuable guidance to policymakers grappling with these pressing challenges. By weaving together three key threads—open data initiatives, entrepreneurial attitudes, and sustainable development—particularly with respect to Central Asia, this study adds a unique dimension to both the scholarly discourse and practical considerations surrounding these themes. Examining open data and entrepreneurship in Central Asia provides specific regional context and reveals the current state of open data practices and their relation to entrepreneurship, highlighting the areas where the study's findings may be most impactful.

Data Governance, Open Data and Open Data Implementation

Data governance represents a nation's regulatory framework for ensuring that data are accessible, timely, and usable (Mao et al., 2022). It incorporates activities such as Data Knowledge, Data Ownership, Data Quality, Data Accessibility, and Data Security to induce a data-centered attitude while ensuring that the use of data is successful. Open data is a data governance strategy that provides frameworks and principles to meet relative data objectives within a business or state (Corrales-Garay et al., 2020). Open data implementation became a practice as a data governance strategy after the Open Data Charter (ODC) themed conference in 2015,

spearheaded by the G7 nations. ODC stakeholders appointed the Open Data Barometer (ODB) as the official non-profit-making organization to evaluate 150+ nations and the organization's commitment to the agreed-upon, six (6) open-data principles. The goal was to tackle government corruption and to encourage transparency in global development. For an effective performance evaluation of ODC principles, ODB developed a methodology for the assessment of open data commitments within member countries, entities, and stakeholders. The methodology measures open data under a tri-subindex, namely open data readiness, open data implementation, and open data impact. Open Data readiness is the commitment of states, citizens, and businesses to pursuing open data; open data implementation is the scope, accessibility, and timeliness according to which open data for 15 listed key economic sectors is published; and Open Data Impact refers to the extent to which there is evidence that open data released by the country's government has had a positive impact upon different domains in the country (European Commission, 2021). ODB posits that this methodology provides simplicity to an otherwise complex data governance strategy that is regarded as 'open data.' However, as with previous studies, it creates a basis to measure this study's Independent Variable (IV) – "open data implementation." Familiarity with data governance, open data, and open data implementation provides a broad understanding of the principles, practices, and processes around open data, helping to frame how these can be implemented in the entrepreneurial sphere across Europe and Central Asia.

Conceptual Framework and Hypothesis Development

This study is based on the Theory of Planned Behavior, first known as the Theory of Reasoned Action. It was authored and formulated by Azjen et al. (1985). It proposes that a person's motivation to engage in a specific behavior is affected by three factors. More specifically, the theory hypothesizes that behavioral intent is a function of behavioral, normative, and control-belief systems. While behavioral beliefs represent personal nuances that form an individual's attitude, normative beliefs represent attitudes that are peculiar and different from the individual; control beliefs refer to abilities that can be controlled by the individual. The theory posits that to form behavioral intention in pursuit of an entrepreneurial objective (for instance), all these belief frameworks are induced by several background variables divided into a tri-spectrum, namely personal, social, and information, as shown in Figure 1.

In line with Ajzen's Theory of Planned Behavior (TPB) (1991), this study posits that the implementation of open data can significantly influence an individual's entrepreneurial intent and attitude, shaped by three primary factors: experience, knowledge, and media exposure. Individuals with experience in accessing, interpreting, and manipulating open data are expected to encounter fewer barriers in its use for entrepreneurial purposes. Knowledge enhancement, defined as a comprehensive understanding of the benefits and potential applications of open data, can foster positive entrepreneurial attitudes. Strategic media exposure

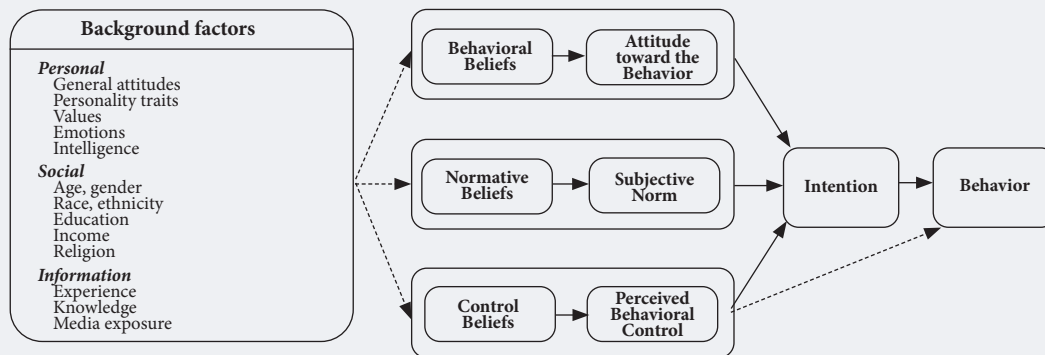
regarding open data, particularly through showcasing success stories of entrepreneurs who have benefited from it, can provide role models and cultivate a narrative that utilizing open data is a common and esteemed entrepreneurial practice. This combination of factors could stimulate the development of an entrepreneurial mindset, consistent with the principles of Ajzen's Theory of Planned Behavior.

Relative to this theory, several studies have attempted to investigate factors that contribute to entrepreneurial attitudes that determine entrepreneurial intentions (Yoon et al., 2011; Israr, Saleem, 2018; Izquierdo, 2013; Fragoso et al., 2019; Manneh et al., 2020; Melhem, Al-shaikh, 2018; Muhammad et al., 2015; Weiss, 2015).

In an empirical study, Tong et al. (2011) applied convenience sampling techniques and multiple regression analysis to investigate the influences underpinning the formation of an entrepreneurial attitudes among students. The study sample consisted of students from four distinct universities, which provided a range of perspectives and backgrounds to broaden the scope of their findings. The results indicate that entrepreneurial attitudes, and by extension, entrepreneurial intentions, are significantly shaped by factors such as the perceived potential for achievement and family business backgrounds. This, in turn, substantiates the Theory of Planned Behavior, suggesting that personal background variables are instrumental in fostering an entrepreneurial disposition, which can subsequently be channeled into entrepreneurial intentions. In the context of the study, the findings of Tong et al. (2011) underscore the importance of understanding factors that foster an entrepreneurial attitude. The results highlight the relevance of individual-level influences such as family background and achievement motivation, which are key variables that can shape entrepreneurial attitudes. This understanding is critical for the analysis of the effects of open data implementation on entrepreneurial attitudes in the specified regions. This could potentially provide insights on how open data implementation might interact with these individual-level factors to influence entrepreneurial attitudes, thereby contributing to the achievement of SDG 8.

Weiss (2015) embarked on an insightful research journey to unravel the factors that drive the intent behind entrepreneurial and creative attitudes. This study targeted Dutch and Indonesian students, establishing a cross-cultural landscape that enriched the diversity of the findings. The research underscored the roles of entrepreneurship education and a desire for success as pivotal elements in the formation of entrepreneurial attitudes that eventually culminate in entrepreneurial intentions. The Theory of Planned Behavior was leveraged to frame these findings, positioning entrepreneurship education as a social background variable that influences behavioral beliefs (attitude), normative beliefs (perception), and control beliefs (ability). Relative to this study, Weiss (2015) offers pertinent insights. The role of entrepreneurial education, as highlighted in Weiss's study, suggests the necessity of understanding the complex interplay between open data implementation and the educational structures that foster entrepreneurial attitudes in the target regions. The study emphasizes the importance of educa-

Figure 1. Theory of Planned Behavior



Source: authors.

tional and motivational factors in shaping entrepreneurial attitudes, which might be relevant when exploring the influence of open data practices on the same. Additionally, the application of the Theory of Planned Behavior could help understand how the introduction of open data can impact social background variables, subsequently affecting entrepreneurial attitudes and intentions. This could provide valuable insights into the ways open data implementation could contribute to achieving SDG 8 in Europe and Central Asia.

Israr and Saleem (2018) embarked on a research investigation to understand entrepreneurial intentions among Italian university students. The crux of their study was to comprehend the reasons behind the inclination of these students toward employment rather than seizing entrepreneurial opportunities within Italy. The study used primary data collection methods and multiple regression analysis to ascertain the key factors influencing these preferences. The findings indicate that family background, entrepreneurial education, gender, extraversion, agreeableness, and openness to experience are key contributors to the development of entrepreneurial attitudes, which subsequently impact entrepreneurial intentions. Interestingly, variables like age, previous academic performance, and neuroticism were found to have no significant influence on entrepreneurship trends in the Italian context. The study accentuates the importance of background factors, including social and personal variables, in shaping behavioral beliefs (attitudes), normative beliefs, and control beliefs (abilities) that drive behavioral intentions in Italy. The findings of Israr and Saleem (2018) contribute significant insights. The study underscores the roles of various factors like family background, entrepreneurial education, personality traits, and gender, which influence entrepreneurial attitudes and intentions. This understanding is instrumental when analyzing how the implementation of open data could interplay with these factors to shape entrepreneurial attitudes in Europe and Central Asia. The highlighted importance of social and personal background variables aligns with the Theory of Planned Behavior, providing a comprehensive framework to analyze the effects of open data implementation on the formation of entrepreneurial attitudes. This could, in turn, provide insights into

how open data initiatives could contribute to the achievement of SDG 8 in these regions.

In another 2020 study, Manneh et al. (2020) delved into the exploration of factors that shape entrepreneurial intentions among university students in Gambia, Western Africa. The study found that the business environment significantly influences students' attitudes toward entrepreneurial intentions. This finding adds weight to the Theory of Planned Behavior, as it underscores the role of social background variables – in this case the business environment – in shaping behavioral beliefs (attitude), normative beliefs, and control beliefs (ability). The research carried out by Manneh et al. (2020) places emphasis on the business environment as a crucial factor influencing entrepreneurial attitudes and intentions and further highlights the need to consider the influence of external business conditions when examining the impact of open data implementation. It suggests that the effects of open data on entrepreneurial attitudes might not be isolated, but rather intertwined with broader business environmental factors. This understanding can help one analyze how the implementation of open data interacts with the existing business environment in Europe and Central Asia to shape entrepreneurial attitudes and contribute to the achievement of SDG 8. The study reinforces the Theory of Planned Behavior, providing a robust theoretical framework for understanding the multifaceted influences on entrepreneurial attitudes.

Mansour and Omer (2020) delved into the investigation of how societal attitudes and perceptions shape individual behavior within Sudan's entrepreneurial landscape. This research contends that both personal and social background factors spur the formation of attitudes which, in turn, have an influence on entrepreneurial behavioral intentions within the Sudanese context. While this study reinforces the principles of the Theory of Planned Behavior, it does not specifically identify any background elements that contribute to this relationship. The research emphasizes the role of societal attitudes and perceptions, as well as personal and social background factors, in shaping entrepreneurial attitudes and behavioral intentions. This understanding is crucial when examining how the implementation of open data

may interact with societal attitudes and personal and social background factors to influence entrepreneurial attitudes in Europe and Central Asia. Even though Mansour and Omer did not identify specific background elements that contribute to this relationship, their research raises interesting questions about what other factors might be at play, including the potential role of open data. Furthermore, their validation of the Theory of Planned Behavior offers a theoretical lens through which the potential effects of open data implementation on entrepreneurial attitudes can be examined.

Wasilczuk et al. (2021) evaluated the entrepreneurial competencies and intentions of students at technical universities. The research spans five countries – Poland, Ukraine, Latvia, Bulgaria, and Lithuania, thereby providing a number of diverse perspectives. The primary data analysis revealed that the educational framework of technical universities does not inherently discourage entrepreneurial attitudes and intentions. Rather, it was observed that students possessing entrepreneurial attitudes and abilities tend to actively pursue entrepreneurial opportunities and intentions. While this study lends further support to the Theory of Planned Behavior, it does not pinpoint any specific background factor as contributing to this observed relationship. However, the findings of Wasilczuk et al. (2021) offer several valuable insights. The research underscores that the educational framework – in this case, of technical universities – does not necessarily obstruct entrepreneurial attitudes and intentions. This suggests potential for open data implementation within educational systems to influence entrepreneurial attitudes and intentions in Europe and Central Asia, even in technical domains. Additionally, the finding that students with entrepreneurial attitudes and abilities tend to pursue entrepreneurial opportunities and intentions highlights the importance of fostering such attitudes and abilities, possibly through open data implementation. Although Wasilczuk et al. did not identify a specific background factor contributing to the relationship, their research hints at the role of other unexplored factors, potentially including open data, in influencing entrepreneurial attitudes. This validation of the Theory of Planned Behavior provides a theoretical basis for understanding the complex interactions between these factors.

An empirical analysis of these studies shows that it is common to study the impact of background factors on attitude formation and development, from both personal and social perspectives. Studies investigating the information background (via open data) route as a factor inducing entrepreneurship attitudes are rare, indicating a gap in investigating the impact of information variables (sourced from open data) on entrepreneurial intentions. Almost no study has assessed the factors that impact entrepreneurial attitudes across a combination of Europe and Central Asia. As such, this study conceptualizes that open data implementation, as a source of information for potential entrepreneurs, is a potential impacting background factor on entrepreneurship attitudes in Europe and Central Asia, as shown in Figure 2.

This study hypothesizes the following:

H1: Open data implementation has a positive impact on entrepreneurial attitudes in Europe and Central Asia.

Methodology

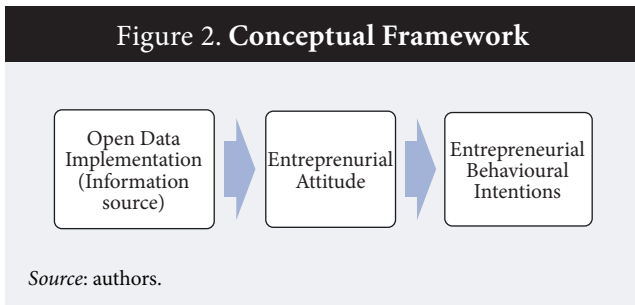
Research Design

The aim of this study was to investigate the impact of open data implementation on entrepreneurial attitudes in Europe and Central Asia. The research design is based on that described by Saunders et al. (2007). These potential findings aim to provide an opportunity for stakeholders to leverage open data implementation in pursuit of the development of entrepreneurship attitudes in Europe and Central Asia.

To perform an investigative experimental study on this nexus, indexing data for Open Data Implementation and Entrepreneurship attitudes were sourced from 36 countries in Europe and Central Asia. An applicable research philosophy is positivism (the epistemological branch of philosophy). Positivist philosophy supports statistical examinations based on quantifiable observations. This philosophy posits that the result of scientific knowledge derived from a scientific process such as an experiment is valid and acceptable. An experimental research strategy provides a framework for testing the causal effects of phenomena (Saunders et al., 2007). This study experimentally tests the causal effect/relationship between open data implementation (as a data governance strategy) and entrepreneurship attitude. The open data implementation and entrepreneurship index dataset for this experimental test were sourced from the Open Data Barometer (ODB) indexing website and Global Entrepreneurship Development Index (GEDI) website, respectively. Both the ODB and GEDI use a combination of secondary and primary data sources to formulate their indices.

The Open Data Barometer indexing methodology uses a tri-secondary data sourcing framework, such as expert surveys, government self-assessments, and secondary data from the UN and World Bank, for its data collection and indexing in pursuit of its open data evaluations. This framework collects 15 types of data from each of its indexing countries, ranging from issues of data availability, format, license, and timeliness to discoverability (WWWF, 2018). On the other hand, the GEDI framework gathers information on the attitudes, abilities, and aspirations of people living in a specific area and compares them to the available resources and infrastructure, such as internet access and transportation to other markets. This GEDI analysis results in 14 factors framework, deployed to evaluate the strength of a country's entrepreneurial environment. Both sets of data cover a 12-months period to create an annual report, making this study's time horizon cross-sectional (Steenekamp et al., 2018).

The quantitative nature of the dataset and the cross-sectional and philosophical paradigm of positivism primes the study of an experimental approach (Melnikovas, 2018). As we aim to validate the hypothesis by assessing the relationship between the variables, this study's reasoning is deductive. Deductive reasoning supports the validation of hypotheses and theories. This form of reasoning denotes general-to-specific reasoning. In contrast, inductive reasoning supports the development of theories.



Data analysis – Model Construction

Developing a model to investigate the impact of open data implementation on entrepreneurship attitudes in Europe and Central Asia will be constructed in several stages.

First, matching datasets were selected for the understudied region to meet the correlation and regression requirements for the econometric analysis. Thus, only nations with open data implementation and entrepreneurship attitude indices in Europe and Central Asia were selected. Countries with no reciprocating index were eliminated to create a balanced dataset for the analysis. This process included 36 European and Central Asian countries suitable for this experiment.

The variables employed in this study are as follows:

1. Open Data Implementation – ODI
2. Entrepreneurial Attitude – EAT

More details on these variables are presented in Table 1.

Second, this study implemented a correlation analysis between ODI and EAT to establish a relationship, if any.

Third, a regression analysis was conducted. This is to determine the causation (cause and effect) relationship between open data implementation and entrepreneurial attitudes in European and Central Asian countries. The ordinary least squares (OLS) model is considered suitable for inferring this relationship because it meets key criteria (Lee et al., 2022).

1. Indication of independent variables (IV) as X and dependent variable (DV) as Y. See Appendix 1¹.
2. The X and Y combinations showed random patterns on a scattered plot. See Figure 4.
3. The skewness of the Y-value falls between – 3 and + 3 and the kurtosis falls from – 10 to + 10. See Table 2
4. Variables should be measured using continuous data. They often carry decimal points, with the number stretching as far out as possible. See Appendix 1
5. Variables should be considered eligible for regression analysis. See Table 3

As such, the regression model is as follows

$$Y = a + bX \tag{1}$$

where Y is EAT representing the unknown intercept of any country (Entrepreneurship Attitude); a is the intercept; b is the coefficients for every independent variable obtained

from the ODI index; X represents the level of ODI that guarantee a level of EAT

Due to the size of the dataset, regression type and the simplicity of presenting the results, as shown on Appendix 1, Microsoft Excel is used for this study’s correlation and regression analysis. An alternative inferential analysis tool is SPSS and Python programming software. Regardless of analysis software, the outcome remains unchanged.

Results and Discussion

Descriptive statistics

Table 2 shows the descriptive statistics indicating a mean of 47.08 with a standard deviation of 18.48 for the independent variable, Open Data Implementation, and 48.43 with a standard deviation of 16.68 for the dependent variable, Entrepreneurial Attitude. This indicates that the average open data implementation index for the 36 countries in Europe and Central Asia selected from the ODB was 47 of 100 in 2016, and the average entrepreneurial attitude index selected from the GEDI for Europe and Central Asia was 48 of 100 in 2016. For both indices, the region was below average. Standard deviation is the amount by which the index differs from the mean value. For this study, the standard deviation is at 18.48 for Open Data Implementation (ODI) and 16.68 for Entrepreneurial Attitude (EAT). With a max of 100 and 87.1 for ODI and EAT, respectively, an empirical review of the nature of the data supports dataset linearity for Pearson correlation.

Standard error was calculated, where the accuracy of a sample mean is 3.09 for Open Data Implementation and 2.83 for Entrepreneurial Attitude. By implication, if several samples from the same population are extracted to calculate the mean, it will produce a mean comparable to the true population mean. A smaller standard error indicates that the sample and its analysis provide a more precise estimate of population value. The median is the midpoint at 46 for Open Data Implementation and 44.7 for Entrepreneurial Attitude.

Kurtosis is the peak sharpness of the frequency distribution curve. When the distribution is too high, the number is greater than +1. For these datasets, it is at 0.94 for Open Data Implementation and -0.76 for Entrepreneurial Attitude, respectively. Skewness is a dataset’s measure of sym-

Table 1. Description of the Studied Variables

Indicator	Description
Open Data Implementation (ODI)	Measures the availability, accessibility and use of open data in Europe and central Asia
Entrepreneurial Attitude (EAT)	Measures the general sense of a country’s population toward recognizing business opportunities.
<i>Note:</i> measurement units for both indicators are from 1 to 100.	
<i>Source:</i> (European Commission, 2001).	

¹ Appendixes are available at the separate file on the article webpage: <https://foresight-journal.hse.ru/2023-17-4/879969835.html>

Table 2. Descriptive Statistics

	ODI	EAT
Mean	47.08	48.43
Standard Error	3.09	2.83
Median	46	44.7
Standard Deviation	18.48	16.68
Sample Variance	341.36	288.19
Kurtosis	0.94	-0.76
Skewness	0.31	0.59
Min.	7	23.2
Max.	100	87.1

Source: authors.

metry (if the number is greater than +1 or lower than -1, the dataset has a substantially skewed distribution). Skewed distributions are also when the data points cluster more toward one side of the scale than the other, thereby creating a curve that is not symmetrical, which means that both the right and left sides are shaped differently. For this dataset, it is 0.31 for Open Data Implementation and 0.59 for Entrepreneurial Attitude, respectively. The lowest values are 7 for Open Data Implementation and 23.2 for Entrepreneurial Attitude and the highest values are 100 for Open Data Implementation and 87.1 for Entrepreneurial Attitude, where the number of observations is 36 for both variables. Thus, it is evident that the dataset similarity meets the requirement for linearity analysis for the Pearson correlation coefficient and ordinary least squares (OLS) model regression.

The graphical representation of the datasets to show their respective nature is as follows:

Lee et al. (2022) indicate that, it is the correlational standard for the outcome to be within the range of -1 to +1, with 0 indicating no correlational significance. +1 indicates a positive correlation and -1 indicates a negative correlation. A positive correlation (+1) indicates that an increase in the independent variable (in this case, ODI) would see a reciprocating increase in the dependent variable (in this case (EAB), and a negative correlation (-1) indicates the opposite. Zero indicates no movement or a connection of any sort between the variables.

For this study, the Pearson correlation value $r = 0.57$ for ODI and EAB in Europe and Central Asia was used for the 2016 experiment. This indicates a moderately positive (significant) relationship between the ODI and EAT in Europe and Central Asia in 2016. Thus, an increase in open data implementation in the region will lead to an increase in entrepreneurial attitudes in Europe and Central Asia.

Table 4 shows that the R-squared value is 0.32, which indicates that Europe and Central Asia's Open Data Implementation (IV) 2016 explains 32% of the entrepreneurial attitudes (DV). The Adjusted R squared value of 0.30 indicates that additional predictors (variables) would improve the model to determine entrepreneurial attitudes in Europe and Central Asia. The probability value of 0.00 indicates that the overall model is very significant and not subject to chance, and the Durbin Watson Statistics (P-value) of 6.47 indicates

that the sourced data has no autocorrelation of any sort (Lee et al., 2022).

For the model, the beta coefficient value for ODI was 0.45, with a significance probability of 0.00. This finding indicates the positive impact of open data implementation on entrepreneurship attitudes in Europe and Central Asia. A probability of 0% indicates that this is not subject to chance, which is significant. By implication, when the indexing score for ODI increases, entrepreneurial attitudes increase and vice versa. By extension, other factors potentially contribute to the impact of entrepreneurial attitudes in Europe and Central Asia.

Breusch-Pagan Test of Regression Robustness

To check the variance equality, the study conducts a Breusch-Pagan test to assess the error variance of a regression model. Breusch-Pagan test is a statistical test that checks for heteroskedasticity (unequal variance) in the residuals of a regression model (Sahudin, Bahrudin, 2023). For this test, the null hypothesis (H0) of the Breusch-Pagan test is that the error variances are all equal (homoskedasticity) and the alternative hypothesis (H1) is that the error variances are not equal (heteroskedasticity).

For this study, as indicated in Appendix 2, Breusch-Pagan test analysis for this study's regression analysis, indicates a heteroskedasticity as its p-value of is 0.166843021. According to (Zahariah Sahudin, Nur Zahidah Bahrudin, 2023), a p-value greater than 0.05 indicates that the dataset or analysis does not have enough evidence to reject the null hypothesis. In the context of the Breusch-Pagan test, the null hypothesis is that the error variances are equal (homoskedasticity) (see Appendix 2). Therefore, the population does not have sufficient evidence to reject the null hypothesis of

Box 1. Key Economic Sectors for Open Data Implementation

1. Map Data
2. Land Ownership Data
3. Detail Census Data
4. Detailed Government Budget
5. Detailed Data on Government Spending
6. Company Registers
7. Legislation
8. Public Transport Timetables
9. International Trade Data
10. Healthcare Performance
11. Primary and Secondary Performance Data
12. Crime Statistics
13. National Environmental Statistics
14. National Election Results
15. Public Contracts

Source: Open Data Barometer (ODB).

Table 3. Pearson Correlation Coefficient

	ODI	EAT
ODI	1	
EAT	0.565795455	1

Source: authors.

Table 4. OLS Regression Output

Variable	ODI
R. Squared	0.32
Adjusted R. Squared	0.30
F-statistics	16.01
Probability (F-statistics)	0.00
Durbin Watson Statistics(P-value)	6.47
B (beta)	0.45
Std Error	0.11
t-Statistics	4.00
Probability	0.00

Source: authors.

homoskedasticity. This suggests that there is no problem of heteroskedasticity in this study’s regression model’s residuals. This is positive for the study, as heteroskedasticity can complicate the interpretation of one’s regression results and can lead to inefficient (although still unbiased) estimators. By implication, Open Data Implementation has a statistically significant positive impact on Entrepreneurial Attitudes in Europe and Central Asia.

This study questions the role of open data implementation in shaping entrepreneurial attitudes toward establishing one’s own commercial enterprises in Europe and Central Asia.

Open Data Implementation is the extent to which data are accessible, timely, and published by each country’s government in 15 key economic sectors. Entrepreneurial Attitude refers to the overall perception of a country’s population regarding identifying potential opportunities, having personal connections with entrepreneurs, holding entrepreneurs in high esteem, being willing to take on the risks that come

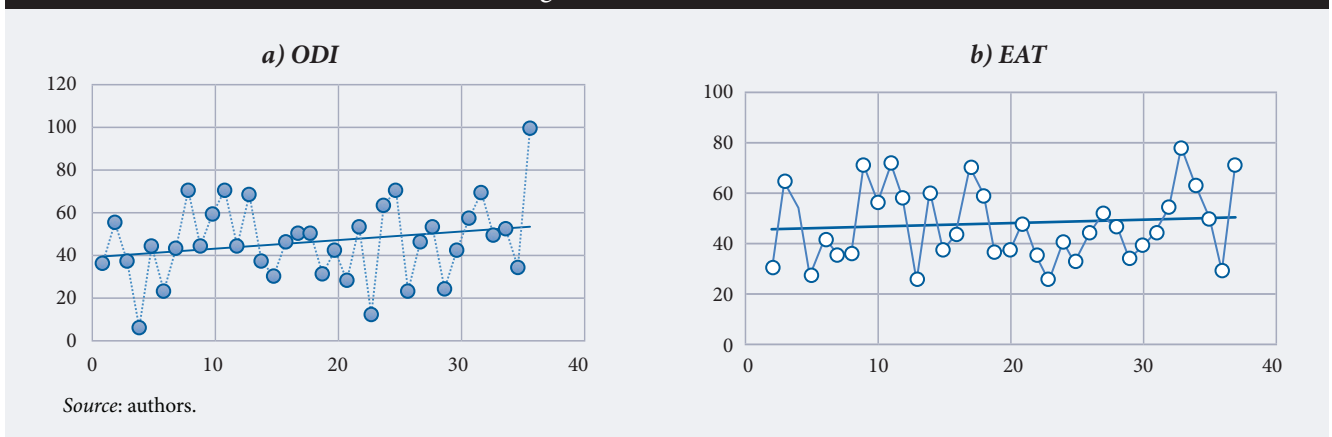
with starting a business, and possessing the necessary skills to successfully establish and operate a business. The analysis of secondarily sourced data shows a 57% positive relationship between Open data implementation (ODI) and Entrepreneurial Attitude (EAT) in Europe and Central Asia. This indicates the degree to which open data implementation and entrepreneurial attitudes moved in the same direction in Europe and Central Asia. This study’s findings also show a regression relationship to the tune of 32% between open data implementation (ODI) and entrepreneurial attitude (EAT) in Europe and Central Asia. By implication, data that are accessible, timely, and published by each country’s government in the 15 key economic sector have a strong positive relationship and positively impact the general sense of a country’s population toward recognizing opportunities, knowing entrepreneurs personally and attaching high status to entrepreneurs, accepting the risks associated with a business start-up, and having the skills to successfully launch businesses by 32%.

This study hypothesis as follows, (H1): *Open data implementation has a positive impact on entrepreneurial attitudes in Europe and Central Asia.* This study accepts H1. This study also aims to numerically measure this impact. The results indicated an impact of 32%.

Conclusions and Recommendations

This study supports the findings of open data report emphasizing the need for improved open data initiatives in the Europe and Central Asia (WWF, 2018; Davies, 2013, 2015). It also validates the findings of Ekundayo et al. (2023). Ekundayo et al. (2023) posit that the most important principle any data governance framework or its related initiative like open data should have is data transparency. According to the findings of Ekundayo et al. (2023), this impact could potentially contribute to economic development by 12%. Policymakers can leverage this insight into the development and deployment of open data or related policies, principles, and frameworks at the state level (Ekundayo et al., 2023). This will help shape entrepreneurial attitudes toward success in the region. Practicing entrepreneurs can also use this approach to shape their human capital attitudes by ensuring continuous and consistent open data implementation at the business level.

Figure 3. Scattered Plots



This will help the team recognize opportunities and be sensitive to entrepreneurial risk while developing much-needed skills for corporate entrepreneurship (Ekundayo et al., 2023).

Based on these findings, this study recommends the deployment and optimization of open data implementation for the change in entrepreneurial attitudes in pursuance of the updated Lisbon strategy, SDG 8.1 objective as well as other economic development initiatives. According to the Open Data Barometer (ODB), reports on Open Data Implementation (ODI) must be published in the 15 key economic sectors listed at Box 1.

According to the Global Entrepreneurship Index (GEDI, 2018), entrepreneurial attitudes are impacted by:

1. The perception and potential of entrepreneurial opportunities within a country's population is known as opportunity perception.
2. Start-up skills perception in a population by comparing the quality of education to determine the entrepreneurial potential.
3. The measure of the inhibiting effect of fear of failure on entrepreneurial action in a population, combined with the country's risk.

4. Attitude of potential or practicing entrepreneurs towards accessing resources and opportunities, as well as the ease of communication among them.
5. The way a country's residents perceive entrepreneurs is referred to as cultural support.

A key limitation of this study is the cross-sectional nature of the experimental datasets. This limited the data sources to those covering 2016. However, this study recommends further experimental investigations using a more recent dataset. In addition, a study's research methodology or design could share insights on the nexus of open data implementation and entrepreneurial attitudes in Europe and Central Asia.

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. The authors declare no competing interests. The data that support the findings of this study are publicly available in Open Data Implementation index for 2016 at <https://opendatabarometer.org/3rdedition/> and Global Entrepreneurship Index for 2016 at <http://thegedi.org/downloads/>. Repository for this study-specific data – Appendix 1 is available via DOI: 10.17632/zxpvt48b3y

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Determinants of Sustainable Consumption Intention

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Abstract

Sustainable consumption has received a lot of attention and attraction from many regions and countries around the world in many different aspects recently. This study investigates factors that influence consumers' sustainable consumption intentions in Vietnam. Despite the growing importance of sustainable consumption, marketing managers still lack adequate information on how to promote it to consumers. This study aims to address this gap by examining the impact of environmental knowledge, man-nature orientation, environmental advertising, and demographic factors such as income, major, degree age and gender on sustainable consumption intention. An online survey was used to collect data from 460 people in Vietnam. The data was used multivariate linear

regression analysis, Cronbach alpha, ANOVA and other methods to identify factors affecting sustainable consumption intentions in Vietnam. The results show that man-nature orientation and environmental advertising have a positive impact on sustainable consumption intention. Furthermore, the study also shows a strong relationship of environmental advertising on Man orientation - natural and environmental knowledge. In contrast, the study did not find a relationship between environmental knowledge and sustainable consumption intention. These results provide theoretical and practical implications for marketing managers in developing effective communication strategies to promote sustainable consumption and encourage environmentally friendly consumption intentions.

Keywords: environmental knowledge; environmental advertising; sustainable consumption, Vietnam

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Introduction

In light of climate change and the increasingly precarious condition of the natural environment, individuals in contemporary society are compelled to modify their patterns of consumption in order to foster enduring sustainability. The significance of this adaptation cannot be overstated in terms of preserving sustainable and secure ecosystems for both current and future populations (IPCC, 2018). There persists a prevailing belief among individuals that the economy is predominantly linked to the manufacturing and utilization of physical commodities. However, human consumption behaviors surpass the sustainable capacities of natural ecosystems in terms of regeneration, processing, and recycling (Rees, 2020; Wackernagel et al., 2002). Over the last several decades, researchers have identified many environmental hazards that pose risks to both human and ecological health (Tanner, Kast, 2003). Consequently, the issue of sustainable development has emerged as a critical concern within contemporary society. According to Princen et al. (2002), the challenges associated with attaining sustainable development may be attributed to the magnitude and nature of unsustainable consumption. While several factors such as technology improvements, social initiatives, economic policies, and production systems contribute to societal progress, it is crucial to acknowledge that without a corresponding shift in consumption patterns, the impact of these developments may be limited (Peattie, 2010). In recent years, there has been a prevailing recognition of the significance attributed to individuals' behaviors in relation to the promotion of sustainable development. Consequently, the adoption and recognition of sustainable consumerism are becoming prevalent and regarded as fundamental phenomena. In contemporary society, there is a heightened level of awareness and prioritization of environmental issues, leading to a notable inclination towards the use of environmentally friendly products. This necessitates the engagement of companies, marketers, and suppliers in the development of innovative methods aimed at reducing carbon emissions and mitigating environmental impact. According to Chiou et al. (2011), firms that prioritize environmental sustainability may experience both financial and social benefits.

Vietnam saw significant changes more than thirty years ago due to the implementation of the Doi Moi policy, which included comprehensive reforms in both the economic and political domains (Nguyen et al., 2018). In the year 2019, the World Bank acknowledged Vietnam's notable transformation from being one of the most impoverished nations globally to being an emerging economy¹. Alterations in consumption patterns have a pivotal role in societal dynamics (Nguyen

et al., 2018). Despite the increasing affluence of the middle class in Vietnam and their growing purchasing patterns, especially in metropolitan regions, scholarly investigations on this subject remain few (de Koning et al., 2015). There is a dearth of scholarly investigation pertaining to the young urban middle class in Vietnam (King et al., 2008).

Vietnam has made significant progress in establishing a self-sustaining society. The Vietnamese government and populace exhibit a notable inclination towards embracing novelty and displaying enthusiasm in their endeavors. The results of a Nielsen survey conducted in 2015 indicate that among all residents of the Asia-Pacific region countries, Vietnamese consumers exhibit the most pronounced levels of social awareness (Le, Kieu, 2019). Specifically, these consumers have a significant inclination to allocate their financial resources towards businesses that prioritize humanitarian and ecological considerations. Despite the stated objectives, many scholars argue that the Vietnamese populace continues to exhibit a deficiency in environmental awareness (Hoon, Hyun Park, 2017), despite the diligent efforts undertaken by the nation. For example, a minority of the Vietnamese populace holds the belief that they have personal accountability for the protection of the environment and the preservation of resources. The Vietnamese government has initiated measures to address the issue of plastic pollution since 2019².

The topic of sustainable consumption has gained critical relevance in Vietnam due to the rising trend in consumption habits and the growing young population. In 2012, around 65% of Vietnam's population consisted of individuals below the age of 30, with this particular demographic constituting approximately 30% of the nation's work force (de Koning et al., 2015). The labor market in Vietnam has a youthful demographic and is experiencing rapid growth, which may be attributed to the concurrent expansion of the country's middle class (PWC, 2018). Insufficient research has been conducted on the expanding middle class in Vietnam and their consumption patterns, particularly within the urban areas of the nation (de Koning et al., 2015). This study assesses the interest of Vietnamese consumers on issues of sustainable consumption through factors such as Environmental Knowledge, Man–nature orientation, Environmental Advertising, on sustainable consumption intentions.

Literature review

Concept of sustainable consumption

Sustainable consumption, as defined by the notions examined, refers to the act of consuming commodities and associated products in order to fulfill fundamen-

¹ <https://www.worldbank.org/en/country/vietnam>, accessed 22.10.2023.

² <https://saigoneer.com/vietnam-news/16685-vietnam-pm-endorses-national-campaign-to-eliminate-single-use-plastic>, accessed 12.05.2023.

tal requirements and enhance overall welfare, all the while mitigating environmental hazards and preserving finite resources (Ofstad et al., 1994). Sustainable consumption comprises a diverse array of strategies aimed at mitigating adverse environmental effects. Sustainable consumption refers to the acquisition and use of products and services that do not have adverse effects on the environment in terms of depleting natural resources, containing dangerous compounds, or emitting pollutants (Svarstad et al., 1994). SCP, or Sustainable Consumption and Production, is a concept that involves fulfilling fundamental needs and improving overall well-being by utilizing goods and services that minimize the consumption of limited natural resources, the emission of harmful byproducts, and the generation of unnecessary waste and pollutants in all stages of their existence. The objective of the methodology is to ensure the protection of the interests of future generations by minimizing the potential for mistakes. The objective of Goal 12 in the 2030 Agenda for Sustainable Development is to attain Sustainable Consumption and Production (SCP) via the adoption of comprehensive transformations in the methods by which societies manufacture and use commodities and services³. The “green consumption” campaign has been in operation spanning from 2009 to 2019.

“Green consumption” or “sustainable consumption” has been defined as the practice in which consumers engage in the use of environmentally friendly and sustainable green products (Le et al., 2019). There has been a surge in scholarly attention towards green consumption practices due to an increasing awareness of environmental issues and the need to address them (Nguyen et al., 2019). The concept of green consumption has been widely recognized as a crucial element of promoting sustainable development (Kim et al., 2012; Lee, 2008). Additionally, it has been acknowledged as a means to stimulate global green marketing efforts (Ottman, 1993; Lee, 2008; Miniero et al., 2014). The aforementioned writers (Peattie, 2001; Dietz et al., 2005; Nguyen et al., 2015; Wu, Chen, 2014) are engaged in the pursuit of comprehending green behaviors and elucidating the determinants that impact intentions towards engaging in such activities. The majority of the 15 publications within our compilation focus on the correlation between intention and environmentally conscious behavior in the Vietnamese market. Furthermore, much research has been conducted on practical approaches aimed at enhancing public comprehension of green consumption, with a specific focus on the younger demographic. Moreover, sustainable consumerism advocates for the adoption of ecologically and socially responsible buying behaviors in order to mitigate the ecological footprint of individuals. The impact of environmental knowledge, people orientation, and environmental advertising on the intention to engage

in sustainable consumption has been demonstrated in various studies (Ulla et al., 2021; Awan et al., 2021; Xu et al., 2019; Hamzah, Tanwir, 2021; Klockner, 2011; Diyah, Wijaya, 2017; Wijaya et al., 2017; Chang et al., 2019; Moraes et al., 2021).

Numerous academic studies have provided empirical evidence about the environmental ramifications associated with sustainable consumerism, a prevalent environmental approach seen within the private sector (Stern, 2000). The concept of pro-environmental consumption behavior, which entails individuals taking actions to reduce their adverse environmental effects, is often associated with sustainable consumer behavior (Dhandra, 2019). Pro-environmental behavior encompasses actions that are beneficial for the environment or have little negative impact on it (Steg, Vlek, 2009).

Noteworthy is a comprehensive analysis of the many perspectives and academic disciplines undertaken by (Reisch et al., 2016) that have made notable contributions to the advancement of sustainable consumption. The field of sustainable consumption research has seen significant advancements due to the valuable contributions from several interdisciplinary perspectives. Environmental sociology has provided valuable perspectives on the social dimensions of individual behavior under many social settings and situations. Empirical research has provided support for the acknowledgment of consumer biases, heuristics, and contextual dependencies by behavioral economics. Extensive scholarly study in the field of political science has focused on examining the role of customers as engaged citizen-consumers. Nevertheless, considerable theoretical advancements have been made in the field of applied philosophy about the ethical foundations of this concept.

Sustainable consumption has made significant progress throughout time, mostly due to the inclusion of several theoretical, behavioral, and social frameworks. Consequently, a substantial and intricate body of literature has emerged on the subject of sustainable consumption, including several academic fields (Liu et al., 2016). This study focuses on the prevailing comprehension of sustainable consumption in relation to the Sustainable Development Goals (SDGs) for the year 2030, given the complexity of this concept.

Research in the Past

Numerous techniques and ideas have been put out in response to the expanding corpus of research concerning the attainment of sustainable consumption (Liu et al., 2016). The field of sustainable consumption research has garnered attention from scholars across several disciplines due to its intricate nature, multidisciplinary approach, and relatively recent emergence (Reisch et al., 2016).

³ https://www.undp.org/sustainable-development-goals/responsible-consumption-and-production?gad_source=1&gclid=Cj0KCQiA3uGqBhDdARIsAFeJ5r3MqBhymEJG6eGc-BaawnNe3DCv56Uf6kpUc0tAMCbmizt34nDZnDsaAqDPEALw_wcB, accessed 18.10.2022.

Additional investigation into the fundamental structures is needed, given the complexity of the issue and the many operationalizations that are required. The subject of sustainable consumer behavior has been a subject of scholarly discourse since at least the 1980s, as shown by academic discussions (Dunlap, 2017). Previous research has focused on analyzing the interplay between pairs of components rather than only studying individual variables when investigating the predictive capacity of environmental concern (Tam, Chan, 2018). The objective of this study is to enhance comprehension of the underlying factors that motivate individuals to engage in environmentally aware consumer behavior.

The empirical evidence indicates that consumers' inclination towards good environmental attitudes, reduced perception of risks, and reliance on certifications together lead to a significant augmentation in consumer expenditure. Numerous research have consistently shown the significant influence that consumers' attention and environmental awareness exert on their decision-making processes when it comes to purchasing goods and services. Consumers' environmental attitudes and knowledge experienced notable changes upon being exposed to information on environmental concerns (Mostafa, 2007; Wang et al., 2021). Green advertising is a prevalent strategy used within the commercial sphere, with the primary objective of communicating ethical principles and promoting environmental awareness. Numerous research (Ruiz, Sicilia, 2004; Kao et al., 2011; Nagar, 2015) have shown that buyers exhibit more brand engagement and have elevated purchase expectations when commercials align with their beliefs and preferences. In fact, many well-known brands are now offering more sustainable products and solutions. For example, Patagonia, a well-known outdoor clothing brand, uses recycled materials in its products and has a goal of becoming carbon neutral by 2025. Another example is Unilever, a global consumer goods company. Unilever has set a goal of becoming carbon positive by 2030 and halving its use of virgin plastic by 2025. About brands' attitudes towards compliance with environmental standards and trends, the research suggests that many brands are taking sustainability seriously. More than 80% of global consumers trust brands that are committed to sustainability (Nielsen, 2021). However, there are still some challenges that brands face in meeting the growing demand for sustainable products. One challenge is the cost of implementing sustainable practices. Another challenge is the lack of clear and consistent environmental standards. Despite these challenges, it is clear that consumers are increasingly demanding sustainable products and brands are responding to this demand. This suggests that there is a growing alignment between consumers' choice of environmentally friendly products and their propensity to buy well-known brands. Student participants have a greater positive response towards advertisements promoting environmentally friendly and durable items compared to those endors-

ing economically advantageous alternatives (Biswas, Roy, 2015). This finding demonstrates the advantages of sustainable products above those promoted via green advertising channels. The examination of sustainable modes of communication, such as "green advertising," assumes significant importance due to its ability to enhance consumers' consciousness about environmental issues and foster their inclination towards ethical consumption (Moraes et al., 2021). Despite the inherent unpredictability and sometimes inaccuracy associated with norms, they possess the capacity to have a significant impact on an individual's behavior and daily intentions (Ajzen, 1991; Chung et al., 2012). The ethics of buyer behavior (also known as ethical purchasing behavior) is a field of study that examines the ethical implications of consumer behavior. It considers the impact of consumer choices on individuals, society and the environment. Some examples of ethical purchasing behaviors include: buying products and services from companies that are committed to social and environmental responsibility, avoiding products and services that are produced using unethical or harmful practices, supporting local businesses.

In short, buyer behavior ethics is a complex field that includes many ethical considerations. It engages with the basic principles of bioethics, but it also challenges them in a number of ways.

Research hypotheses

Environmental knowledge

The concept of "environmental knowledge" encompasses the comprehension of various environmental concerns and the recognition of the interdependence between ecosystems and human civilization (Haron et al., 2005). The measurement of consumers' environmental consciousness and commitment to a sustainable future may be assessed via the evaluation of their level of environmental literacy, an individual's disposition and understanding of environmental issues (Eren, Yaqub, 2015; Lin, Niu, 2018; Hamzah, Tanwir, 2021).

H1: Environmental knowledge has a positive impact on sustainable consumption intention among consumers in Vietnam

Man-nature orientation

The concept of "man-nature orientation" as defined by (Samovar et al., 1981) refers to the inclination of persons to either exercise control over natural processes or to be subservient to them. The theoretical construct of man-nature orientation, as posited by (Chan, 2001; Marcela, 2010), offers a conceptual framework for understanding the factors that impact consumers' inclination towards engaging in environmentally aware consumer behaviour. Sustainable Purchase Intention is primarily shaped by two key elements, namely Man-Nature Orientation and a Healthy Consumption Lifestyle (Diyah, Wijaya, 2017).

H2: Man–nature orientation has a positive impact on sustainable consumption intention among consumers in Vietnam

Environmental advertising

Green advertising, sometimes referred to as environmental advertising, is a marketing tactic that places focus on the favourable environmental impacts associated with a product or service throughout all stages of its existence, including its inception and final disposal. The prevailing consensus acknowledges that the fundamental aim of advertising is to enhance the sales of a company's goods or services via the strategic targeting of consumers' logical and emotional demands. Customers tend to assign more importance to environmental product attributes in comparison to physical elements in isolation (Phau, Ong, 2007).

H3: Environmental advertising has a positive impact on sustainable consumption intention among consumers in Vietnam

H4: Environment advertising has a positive impact on environmental knowledge among consumers in Vietnam

H5: Environment advertising has a positive impact on man-nature orientation among consumers in Vietnam

Conceptual model of the study that represents the links between considered variables as illustrated by hypotheses is reflected at Figure 1. Their dimensions as illustrated by the statements evaluated by respondents are summarized at Table 1.

Result Analysis

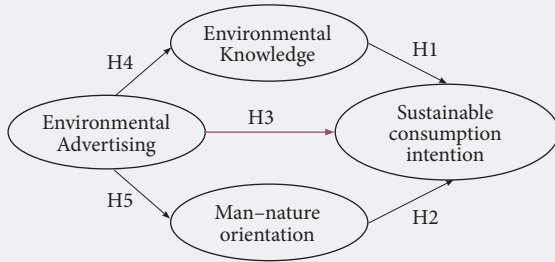
Our survey was conducted among a sample of 460 Vietnamese consumers to get insights into their opinions and behaviors about ecologically responsible shopping. Table 2 presents the demographic characteristics of the participants, including variables such as gender, age, work status, and monthly income. The sample has a balanced distribution of gender, with men comprising 46.7% and females comprising 53.3% of the total population. The sample data reveals that a significant percentage, namely 65%, of the customers fall within the age bracket of under thirty, indicating a notable overrepresentation of young consumers. Based on the statistical data published by the General Statistics Office of Vietnam in 2022, it can be inferred that around 57.2% of the individuals surveyed may be categorized as employees or workers. Significantly, a considerable proportion of the participants, namely 41.3%, reported a monthly pay range of 5 to 10 million VND. In comparison to the salary levels in other regions of Vietnam, this particular wage level might be considered quite satisfactory. The findings suggest that there is a notable level of concern among young customers about sustainability, as well as a strong inclination towards eco-friendly products. Furthermore, within the sample, a significant proportion of individuals (specifically 26.7%) fall within the age range of 40 to 60 and exhibit

a strong inclination towards products that prioritize safety and health.

This study investigates the impact of age on individuals' environmental literacy, social maturity, susceptibility to environmental advertising, and inclination towards sustainable consumption. The use of analysis of variance (ANOVA) is a recommended statistical approach for the examination and assessment of mean disparities across various age cohorts. Table 3 presents empirical evidence that substantiates the premise of a significant correlation between age and individuals' propensity for sustainable consumption, with statistical significance seen at the 1% level. Hence, there exists a range of perspectives and patterns of conduct pertaining to environmentally conscious consumerism among different age cohorts. When doing a comparison between individuals of various age groups, it is seen that the variable of environmental awareness exhibits a statistically significant difference at the 1% level. Upon examination of the mean values, it is evident that the age group ranging from 50 to 60 exhibits the highest mean value (4.472b), whilst those aged between 18 and 25 have the lowest mean value (4.123a). Based on the findings, individuals belonging to the senior population exhibit a higher level of environmental consciousness compared to their counterparts in the younger demographic. The findings of the study indicated that individuals across different age groups were exposed to varying degrees of environmental advertising. However, it was observed that there were no statistically significant variations in these exposures. The observed phenomenon may be attributed to the limited targeting of certain demographic groups, such as age-defined segments, in environmental advertising. Instead, the emphasis is placed on tailoring campaigns to individual clients.

The study examined the impact of individuals' occupations on their level of environmental awareness, attitudes towards human behavior, responsiveness to environmental advertising, and inclination towards adopting sustainable purchasing practices. An analysis of variance (ANOVA) was conducted to examine variations in means across different occupations. Significant statistical differences were observed across occupational groups for all three variables (refer to Table 4), with a threshold of significance set at 1%. This suggests that there are significant variations in educational attainment, perspectives, and consumer behavior across different occupational groups. Upon careful analysis of the three components, it becomes evident that environmental knowledge exhibits the highest degree of variability across various occupations. The average values vary between 4,118ac for the group including workers and employees (1) and 4,401cd for the group containing civil servants and public employees (2). This conclusion posits that those employed in public service and government positions possess a more profound comprehension of the environment in comparison to the broader populace. There is no statistically

Figure 1. Research Hypotheses



Source: authors.

significant variation seen among sectors in relation to environmental advertising. The current tendency may be attributed to the use of personalized environmental advertising strategies that cater to individual preferences and inclinations, rather than only targeting certain occupational groups.

Wang and Rhemtulla (2021) used advanced statistical techniques, such as structural equation modeling (SEM), to examine the associations among various variables. The team used the AMOS.22 software and utilized the Structural Equation Modeling (SEM) approach to evaluate their hypotheses. Confirmatory factor analysis (CFA) and other statistical techniques were used to assess the validity and reliability of the theoretical constructs. The significance and level of certainty associated with each notion are shown in Table 5. The constructs of environmental knowledge, man-nature orientation, environmental advertising, and sustainable consumption intent have strong internal consistency, as shown by high Alpha Cronbach coefficients. The study reveals a range of Alpha Cronbach values for different constructs. Specifically, the coefficients for Environment Knowledge (EK) range from 0.855 to 0.871, while those for Man-Nature Orientation (MNO) range from 0.730 to 0.774. Sustainable Consumption Intention (SCI) and Environment Advertising (EA) also exhibit variation, with coefficients ranging from 0.734 to 0.790 for both constructs. The presence of Alpha Cronbach values more than 0.7, as seen in Table 5, indicates a strong and enduring association between latent and observable variables (de Leeuw et al., 2019).

The term of “convergent validity” pertains to the degree of correlation between one set of assessment items and another set of questions, including several elements. Factor loading, composite reliability, and average variance extracted (AVE) are used as measures to assess the degree of convergent validity. The minimal threshold for factor loading, which is the correlation between an item and its associated factor, is reported to be 0.40 in the studies conducted by Hsieh and Hiang (2004) as well as Hashmi et al. (2021). According to the research conducted by Hashmi et al. (2021) and Khan

Table 1. Statements Proposed for Evaluation by Respondents to Measure Studied Dimensions

Sustainable Consumption Intention (Ofstad et al., 1994; Lee, 2014)
<ul style="list-style-type: none"> • I am willing to pay for sustainable products • I like to consume sustainable products • I will prioritize using sustainable products • I will choose brands with good environmental protection policies
Environmental Knowledge (Eren, Yaqub, 2015; Haron et al., 2005)
<ul style="list-style-type: none"> • I buy the product because the packaging is reusable • Encourage and prioritize the use of renewable, available energy sources such as solar energy • Garbage collection and recycling are very important in contributing to environmental protection • I prefer to read the document on the computer instead of taking its print on paper • I turn off electrical appliances when not in use to save energy • I think the choice of public transport is important for a sustainable environment • I attended any project or seminar to acknowledge the environmental awareness • Promotions of renewable energy resources are necessary for a sustainable environment.
Man-Nature Orientation (Chan, 2001)
<ul style="list-style-type: none"> • I would maintain harmony with nature • I need to understand the ways of nature and act accordingly • Human beings are part of nature and are always connected to nature • We should adapt instead of mastering the environment
Environmental Advertising (Rahbar, Abdul-Wahid, 2011)
<ul style="list-style-type: none"> • Environmental advertisements enhance my knowledge about sustainable consumption • I enjoy watching environmental advertisements via social media • Environmental advertisement guide customers in making an informed purchasing decision • I think brands that advertise sustainable products are serious about protecting the environment
Source: Author synthesis.

et al. (2022), it is recommended that the composite reliability, which evaluates the internal consistency of the items used to evaluate a certain component, should be equal to or greater than 0.70. The measure of the variation captured by the indicators of a concept is known as the average variance extracted (AVE), as shown by Fornell and Larcker (1981) and Khan et al. (2022). It is recommended that the average value of the variable under consideration (AVE) should exceed 0.50. The concurrent validity of the study is shown in Table 3, which presents the observed values ranging from 0.511 to 0.515. In order to be deemed genuine, the aforementioned numerical values must exceed 0.5. The average value (AVE) exceeds the predetermined cutoff threshold of 0.5. Both the relative and absolute values of the composite dependability (CR) exceeded the threshold of 0.70. The data is presented in a summary fashion in Table 6. The constructs of Environment Knowledge (EK), Man-Nature Orientation (MNO), Environment Advertising (EA), and Sustainable Consumption Intention (SCI) demonstrated satisfactory levels of convergent validity.

Table 2. Demographic Profile of Respondents

Description	N	Percentage (%)
Gender		
Male	215	46.7
Famale	245	53.3
Age (years)		
18 – 25	195	42.4
25 – 30	106	23.0
30 – 40	36	7.8
40 – 50	63	13.7
50 – 60	60	13.0
Major Occupations		
Workers – Employees	263	57.2
Civil servants and state employees	118	25.7
Merchandise, Trade	41	8.9
Student	28	6.1
Housework	10	2.2
Income (dongs)		
Less than or equal to 5 million	105	22.8
From 5 to 10 million	190	41.3
From 5 to 15 million	83	18.0
From 15 to 20 million	39	8.5
From 20 to 30 million	33	7.2
More than 30 million	10	2.2

Source: authors, based on field survey data, 2023.

All the factor loadings shown in Table 6 have values above 0.5. Based on the findings of Al-Lozi et al. (2018) and Sung et al. (2019), it can be concluded that this statement holds true. Factor loading, as described by Al-Lozi et al. (2018), is a statistical technique used to evaluate the magnitude of a connection between variables. The assessment of discriminant validity among the variables may be conducted by the use of a comparison approach, as proposed by Rimkeviciene et al. (2017) within the framework of covariance-based structural equation modeling (SEM). The researchers used Kaiser-Meyer-Olkin (KMO) analysis to assess the suitability of the relationship performance indicators for inclusion in the factor analysis of the scale. All of the obtained results exceeded the threshold value of

0.5. In order to establish statistical significance, the Kaiser-Meyer-Olkin (KMO) score in the research must exceed 0.5, with a threshold of 0.930 being the critical value. One specific element with an eigenvalue beyond one (1.066) was also removed. According to Sung et al. (2019), the eigenvalue may serve as a statistical measure for objectively assessing the level of volatility shown by a certain component. In order to ascertain the interrelationships among the observed variables inside the factor, a statistical test known as Bartlett's test of sphericity was conducted. A statistically significant correlation ($p < 0.05$, $r^2 = 0.00$) was identified between the observed variables inside the factor, as shown by Bartlett's test of sphericity. A statistically significant association was observed upon computation of a factor loading coefficient of 0.7 for the relevant variable. The sum of the loadings for all seven components exceeded 0.70. Previous studies have shown empirical evidence for loadings that are equal to or greater than 0.5 (Yu et al., 2013). During the measurement phase, mean values were obtained for each multivariate characteristic. In order to effectively meet the criteria of the structural equation modeling (SEM) framework, it is essential to accurately situate the factors within the designated dimensions, as determined by the outcomes of the exploratory factor analysis (EFA).

Discriminant validity is examined by comparing the ratio between the square root of AVE and the correlation coefficient (Fornell, Larcker 1981). As Table 7 shows, the diagonal elements of the matrix, corresponding to the square root of the constructs, are all higher than the correlation coefficients between the constructs, confirming discriminant validity (Agan et al., 2013). The correlation coefficient between the latent composite constructs and all other constructs is also less than 0.7, indicating that the constructs are sufficiently different from each other (Urbach, Ahlemann 2010).

In this study, the overall fit indexes show that the model has a high degree of fit to the data. The P value is less than 0.01, indicating that the difference between the observed covariance matrix and the expected covariance matrix is not statistically significant. The χ^2

Table 3. Aspect of Sustainable Consumption Is Based on Age

Factor	Age, years (number of respondents)					Robust Test Sig. Welch ≤ 0.05
	18–25 (N=195)	25–30 (N=106)	30–40 (N=36)	40–50 (N=63)	50–60 (N=60)	
Environment Knowledge (EK)	4.123 ^a	4.129 ^{ac}	4.142 ^{ac}	4.3 ^{ab}	4.472 ^b	***
Man-nature Orientation (MNO)	4.241 ^a	4.164 ^a	4.366 ^a	4.425 ^a	4.313 ^a	0.015*
Environment Advertising (EA)	4.228 ^a	4.257 ^a	4.381 ^a	4.420 ^a	4.350 ^a	-
Sustainable Consumption Intention (SCI)	4.289 ^a	4.306 ^a	4.430 ^a	4.447 ^a	4.454 ^a	0.029*

Note: * — p-value < 0.1; ** — p-value < 0.05; *** — p-value < 0.001. Significant at the 0.05 level. If the value of Levene is less than 0.05, the Robust test is used. If the value of Levene is more than 0.05, the Anova test is used. The numbers in the same row followed by different letters are significant at the 5% level via the statistical Anova or Robust test.

Source: authors.

Table 4. Interest in Aspects of Sustainable Consumption Is Based on Occupation

Factor	1 N=263	2 N=118	3 N=41	4 N=10	5 N=28	Robust Test Sig. Welch ≤ 0.05
Environment Knowledge (EK)	4.118 ^{ac}	4.401 ^{bd}	4.259 ^{cd}	4.375 ^{cd}	4.080 ^{cd}	0.001**
Man-nature Orientation (MNO)	4.423 ^{ac}	4.418 ^{bd}	4.219 ^{cd}	4.120 ^{cd}	4.085 ^{cd}	0.006**
Environment Advertising (EA)	4.219 ^a	4.389 ^a	4.493 ^a	4.650 ^a	4.089 ^a	0.001**
Sustainable Consumption Intention (SCI)	4.275 ^{ac}	4.489 ^{bd}	4.481 ^{cd}	4.47 ^{cd}	4.241 ^{cd}	0.002**

Note: Workers – Employees (1), Civil servants and state employees (2), Merchandise, Trade (3), Student (4), Housework (5). * — p-value < 0.1; ** — p-value < 0.05; *** — p-value < 0.001. Significant at the 0.05 level. ANOVA Sig.F ≤ 0.05 . If the value of Levene is less than 0.05, the Robust test is used. If the value of Levene is more than 0.05, the Anova test is used. The numbers in the same row followed by different letters are significant at the 5% level via the statistical Anova or Robust test.

Source: authors.

value is 1289,551 with degrees of freedom of 266,859, indicating that this difference is small. The GFI index is 0.900 and the CFI index is 0.934 both greater than or equal to 0.900, showing that the model has a large improvement compared to the model without hidden factors. The TLI index is 0.924, also greater than or equal to 0.900, showing that the model has a large improvement compared to the independent model. The RMSEA index of 0.042, less than or equal to 0.080, indicates that the model has a high fit to the sample size. These indicators help to test hypotheses about the relationships between the variables in the model. Collected data are presented in Table 8.

Studying the impact of environmental knowledge, natural human orientation and environmental advertising on sustainable consumption intention. Consider using the correlation coefficient method and regression analysis to test hypotheses. Table 9 shows that there is a close and statistically significant relationship between the independent variables and the dependent variable. The coefficient of determination R² is 0.595, showing that 59.5% of the variation in sustainable consumption intention is explained by the independent variables. Among the independent variables, natural human orientation and environmental advertising have a positive and statistically significant impact on

Table 5. Factor Loading and the Cronbach's Alpha Estimates

<i>Sustainable Consumption Intention (SCI)</i>		0.803
SCI1	I am willing to pay for sustainable products	0.734
SCI2	I like to consume sustainable products	0.739
SCI3	I will prioritize using sustainable products	0.752
SCI3	I will choose brands with good environmental protection policies	0.790
<i>Environmental Knowledge (EK)</i>		0.877
EK1	I buy the product because the packaging is reusable	0.866
EK2	Encourage and prioritize the use of renewable, available energy sources such as solar energy	0.864
EK3	Garbage collection and recycling are very important in contributing to environmental protection	0.869
EK4	I prefer to read the document on the computer instead of taking its print on paper	0.871
EK5	I turn off electrical appliances when not in use to save energy	0.859
EK6	I think the choice of public transport is important for a sustainable environment	0.855
EK7	I attended any project or seminar to acknowledge the environmental awareness	0.857
EK8	Promotions of renewable energy resources are necessary for a sustainable environment	0.855
<i>Man-Nature Orientation (MNO)</i>		0.782
MNO1	I would maintain harmony with nature	0.730
MNO2	I need to understand the ways of nature and act accordingly	0.732
MNO3	Human beings are part of nature and are always connected to nature	0.774
MNO4	We should adapt instead of mastering the environment	0.738
<i>Environmental Advertising (EA)</i>		0.783
EA1	Environmental advertisements enhance my knowledge about sustainable consumption	0.751
EA2	I enjoy watching environmental advertisements via social media	0.746
EA3	Environmental advertisement guide customers in making an informed purchasing decision	0.700
EA4	I think brands that advertise sustainable products are serious about protecting the environment	0.723

Source: authors, based on field survey data, 2023.

Table 6. Assessment of the Measurement Model

a) Parameters of test		
Kaiser-Meyer-Olkin (KMO)	0.930	
Cumulative % (Initial Eigenvalues)	58.768	
Bartlett's Test of Sphericity (Sig.)	0.000	
Initial Eigenvalue	1.066	
b) Convergent validity items		
Construct	AVE	Composite Reliability
Environment Knowledge (EK)	0.512	0.882
Man-nature Orientation (MNO)	0.515	0.794
Environment Advertising (EA)	0.511	0.787
Sustainable Consumption Intention (SCI)	0.514	0.807
c) Factor loadings for studied constructs		
Item	Loading	
<i>Environmental Knowledge (EK)</i>		
EK 1	0.631	
EK2	0.685	
EK3	0.652	
EK4	0.628	
EK5	0.699	
EK6	0.818	
EK7	0.743	
EK8	0.739	
<i>Man – Nature Orientation (MNO)</i>		
MNO 1	0.609	
MNO 2	0.697	
MNO 3	0.721	
MNO4	0.602	
<i>Environmental Advertising (EA)</i>		
EA1	0.652	
EA2	0.728	
EA3	0.714	
EA4	0.702	
<i>Sustainable Consumption Intention (SCI)</i>		
SCI1	0.665	
SCI2	0.715	
SCI3	0.666	
SCI3	0.737	

Source: authors, based on field survey data, 2023.

sustainable consumption intention. This is consistent with previous studies. Specifically, the regression coefficient β of natural human orientation is 0.240, with a P value less than 0.05. The regression coefficient β of environmental advertising is 0.447, also with a P value less than 0.05. Therefore, hypotheses H2 and H3 are accepted. However, environmental knowledge did not have a statistically significant impact on sustainable consumption intentions. The regression coefficient β of environmental knowledge is only 0.034, with a P value greater than 0.05. Therefore, hypothesis H1 is rejected. This may be because environmental knowledge does not reflect consumer attitudes and values.

In addition, the study also explores the role of environmental advertising in enhancing environmental knowledge and natural human orientation. Environmental advertising has a strong positive correlation with these two variables, with coefficients of determination R^2 of 0.422 and 0.614, respectively. The detailed results are as follows: H4: Environmental advertising has a positive impact on environmental knowledge ($\beta = 0.864$, $P < 0.05$), H5: Environmental advertising has a positive impact on orientation natural humans ($\beta = 0.925$, $P < 0.05$). Therefore, hypotheses H4 and H5 are accepted.

Discussion

In order to get a deeper comprehension of how men's intrinsic orientation impacts their goals for sustainable consumption, this study used structural equation modeling. The present study's findings support the conclusions of previous studies conducted by (Marcela, 2010; Klockner, 2011; Diyah, Wijaya 2017; Wijaya et al., 2017; Chekima, 2016), which have shown similar results. Numerous studies have shown a correlation between the inclination to engage in sustainable consumption and an inherent human orientation factor, which subsequently promotes the acceptance and use of environmentally friendly products and services. The study conducted by (Chan, 2001) offers empirical support for the significance of inherent disposition in shaping individuals' daily experiences and influencing their actions, which are influenced by the surrounding situation.

Table 7. Discriminant Validity (Intercorrelations) of Constructs

Construct	MSV	Max R(H)	SCI	EK	MNO	EA
SCI	0.513	0.819	0.717			
EK	0.477	0.898	0.531	0.716		
MNO	0.478	0.803	0.709	0.691	0.718	
EA	0.478	0.795	0.716	0.561	0.716	0.714

Source: authors.

Table 8. Model Fit Indicators in SEM

Indicators	Cut-off values	Calculated values	Conclusion
Chi-square/df	≤ 3.000	2.493	Fit
CFI	≥ 0.900	0.934	Fit
GFI	≥ 0.900	0.910	Fit
TLI	≥ 0.900	0.924	Fit
RMSEA	≤ 0.080	0.057	Fit

Source: authors, based on field survey data, 2023.

The results suggest a positive association between environmental advertising and the adoption of sustainable consumption practices. According to Table 9, it can be seen that. The conclusions gained in this study are supported by the results of (Xue, 2014; Moraes et al., 2021; Biswas, Roy, 2015). The findings of this study indicate that those who are exposed to environmental advertising exhibit a more favorable attitude and a heightened level of knowledge about the benefits associated with the use of environmentally friendly products.

This study provides support for the hypothesis that environmental advertising has a substantial impact on consumers' level of awareness about environmental concerns. The assertion is substantiated by the scholarly investigation conducted by (Xue, 2014). This study also examined the hypothesis that exposure to environmentally conscious advertising would enhance individuals' inclination towards naturalistic human orientation, and found a significant positive association between the two variables. The findings of this study are in line with the previous research conducted by (Ruiz, Sicilia, 2004; Kao et al., 2011; Nagar, 2015). However, the findings of our study indicate that there is no significant correlation between individuals' level of environmental consciousness and their inclination to participate in environmentally conscious consumer behavior. There seems to be no significant correlation between an individual's level of environmental literacy and their inclination to engage in purchasing behavior (Chekima et al., 2016; Tanner, Kast, 2003). Several studies have shown a significant association between the environmental information market and consumers' inclination to engage in environmentally conscious

buying behavior (Awan et al., 2021; Xu et al., 2019; Hamzah, Tanwir, 2021).

Many variables affect whether or not a customer will really make an ecologically friendly purchase. A person's outlook, values, assumptions, motives, emotions, experiences, societal pressures, practicalities, and satisfaction all play a role. Consumers' self-deprecation, self-enhancement, and consideration of both immediate and distant consequences are all influenced by nature orientation and environmental advertising. In this article, "environmental knowledge" refers to an awareness of environmental issues as well as an ability to address such issues. Environmental education may not have a significant effect on customers' intentions to make ecologically responsible purchases if there is a gap between knowledge and action. Many people are aware of environmental problems, yet they do little to address them. A lack of motivation and confidence are two of the main reasons behind this. Also, there are several possible extraneous impacts on learning about the environment, including economic interests and lifestyle choices. It's possible that customers may have a better understanding of environmental issues as a consequence of this trend, but they may still select for practices that aren't sustainable. When taking the larger picture into account, it's possible that a person's attitude towards nature is influenced by a number of things, including their level of education, their life experiences, and their proximity to natural places. Consumers' attention to environmental concerns and their respect for nature may both rise as a result of environmental education efforts. Eco-friendly goods and services may be developed by companies and sold at affordable prices. Sustainable consumption is a multi-faceted notion that involves awareness, conduct, and government restrictions.

Through the dissemination of information on the ecological consequences associated with consumer choices and the promotion of sustainable goods and services, advertising may have a beneficial influence on the practice of sustainable consumption. Nevertheless, it should be noted that advertising is not the only determinant of sustainable consumption. When assessing the variables influencing consumers' decision to engage in sustainable consumption, it is seen that internal elements, namely self-awareness and values, have more significance compared to external influences,

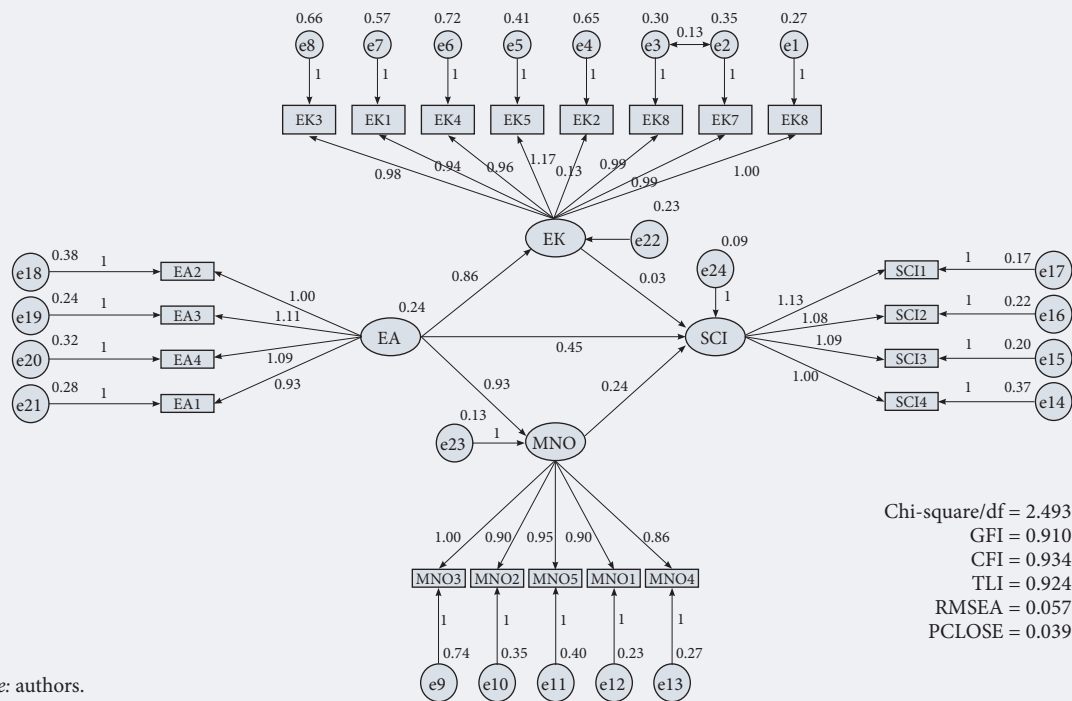
Table 9. Summary of the Structural Model

Relationship	Estimate β	S.E	C.R	P - value	Hypothesis	Hypothesis Result
SCI \leftarrow EK	0.034	0.044	0.778	0.437	H1	Reject
SCI \leftarrow MNO	0.240	0.077	3.135	0.002	H2	Accepted
SCI \leftarrow EA	0.447	0.111	4.036	***	H3	Accepted
EK \leftarrow EA	0.864	0.088	9.873	***	H4	Accepted
MNO \leftarrow EA	0.925	0.103	8.9444	***	H5	Accepted

$R^2 = 0.595$ (SCI), $R^2 = 0.422$ (EK), $R^2 = 0.614$ (MNO)

Source: authors.

Figure 2. SEM Model



Source: authors.

such as advertising. This assertion is supported by the observation that there exists a negligible association between individuals' level of environmental awareness and their engagement in sustainable consumption practices. From a conceptual standpoint, it is logical to assert that the choice to choose a sustainable lifestyle is inherently subjective and individualistic. The impact of advertising on our decision-making process is undeniable, but it lacks the ability to coerce us into making a predetermined choice. The present thesis posits a diminished stance about the impact of advertising on promoting sustainable consumption. Furthermore, it is worth noting that the correlation between advertising and sustainable consumption may possess a level of complexity that surpasses our present understanding. The influence of this connection might potentially be influenced by other factors, such as the qualities of advertising or the individual attributes of customers. Further investigation is necessary to enhance our understanding of the correlation between advertising and sustainable consumption.

Conclusion

The examination of green consumer behavior has significant value due to the imperative nature of comprehending the factors that influence intentions to engage in sustainable purchasing. The primary objective of this study is to enhance comprehension of the factors that exert effect on consumers' sustainable purchase choices. A study investigating the influence of age and occupation on the inclination of Vietnamese consumers towards sustainable consumption indicates that indi-

viduals in the age range of 50 to 60, particularly those employed in government and public service sectors, exhibit a greater propensity for sustainable consumption compared to younger age groups and individuals involved in alternative occupations. This demographic has more financial stability and a higher level of discretionary income compared to other groups, enabling them to allocate resources towards the acquisition of premium, secure, and ecologically sustainable products and services. The present cohort exhibits a heightened comprehension of social and environmental concerns, resulting in an elevated level of concern for the well-being and contentment of themselves and their close relations. Consequently, there is a growing inclination among customers to seek out products and services that prioritize health, minimize risks, and demonstrate environmental sustainability.

The degree of an individual's engagement with the natural environment (MNO) has a substantial influence on their viewpoint about sustainable consumption. Customers exhibiting a high level of MNO (Materialism, Need for Cognition, and Openness to Experience) have a greater inclination towards prioritizing the security of their purchases and the promotion of sustainable development. In addition, customers exhibit a proclivity towards environmentally friendly products, namely those manufactured using recycled or biodegradable materials, as a means of showcasing their commitment to environmental preservation and harmonious coexistence with the natural environment. Furthermore, empirical research has shown that environmental advertising has a substantial impact on

individuals' inclination to engage in sustainable consumption behaviors ($\beta = 0.447$). The findings of this study indicate that an increase in consumers' confidence in environmental advertising has led to a corresponding increase in their knowledge of eco-friendly products and a greater recognition of their benefits. The facilitation of environmental consciousness and the enhancement of consumers' ability to differentiate between environmentally friendly products and conventional alternatives might potentially streamline the procedure of recognizing and choosing eco-conscious merchandise. Moreover, individuals' comprehension and valuation of the environment may be impacted by the depictions they see in various forms of media. The aforementioned marketing strategy effectively fosters a heightened appreciation for the environment and biodiversity by disseminating pertinent information, expertise, and educational resources.

The findings of the present study indicate that there is no significant correlation between environmental

awareness and the inclination to practice sustainable consumption. This contrasts with previous research done in Western settings. One may posit that the purchasing power of consumers is impeded by their existing income levels, their insufficient environmental consciousness, or their lack of incentive to engage in sustainable consumption. Hence, it is essential to cultivate and sustain supplementary elements such as pro-environmental attitudes and values, risk awareness, individual effectiveness, supporting social influences, affordability, and accessibility to environmentally sustainable products and services. The aforementioned factors, in conjunction with heightened environmental knowledge, bolster consumers' dedication to engaging in ecologically conscious buying practices. Given the pivotal role that the younger generation plays in ensuring the enduring sustainability of a country, it is imperative to enhance the educational efforts targeting students and schoolchildren on the significance of sustainability.

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Decarbonisation: A Case Study of Malaysia

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Abstract

The study aims to assess the decarbonization efforts of corporations in Malaysia in relation to the country's national net-zero emission targets. A qualitative approach was adopted, employing two focus group discussions (FGDs) with a total of 18 participants. The FGD questions were developed based on the participants' expertise and experiences. Thematic analysis was employed to analyze the collected data. This study sheds light on key decarbonization practices at Malaysian companies, which place greater emphasis on environmental regulatory compliance and cost-saving measures. However, investments in decarbonization remain a small part of overall capital investments and receive little attention from

corporate leadership. The importance of addressing the concerns raised by this study is key to realizing Malaysia's Determined National Commitment (NDC) to achieve net zero emissions by 2050. This study contributes to the existing literature by providing insights into the decarbonization efforts of corporations in Malaysia, specifically in the context of the country's national net-zero emission targets. The research utilizes a qualitative approach and applies thematic analysis to explore the perceptions and motivations driving decarbonization initiatives. The study also highlights the role of government pressures and the need to address critical business concerns for successful decarbonization.

Keywords: decarbonisation; corporate sustainability; competitive advantage; carbon pricing; capacity-building; Malaysia

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Introduction

Limiting global warming to well below 2°C requires a dramatic acceleration of decarbonization efforts to achieve near-zero anthropogenic greenhouse gas emissions by the mid-century. In the pursuit of decarbonization, investment appraisals and carbon internal pricing play vital roles. Carbon pricing is a mechanism that accounts for the external costs of greenhouse gas (GHG) emissions, which are costs borne by the public (Green, 2021; Khan, Johansson, 2022). Internal carbon pricing (ICP) enables companies to assign a monetary value to each ton of carbon emissions, even in the absence of external carbon pricing policies and regulations (Ma, Kuo, 2021; Zhu et al., 2022). By incorporating their own carbon price, companies can better assess investments, manage risks, and shape strategies (Mercer et al., 2020). ICP can steer organizations toward low-carbon practices and inform decisions related to capital investments, particularly those that directly impact emissions, energy efficiency, or the energy sources portfolio (Russo et al., 2021).

According to research by the Carbon Disclosure Project, the adoption of ICP is on the rise, with an 80% increase in the number of companies utilizing or planning to utilize internal carbon pricing over a span of five years (Carbon Disclosure Project (CDP).¹ It accelerates decarbonization efforts by driving decarbonization across the value chain and facilitating the transition to a low-carbon economy (Byrd et al., 2020). Overall, ICP supports the identification of profitable low-carbon investment opportunities, enhancing the business case for companies to adopt such practices (Carroll et al., 2019).

Malaysia, as one of the major countries in Southeast Asia, a signatory to the Paris Agreement, has committed to reducing its carbon emissions by 45% by 2030 and achieving net-zero emissions by 2050 (Reyseliani et al., 2022). However, Malaysia's actual carbon emission reductions have been lagging behind since signing the agreement (UNDP, 2016). Factors, such as a growing population, industrialization, and heavy reliance on fossil fuels for energy generation contribute to Malaysia's rising carbon emissions (Abbasi et al., 2022). To meet these climate targets, Malaysia must transition to cleaner energy sources, improve energy efficiency, and implement policies promoting sustainable transportation and reducing deforestation (UNDP, 2021).

In 2019, the International Energy Agency reported that Malaysia's CO₂ emissions increased by 3.2% to approximately 248.7 million metric tons. Due to the COVID-19 pandemic, Malaysia's CO₂ emissions decreased significantly in 2020. According to the IEA,

Malaysia's CO₂ emissions decreased by 9.3% to approximately 225.7 million metric tons. Preliminary data from the IEA shows that in 2021, Malaysia's CO₂ emissions increased by 4.5% to approximately 235.8 million metric tons.²

The decision to choose Malaysia as a focal point for this research is underpinned by several compelling reasons. Firstly, Malaysia represents a fascinating case study in understanding both the challenges and opportunities associated with decarbonization. Analyzing corporate decarbonization efforts in Malaysia provides invaluable insights into the determinants that shape corporate action in line with national climate goals. The outcome of this investigation stands to not only unravel the challenges and propellers of decarbonization in Malaysia but also suggests effective strategies for a swift shift to a low-carbon economy. Importantly, by spotlighting Malaysia, this research emphasizes the significance of tailoring strategies to the distinctive hurdles each nation confronts on their path to decarbonization. It underscores the need for region-specific strategies and policy measures that can usher sustainable progress and climate change mitigation.

Moreover, Malaysia's trajectory as an emerging economy with a burgeoning industrial sector offers a quintessential portrayal of the tightrope walk between economic expansion and curbing carbon emissions—a challenge resonating with several emerging economies. Furthermore, Malaysia's position as Southeast Asia's second-largest oil and natural gas producer, as well as its ranking as the world's fifth-largest liquefied natural gas (LNG) exporter in 2019, paints a telling picture. With its strategic location on critical sea trade routes and the data from the US Energy Information Administration (EIA) underscoring its heavy dependence on fossil fuels, the nation's transition to a greener, low-carbon energy model serves as a pertinent case study.

Another dimension that makes Malaysia an interesting case is its rich biodiversity and vast coastline, both of which are under the looming threat of climate change repercussions, notably rising sea levels. By delving into Malaysia's decarbonization strategies, one can derive lessons on how nations can brace against and counteract climate change adversities. On the policy front, Malaysia's initiation of several green policies and acts, like the National Biofuel Industry Act of 2007, the formation of the Sustainable Energy Development Authority (SEDA), and the Green Technology Master Plan spanning 2017 to 2030, offers a lens into the efficacy of governmental interventions. These insights are instrumental for nations worldwide. More recently, under the banner of the Paris

¹ https://www.rbc.com/community-sustainability/_assets-custom/pdf/84280_BRO_2013CarbonDisclosure_E.pdf, accessed 14.10.2023.

² <https://www.iea.org/reports/key-world-energy-statistics-2020>, accessed 14.10.2023.

Agreement, Malaysia has set forth an ambitious plan to reduce its emissions intensity by 45% by the year 2030, benchmarked against 2005 levels, with one-tenth of this reduction being reliant on international help. In essence, by dissecting Malaysia's endeavors toward decarbonization, stakeholders, from policy-makers to researchers, stand to gain a deep understanding of the intricate dance between transitioning to a low carbon economy while ensuring sustained economic prosperity.

Despite the growing body of research on decarbonization in Malaysia, there are still several gaps that need to be addressed. First, there is a lack of comprehensive studies that examine the different sectors and industries in terms of their decarbonization efforts. Second, there is a need for an in-depth analysis of strategies that can transform decarbonization from mere compliance into a competitive advantage for companies. This analysis should consider various factors, such as investment criteria, the percentage of investments allocated to decarbonization, company perspectives on decarbonization, emission disclosure obligations, carbon internal pricing, and the impact of the United Nations' Sustainable Development Goals and the Paris Climate Agreement on company operations and future planning. Addressing these research gaps is crucial as it will provide policymakers, practitioners, and stakeholders with the necessary insights to make informed decisions and develop effective strategies to accelerate decarbonization in Malaysia. Furthermore, it will contribute to global climate action efforts by fostering sustainable and low-carbon practices within the country.

Literature Review

Decarbonization and Corporate Sustainability

Decarbonization entails efforts to reduce greenhouse gas emissions and decrease reliance upon fossil fuels, while corporate sustainability involves responsible business practices that encompass social, economic, and environmental dimensions. These two concepts are interrelated and mutually influential in striving toward sustainable development goals. The reviewed literature provides several findings highlighting the importance of sustainable technological innovation and value chain reconstruction in achieving sustainable decarbonization at both the local and global levels (Balaras, 2022; Peng et al., 2022; Zamri et al., 2022).

Studies also emphasize that corporate sustainability and inclusive economic development must be integral parts of decarbonization efforts (Romashova, Cherepovitsyna, 2023). In this context, factors such as cultural considerations, environmental regulations, and public participation in decision-making regarding decarbonization and corporate sustainability are crucial (Hakovirta et al., 2022; Setiawan, Setiyo, 2022).

Decarbonization Strategy and Competitive Advantage

Decarbonization strategy and competitive advantage have emerged as critical topics in the field of sustainable business and environmental management. As the world faces the pressing challenges of climate change and the transition to a low-carbon economy, businesses are increasingly recognizing the need to develop effective decarbonization strategies. Studies have highlighted the presence of a low-carbon premium during periods of accelerated decarbonization, indicating that investing in low-carbon companies can result in higher returns without significantly altering the overall risk profile (Ouchani et al., 2022). This suggests that companies that adopt effective decarbonization strategies can gain a competitive edge on the market.

Additionally, the integration of environmental, social, and governance (ESG) factors into investment strategies has been shown to outperform screening or divestment approaches, indicating that incorporating sustainability considerations into business practices can lead to better financial performance (Chantre et al., 2022; Jean et al., 2019). Finally, the literature recognizes the significance of commercialization and technological advancements in the decarbonization process. New product generation and the successful market adoption of sustainable technologies play a pivotal role in driving industrial decarbonization (Wan et al., 2022). By focusing on innovative solutions and market-driven approaches, companies can enhance their competitive position and contribute to the overall decarbonization goals.

Malaysia's Low Carbon Development

Malaysia began its journey towards a greener future in 2006, with several policies and strategies introduced to reduce its carbon footprint. Among these initiatives were the inclusion of palm biodiesel in diesel fuel, the establishment of a Sustainable Energy Development Authority (SEDA) to encourage the use of renewable energy, initiatives to promote public transportation over private vehicles, and an emphasis on green technologies (Zamri et al., 2022). Significant plans and policies included the Ninth through Eleventh Malaysia Plans, the National Biofuel Industry Act, and the National Renewable Energy Policy. The Green Technology Master Plan (2017–2030) stands out, targeting a 45% reduction in greenhouse gas emissions by 2030 and setting bold goals in transport, building, and waste management sectors (Mohamed et al., 2016).

Malaysia quantifies its carbon emissions intensity in several ways, considering both per capita and GDP metrics. With specific emphasis on land use and forestry (LULUCF), the government's 2011 report showcased significant reductions from 2005 levels.

The country achieved a commendable 32.5% carbon emissions intensity reduction in 2011, with forest gazetting playing a significant role. However, there is a need to recognize the difference between real emission reductions and maintaining carbon sink capacity, emphasizing the importance of other mitigation policies. Malaysia's target of a 45% carbon intensity reduction is measured per GDP unit, indicating that while the country aims for "green growth," overall GHG emissions might rise as the economy expands (Mohamed et al., 2016).

In the literature, Malaysia's decarbonization journey is explored in depth. The nation grapples with high emissions stemming primarily from the energy sector. Barriers to greener growth include political challenges, regulatory limitations, and a heavy reliance on fossil fuels. Recommended strategies encompass renewable energy promotion, energy efficiency enhancement, and sustainable transportation. Critical issues such as standardizing internal carbon pricing and securing funds for green projects are also noted. It is clear that understanding local companies' perspectives can aid in formulating effective policies, ensuring Malaysia's smooth transition to a low-carbon economy.

The literature review highlights key findings from various studies on decarbonization in Malaysia. The country faces challenges related to its carbon-intensive development path, primarily driven by the energy sector resulting in high greenhouse gas emissions (Zamri et al., 2022). Factors such as a lack of political will, inadequate regulations and incentives, and heavy reliance on fossil fuels contribute to this carbon lock-in (Ghosh, Gupta, 2022). To address this situation, proposed strategies include increasing the share of renewable energy, improving energy efficiency, and promoting sustainable transportation (Ilham, Fajar, 2020).

Challenges exist in implementing internal carbon pricing, including the need for standardized calculation methods and appropriate pricing structures (Zhang et al., 2021). Access to finance and funding for low-carbon projects remains limited, highlighting the need for supportive policies and institutional arrangements (Lim et al., 2020). Reviewing and updating environmental legislation is recommended to align policies with contemporary conditions (Sufian et al., 2021). Understanding Malaysian companies' perspectives can inform the development of relevant policies, regulations, and partnerships to facilitate the transition to a low-carbon economy in Malaysia and other countries pursuing net-zero commitments (Lusiana et al., 2021).

Methodology

Research Methodology

The participants in this study were carefully selected based on their expertise and active involvement in the company's sustainability and decarbonization

processes. To ensure a comprehensive perspective, the sample profile included individuals at various management levels, encompassing GMs and above, heads of departments/divisions, and managers. By involving experts in these areas, the study aimed to gather valuable insights and perspectives from individuals actively driving sustainability and decarbonization within the organization, contributing to a well-rounded and informed understanding of the topic under investigation.

The focus group discussions (FGDs) were expertly moderated by a team member with over 10 years of experience in conducting FGDs and one-on-one interviews. The FGDs followed a semi-structured format, with carefully designed open-ended questions to elicit detailed responses from the participants. The questions were strategically crafted to explore how businesses approach decarbonization as a practice, the challenges they encounter, and their viewpoints on the changes necessary to overcome those challenges. To ensure accuracy and authenticity, the summary notes for each FGD were confirmed by each participant, reflecting their frank and honest opinions.

During this study two rounds of FGDs were conducted, with the first group scheduled from 11:00 am to 11:50 am and the second group after lunch, from 2:00 pm to 3:00 pm on March 11th, 2023. The sample profile consisted of 18 participants, including three individuals at the management level (GM and above), seven heads of departments/divisions, and 11 managers and below. The selection of the Property Construction/Development, Plantation, and Manufacturing sectors for this study was based on its significant contribution to greenhouse gas (GHG) emissions, including carbon dioxide (CO₂) and methane (CH₄). GHG emissions are a primary cause of climate change and global warming.

The formulation of the provided questions is rooted in a meticulous process that combines insights from literature reviews and established best practices. Essentially, before these questions were crafted, there was an in-depth examination of academic and industry research to ensure a comprehensive understanding of the subject at hand. Concurrently, the most effective and efficient methods or standards, as acknowledged by experts or leading institutions in the field, were also considered. This dual reliance on both academic literature and tried-and-true methods guarantees that the questions are not only relevant but are also adept at capturing the necessary data for the investigation. Investment policies and company practices regarding decarbonization can vary by industry, company size, and sustainability commitment (Ghosh, Gupta, 2022; Gomez Echeverri, 2018). The questions asked related to:

- 1) What are your corporate decarbonization investment criteria?
- 2) What is the share of total corporate investments in decarbonization?

- 3) Beyond compliance with government regulations and incentives, what is your or your company's view of decarbonization efforts?
- 4) In your opinion, what is needed to pivot decarbonization from being a matter of simple compliance to becoming a competitive advantage for companies?
- 5) What is your company's view of mandatory annual disclosures of carbon (GHG) and Scope 3 emissions?
- 6) Is ton CO₂ equivalence or carbon internal pricing the practice at your company?
- 7) UN Sustainable Development Goals and Paris Climate Accord: how have these impacted your operations and future planning?
- 8) Any other comments or thoughts on sustainability, carbon emission, climate change, renewable energies, annual reporting, or other issue?

Thematic Analysis

This study employed a rigorous thematic analysis of FGDs to gain a profound understanding of participants' perspectives on decarbonization. Thematic analysis is a robust qualitative research technique that systematically identifies, analyzes, organizes, describes, and reports the major themes present in the collected data, yielding comprehensive and reliable results. To ensure the validity of the analysis, the author conducted multiple exhaustive readings of the interviews, leading to the development of an initial list of codes. These codes were later reviewed and discussed with other authors, reaching a consensus on their relevance and applicability.

In line with the principles of qualitative inquiry literature (Byrne, 2022; Kiger, Varpio, 2020; Thompson, 2022), the authors adhered to criteria ensuring the trustworthiness in their research. Continuous peer debriefing of the transcripts, translations, selected themes, and analysis of results contributed to the credibility of the findings. The authors followed a logical decision-making process, supported by the existing literature, to ensure the dependability of research outcomes.

In addition to the aforementioned methodologies, this study also employed the use of word clouds as a visual representation tool to further understand the frequency and prominence of specific terms related to decarbonization used by the participants. Word clouds, which depict words in varying sizes based on their occurrence, provide a snapshot of the salient topics discussed during the FGDs, allowing researchers and readers to instantly gauge key areas of focus.

To enhance confirmability, two primary strategies were employed. Firstly, the authors engaged in triangulation by cross-referencing interviewee responses with other sources, such as existing literature and personal observations (Flick, 2018). This approach added further validity to the findings by corroborat-

ing data from multiple perspectives. Secondly, the inclusion of direct quotations from participants in the document provided an authentic reflection of their perspectives and added transparency to the analysis.

The transferability of the study's results is facilitated by the contextual descriptions included in the primary document. By providing detailed information about the research setting and participants, other researchers can better understand and evaluate the applicability of the findings to different contexts. Overall, the study's meticulous approach to thematic analysis, combined with its adherence to trustworthiness criteria, ensures that the results are robust, reliable, and valuable in contributing to the understanding of decarbonization perspectives.

A word cloud is a visual representation tool that portrays the frequency and prominence of specific terms within a given dataset, with the size of each word indicating its relative frequency or importance. In the context of our study on decarbonization perspectives in Malaysia, the word cloud generated provides insights into the most discussed and emphasized topics by the participants.

Current Practice

Compliance with Regulations and Follow-up on Government Incentive

When participants were asked about their corporate decarbonization investment criteria, the sub-themes that emerged shed light on the prevailing decarbonization practices among Malaysian businesses.

“Compliance with environmental regulations emerged as a top priority for nearly all organizations, followed closely by the consideration of government incentives such as grants, subsidies, or tax relief” (Expert 1, 2).

The inquiry into corporate decarbonization investment criteria revealed distinct sub-themes that shed significant light on the prevalent decarbonization practices within Malaysian businesses. One of the foremost priorities emerging from participant responses is the imperative of complying with environmental regulations, a sentiment echoed across nearly all organizations. This underscores the critical role that regulatory adherence plays in the decarbonization landscape. Scholars have extensively investigated

Table 1. FGD Number of Participants (Total N = 18)

Field	Group 1	Group 2
Property Construction/Development	2	3
Plantation	4	4
Manufacturing	3	2
Total	9	9
<i>Source: authors.</i>		

the effectiveness of various drivers in reducing carbon emissions and achieving deep decarbonization. For instance, Great Britain's transition to renewable energy sources, the closure of coal power stations, increasing carbon prices, and the implementation of energy efficiency measures were identified as key drivers responsible for a remarkable two-thirds reduction in carbon emissions from electricity generation (Gellert, Ciccantell, 2020; Green, Staffell, 2021; Price et al., 2018). Additionally, scholarly exploration has delved into the interplay between technology adoption and enforcement strategies. Research has demonstrated that tradable emissions permits (TEPs) have the potential to alter compliance behavior, diminishing the advantages of violating environmental regulations (Patel, 2012). This finding underscores the interconnectedness of compliance, enforcement, and technology adoption. Moreover, studies suggest that enhancing the rigor of enforcement strategies for TEPs could expedite the diffusion of innovative technologies, underscoring the pivotal role of enforcement in driving sustainable practices. These insights underscore the multifaceted nature of compliance mechanisms and underscore the crucial synergy between regulatory frameworks and societal practices (Nyanga, Nyanga, 2020).

Cost Saving

Participants showed a strong interest in cost-saving measures related to decarbonization efforts. For instance, they expressed enthusiasm for practices such as transitioning from fluorescent to LED lighting or incorporating solar panels to generate electricity. These findings suggest that efforts to improve the public's understanding of energy use and savings could have significant benefits (Bistline et al., 2022; Gupta et al., 2021).

“However, despite acknowledging the benefits of cost-saving measures, the participants remained uncertain about the extent to which decarbonization could offer a competitive advantage in their respective industries” (Expert 3, 5, 7).

The extent to which decarbonization can offer a competitive advantage in different industries remains uncertain (Gomez Echeverri, 2018; Nyanga, Nyanga, 2020). The analysis of carbon cost pass-through suggests that the impact of carbon pricing on product prices varies depending on factors such as international trade, market structure, and free allowance allocation (Kazi et al., 2021; Patel, 2012). While some energy-intensive industries express concerns about competitiveness, studies indicate that manufacturing industries may face more competitiveness issues in a world with a carbon price (Fleschutz et al., 2021).

Investing in Decarbonization as a Low Priority

Investing in decarbonization appears to be a low priority for two distinct groups. The first group, repre-

sented those companies that devote under 8% of annual investments to decarbonization, acknowledged that their current allocations were relatively small.

“The lack of firm government policies on achieving net-zero emissions as a contributing factor to their cautious approach” (Expert 4, 8, 12).

“On the other hand, the second group, accounting for approximately 6% of annual investments, expressed a desire to invest more in decarbonization. However, they admitted to being confounded by the complexity and uncertainty surrounding decarbonization strategies, which has hindered their ability to allocate greater resources toward this cause” (Expert 5, 9).

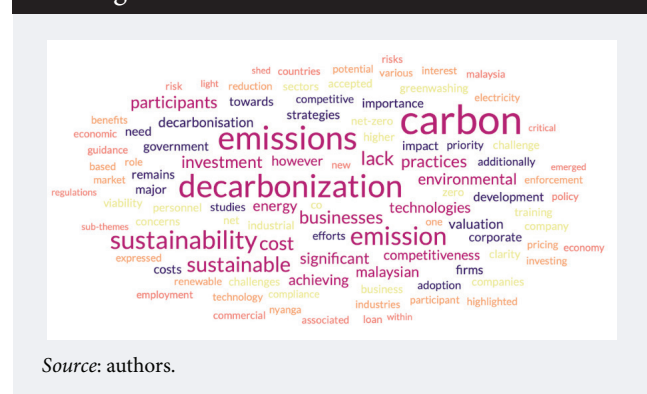
Decarbonization is considered a high priority based on the literature provided. The need for decarbonization is emphasized in the context of achieving the goals of the Paris Agreement and controlling global warming within acceptable parameters (Elkerbout et al., 2020; Ingeborgrud et al., 2020). It is noted that developing countries, in particular, require assistance due to a shortage of capital to carry out decarbonization strategies (Hammond, 2022; Rattle et al., 2023). The abstracts also discuss the importance of renewable energy in decarbonizing electricity systems, with a focus on Indonesia (Khatiwada et al., 2022). Additionally, the substitution of petroleum-derived feedstocks with biomass and biomass-derived feedstocks is seen as an imperative step toward the decarbonization of industrial processes (Gianoli, Bravo, 2020). Overall, the abstracts highlight the urgency and importance of decarbonization efforts in various sectors and regions.

Acute Shortage of T Personnel and Training Courses for Staff and Managers

One of the major challenges hindering effective decarbonization efforts is the acute shortage of trained personnel and the absence of relevant training programs for staff and managers.

“The lack of qualified personnel and specialized training programs poses a significant obstacle for businesses seeking to implement successful decarbonization initiatives” (Expert 6, 14).

Figure 1. Decarbonization Word Cloud



The lack of qualified personnel and specialized training programs is a significant obstacle for businesses seeking to implement successful decarbonization initiatives (Milani, Cerabino, 2020). Market mechanisms alone are unlikely to deliver the necessary skilled workers in a timely manner, leading to a slower and costlier transition (Ciotola et al., 2021). Small businesses, in particular, may lack the knowledge, skills, and resources to operationalize sustainable or green business practices (Betiku, Bassey, 2022). This highlights the need for broader access to resources and peer-to-peer sharing of knowledge and benchmarking in sustainable business practices (Shirov et al., 2023). Overall, the retention and effective utilization of trained personnel remains challenging, requiring significant changes in government policy and steps taken by training providers.

Concerns and Issues

Taxonomy - Clarity and Global Interoperability

In the context of decarbonization, participants expressed various concerns and challenges. One participant expressed frustration at the lack of clarity in defining decarbonization and the absence of global interoperability standards.

“An example of Malaysian exports being accused of forced labor by American and EU authorities due to the working and living conditions of foreign laborers. The lack of a clear and globally accepted definition for sustainable practices poses challenges for businesses operating in international markets” (Expert 7).

Scholarly works in the field of sustainable business literature reveal a lack of consensus in defining sustainability for businesses, which can detrimentally impact the business logic derived from sustainability concepts. This lack of clarity is also reflected in the existing typological reviews of sustainable business literature, which are lacking in their investigation of underlying theoretical frameworks and the implications of their application (Hsieh, 2020).

These challenges highlight the need for a better understanding of sustainability practices and the development of a comprehensive sustainability taxonomy to support critical discussions and practical applications (GRI, SASB, 2021).

Greenwashing – Knowingly and unknowingly!

Another participant raised concerns about greenwashing in the industry. They highlighted instances of high-profile investigations and court convictions involving misleading sustainability claims. These incidents have made them wary of venturing further into the field of sustainability without ensuring genuine and verifiable practices.

“Reported greenwashing, high-profile investigations, and court convictions in the recent years remain major concerns for them when taking more aggressive steps into this new field” (Expert 8).

“Highlighted a past incident that involved his company venturing into the manufacturing of biodiesel from palm oil, thinking that it was renewable energy. Unfortunately, the company was accused of greenwashing as part of the company palm oil production was from a new plantation that was previously a tropical rainforest” (Expert 9, 11).

Studies have shown that corporate greenwashing is a widespread phenomenon, but few have investigated its effects on consumers (Malecki, 2021). However, prosecuting environmental offenders remains challenging due to complex legal definitions, jurisdictional issues, and considerations about the burden of proof (Al Baroudi et al., 2022; Betiku, Bassey, 2022).

Conflict of Interests

Furthermore, participants observed a sudden surge in “carbon emission or sustainability experts” from major consultancy firms, raising questions about their authenticity and expertise. The potential conflict of interest for these firms, offering various services like sustainability consulting and emission disclosure, also became a point of concern. They questioned the authenticity and expertise of these overnight experts and stressed the importance of relying on reliable sources for credible advice and guidance.

“An overnight surge in “carbon emission or sustainability experts” from major consultancy firms makes one wonder about conflicts of interest given that such firms offer a multitude of services like auditing, consulting in sustainability, emission disclosure, and assurance of sustainability reports” (Expert 10, 15).

The issue arises because these firms provide a range of services that may create conflicts between their auditing and consulting roles. For example, firms may manipulate their carbon emission disclosures to favor their clients’ interests, even after incurring environmental controversy costs (Schapper et al., 2022). To address this, some companies voluntarily engage external parties for independent assurance of their greenhouse gas statements, particularly when there is higher information asymmetry between insiders and outsiders (Malecki, 2021). However, it is important to note that resolving carbon information asymmetry requires carbon assurance, which cannot be substituted for by financial auditing.

Rate of Transition to Net-Zero Emissions and Cost for the Private Sector

Participants stressed the importance of relying on transparent and unbiased guidance in sustainability-related matters. While acknowledging the positive impact of decarbonization, particularly demonstrated during the Movement Control Order (MCO) when air pollution in Kuala Lumpur significantly decreased, participants pointed out that achieving such results came at a substantial cost to the economy, with private sectors bearing the major financial burden.

“The air pollution in the KL (Kuala Lumpur) city area cleared up within a week of the MCO and remained clean until it was lifted, sometime late last year. However, this occurred at a huge cost to the economy and by extension we feel that the private sectors bore the major costs, enjoying some benefits but society/economy benefited the most and bore the least amount of cost” (Expert 1, 11, 13).

The challenge of maintaining competitiveness while pursuing net-zero emission goals was another significant consideration, with participants questioning the potential impact on employment and industrial development. Balancing environmental objectives with economic competitiveness emerged as a complex and crucial challenge that requires thoughtful planning and strategies to avoid adverse consequences for the nation’s economy and job market.

“If Malaysia races ahead of other competing countries in achieving net-zero emissions, can we still maintain our competitiveness or will we lose out in employment and industrial development?” (Expert 12, 14).

The costs associated with attaining net-zero emissions can vary depending on the chosen technology and approach. Studies have shown a range of costs for different methods. For instance, the cost of avoided CO₂ emissions through indirect ocean capture (IOC) was estimated between 373 and 604 per metric ton of CO₂ (Isaac et al., 2020; Stefanović et al., 2014). Another proposed strategy involves a carbon tax policy based on the zero-emissions cost (ZEC) metric, which could potentially shift the energy sector toward net-zero emissions, but might also carry the risk of triggering an economic recession (Skobelev et al., 2023; Zibunas et al., 2022). Additionally, the adoption of net-zero emission buildings in Australia resulted in the effective reduction of 44 Mt of CO₂ emissions per year, although the associated implementation cost was not specified. The cost targets for less-common zero-emission generation technologies such as nuclear, concentrating solar, and offshore wind ranged from 39 to 91 per MWh, contingent upon the desired grid penetration level (Zibunas et al., 2022). In conclusion, the journey toward achieving net zero emissions may necessitate substantial investments, yet the specific expenses can vary based on the chosen technology and approach.

Long-Term View

The long-term view on decarbonization encompasses several critical sub-themes, such as emissions valuation, the commercial viability of sustainable technologies, competitive advantages, and the role of carbon sinks and emission trading systems.

Emission Valuation

While some companies acknowledge carbon pricing and the need for loan portfolio risk assessments of carbon emissions, the challenge lies in establishing a universally accepted valuation method that is en-

dorsed by public auditors and the Malaysian government.

“[They] have heard of it but do not practise it at their respective companies. It was mentioned that one of the property developers (Sunway REIT, a listed Malaysian company) is practicing carbon internal pricing but I wonder how realistic this is since it’s a fixed price till 2030. Two other participants mentioned some Malaysian banks (CIMB was mentioned) are practicing loan portfolio risk assessment of the carbon emissions of their lenders” (Expert 1, 5, 13).

“The challenge is how to factor emissions or sustainability into our corporate decision making, which gets a bit debateable as the valuation of emissions or sustainability is still in a state of flux” (Expert 12, 14).

“Good to have some commonly recognized methods of valuation that are accepted by public auditors and the Malaysian government” (Expert 12, 15).

Establishing a universally accepted valuation method for carbon emissions that is endorsed by public auditors and the Malaysian government is a challenge. Companies recognize the importance of carbon pricing and the need for loan portfolio risk assessments of carbon emissions (De Jong et al., 2015; Trinks et al., 2022). However, there is a lack of standardized and internationally accepted data for estimating financed emissions (Bolwig et al., 2020; Mittal, Raman, 2022). The concept of financed emissions based on the corporate carbon footprint (CCF) can be used to assess exposure to climate risks and develop a climate strategy (Bolwig et al., 2020). The Greenhouse Gas Protocol and Technical Guidance for Calculating Scope 3 Emissions provide important guidance for quantifying financed emissions (Bolwig et al., 2020; Rosyid, 2016). Carbon valuation involves ascribing value to actions and objects in terms of carbon emissions, and it depends upon the construction of alternative scenarios (Elkerbout et al., 2020). Higher carbon emissions are associated with higher loan spreads, indicating that environmental risks drive spread premia (Rosyid, 2016). A market-based solution can complement explicit environmental regulations (Hakovirta et al., 2022).

Commercial Viability

The commercial viability of sustainable technologies remains a subject of debate, causing businesses to be cautious about investing in decarbonization. Uncertainties and risks associated with high investment costs and longer payback periods hinder decisive actions in this domain.

“The technologies and know-how may be there but how is commercially viability still debatable?” (Expert 3, 6, 14).

“What is the hurry to invest large amounts in decarbonization and bear large risks and uncertainty?” (Expert 2, 8, 10)

The commercial viability of sustainable technologies remains a subject of debate, causing businesses to

be cautious about investing in decarbonization. Research shows that smaller companies face both credit constraints and a lack of green management, which hinders their investment in cleaner technologies (Ma et al., 2022; Xiang et al., 2022). Additionally, businesses may be hesitant to replace non-sustainable products with sustainable ones because they struggle to see how sustainable products can provide a stronger competitive advantage (Skobelev et al., 2023). However, there is growing interest and receptiveness among customers toward sustainable innovations, indicating a potential market for sustainable products (Zibunas et al., 2022).

Overall, while there are challenges and uncertainties, there is a growing recognition of the importance of sustainability, and businesses may need to adapt and embrace sustainable technologies to meet the changing demands of the marketplace (Zhang et al., 2022).

Competitive Advantages

Furthermore, concerns arise about the ability to maintain competitiveness in employment and industrial development if Malaysia were to lead in achieving net-zero emissions compared to other countries. The concept of carbon capture and storage presents a new and intriguing avenue for sustainability, but the lack of clarity regarding official policy or direction hampers investments in this area.

“If Malaysia races ahead of other competing countries in achieving net zero emissions, can we still maintain our competitiveness or would we lose in employment and industrial development?” (Expert 15).

“We can see some social benefits but corporations incur higher costs and this is finally paid for by the end-users” (Expert 12, 14).

The studies suggest that more efficient energy use and a focus on sectors such as manufacturing, electricity, and transportation can help restrain the rise in CO₂ emissions without hampering economic growth (Sherman et al., 2020). Additionally, the research indicates that industrialization has a statistically significant negative impact on CO₂ emissions, while foreign direct investment and real gross domestic product have a significant positive impact (França et al., 2023). Therefore, it is important for Malaysia to devise carbon emission reduction strategies that consider the mediating effect of carbon damage costs and the use of significant regulations to attract more foreign direct investment. While there may be higher costs to corporations, the adoption of renewable energy is recommended to reduce carbon emissions and achieve a balance between economic development and environmental sustainability.

The Carbon Sink and Emission Trading System

The Carbon Sink and Emission Trading System (ETS) plays a vital role in decarbonization efforts, yet it is concerning that these crucial aspects, along with car-

bon emission reduction, climate change, and sustainability, are not given high priority on most company board of directors' agendas. Participants highlighted that discussions on these topics are infrequent during board meetings, potentially hindering the adoption of robust and decisive actions toward decarbonization.

“Carbon capture and storage is a new and interesting area but there is a lack clarity in official policy or direction.” (Expert 7, 10, 14).

“Another participant shed light on the infrequent nature of discussions regarding emissions and sustainability in board meetings, sharing” (Expert 11, 13).

“Emissions or sustainability as a Board of Directors (BoD) meeting agenda item usually appears once a year, to approve the publication of the sustainability reports and any update on matters related to sustainability/emissions. If there was any public allegations or breach of law relating to sustainability/emissions then these issues might be addressed a few more times until the issue is resolved, in the last three years, this has happened only once.” (Expert 1, 5, 9).

Interestingly, research demonstrates the pivotal role that ETS policies can play in driving carbon emission improvements and fostering innovation capabilities among listed companies (Verde et al., 2021; Zheng et al., 2021). Additionally, the adoption of ETS can yield dual benefits of enhancing green development efficiency and promoting regional carbon equality, thereby boosting green total factor productivity and reducing investments in carbon-intensive industries (Sherman et al., 2020). To enhance the security and efficiency of ETS, an innovative approach called Blockchain-enabled Distributed ETS (BD-ETS) has been proposed. This model transforms the conventional centralized trading mode into a distributed system based on smart contracts, potentially enhancing the overall effectiveness of emissions trading (Dong et al., 2022). Emissions trading systems exhibit distinctive characteristics, including allowance allocation, the possibility of market linkage, and price volatility, necessitating a comprehensive understanding of the behaviors exhibited by producers and consumers within these systems (Zheng et al., 2021). Notably, the EU ETS has demonstrated success in emissions reduction and addressing environmental externalities, offering valuable insights for the establishment of a global emission trading system.

Figure 2 provides a comprehensive overview of the formation of the decarbonization concept. As we delve deeper into the intricacies of this formation, we note that at the heart of Malaysian businesses' decarbonization agenda is a strong inclination to prioritize compliance with environmental regulations. This priority is not a standalone; it is intricately linked with their tendency to also consider government incentives. Transitioning further into the details of their strategies, there is palpable enthusiasm among these

businesses for adopting cost-saving measures. One prominent example is their shift to energy-efficient solutions. However, despite this enthusiasm, a cloud of uncertainty looms regarding the actual competitive edge these measures can provide across various industrial sectors. This uncertainty serves as a transition to an alarming revelation: for a significant number of businesses, decarbonization is not a top-tier investment priority. The roots of this mindset can be traced back to two intertwined reasons: the perceived absence of robust government policies supporting decarbonization and the inherent complexities of the decarbonization process itself. Building upon these challenges, the narrative arrives at another pressing concern - the scarcity of expertise. Malaysian businesses are grappling with a notable skills gap. This gap is not just about the absence of skilled personnel, but it is also about the glaring lack of specialized training programs tailored for decarbonization. This situation further complicates the already intricate puzzle, making the effective realization of decarbonization objectives an uphill task.

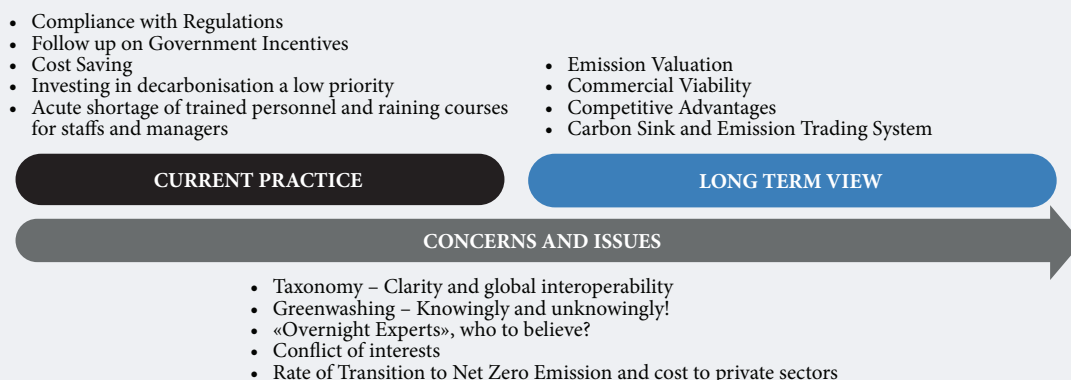
Conclusions and Policy Recommendations

Our research has provided a comprehensive understanding of current decarbonization practices within Malaysian companies. While there is a pronounced commitment to adhere to environmental regulations and adopt cost-saving measures, there remains a palpable reservation in treating decarbonization as a key investment area. Such an approach necessitates revision to ensure alignment with Malaysia’s National Determined Contribution (NDC) of attaining net-zero emissions by 2050. The thematic dissection reveals that for many businesses, compliance with environmental standards is non-negotiable, with a significant emphasis also placed on national government incentives, including grants and tax relief measures. How-

ever, while cost-reduction tactics are popular, there is hesitancy in holistically embracing decarbonization. This reluctance is fueled by the absence of clear national policies and the perceived intricacies of decarbonization strategies. A glaring challenge highlighted is the critical deficit of personnel trained in decarbonization. This obstacle is further magnified by the rise of so-called experts, clouding the market and raising concerns over the genuineness of their expertise. Several nuanced challenges have also come to the fore, including the need for clearer definitions around sustainability at a national level, the conundrum of balancing competitiveness and sustainable transitions, and the surprisingly sparse discussions about these pivotal topics in top-tier corporate meetings.

To craft a harmonized global strategy, it is imperative to establish a universally accepted taxonomy and reporting structure for sustainability and carbon emissions. Such an initiative mandates collaboration from the national government, global entities like the United Nations SDG Funds, and standards organizations including the International Accounting Standards Board (IASB). To address the rise of questionable consultants, the national government should mull over the inception of a certification institution. Such a body would benchmark and confirm the credentials of these professionals, alleviating the industry’s prevailing scepticism. Moreover, at the national level, there is a pressing need to craft and promote robust training programs aimed at decarbonization. Simultaneously, clear and actionable policies, furnished with discernible guidelines on sustainable practices, would facilitate businesses in their transition endeavors. Educational institutions, possibly with regional government collaboration, should pioneer programs that satiate the existing knowledge void in sustainable practices. Partnering with industry stakeholders ensures that the curriculum remains aligned with re-

Figure 2. Decarbonization Concept



Source: authors.

al-world requirements. It is paramount for businesses to recalibrate their operational strategies. This means placing decarbonization at their core. This transition would necessitate the establishment of tangible goals, crafting strategic pathways to realize net-zero ambitions, and instituting regular reviews to gauge the efficacy of these endeavors.

Further Research

The landscape of further research beckons, aiming to unearth strategies that transcend the mere adherence to regulatory requirements and genuinely propel companies toward prioritizing decarbonization. This avenue could involve a meticulous exploration of the latent advantages that decarbonization confers upon companies as a competitive edge. Additionally, delving into the intricacies of obstacles that obscure these advantages from the perspective of companies is an avenue that holds promise.

Venturing into the realm of research necessitates a comprehensive inquiry into the potential of carbon internal pricing as a tool for investment appraisal. This entails scrutinizing its capacity to effectively assess the commercial viability of decarbonization technologies. Such an exploration not only enriches the decision-making arsenal of businesses but also offers novel insights into the economic viability of sustainable endeavors.

The frontiers of further research extend to unraveling the true essence of a “clear taxonomy” and an unswerving framework for measuring emissions, one that seamlessly transcends diverse economic contexts. This avenue of inquiry, when navigated adeptly, lays the groundwork for broader adoption across diverse economies and businesses. An understanding of these intricacies not only catalyzes broader adoption but also engenders a harmonized approach in grappling with emissions measurement.

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Competitive Strategies for Corporate Sustainability

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Abstract

This is an exploratory study to gain insight among tax and Environmental, Social, and Governance (ESG) practitioners on the link between ESG and tax compliance. Prior studies used secondary data to examine the association between ESG and tax avoidance and reported inconclusive results. This leads to speculative discussions to support the results, among which are corporate ethics and corporate hypocrisy. This motivates the present study to examine the perception among involved parties to understand their views on the relationship. A total of 22 respondents representing firms,

consultants, and regulators are interviewed. We found a gap between the perception of firms and tax regulators and that of consultants concerning the link between ESG and tax compliance. There is also inconsistent views among sustainability and tax personnel at firms. Interestingly, we found that only government-linked companies perceived tax compliance as part of their social responsibilities. Our study implies that there is evidence to support a negative relationship and no relationship between tax avoidance and ESG but no evidence to support corporate hypocrisy.

Keywords: tax compliance; tax avoidance; ESG

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Introduction

The present business environment demands that firms not only serve their shareholders but also other stakeholders. Pressure from stakeholders such as investors, regulators, and the public causes firms to engage in environmental, social, and governance (ESG, hereafter) initiatives (Cicchello et al., 2023). While such pressure can be argued to be a source for firms to engage in ESG activities, prior studies have found that the act can also be tied to morality and the ethical stand of the firm (Bouzzine, Lueg, 2023; Mitnick et al., 2023) or simply a strategic business move to gain economic benefits from the customers (Hamza, Jarboui, 2020; Herremans et al., 1993).

At the same time, the ESG agenda has coincided with an increasing efforts by the Organisation of Economic Co-operation and Development (OECD, hereafter) to combat aggressive tax avoidance strategies (Fonseca, 2020). Corporate tax avoidance is also associated with unethical or immoral stances (Jenkins, Newell, 2013; Scheffer, 2013; Sikka, 2010) and a firm's pursuit of pure economic benefits for shareholders (Wang et al., 2020). With the initial publication of the OECD's guidelines on multinational enterprises¹ (MNEs, hereafter) in 2008 (revised in 2011), many countries subscribed to the idea of incorporating tax governance and tax compliance as important elements in the broader risk management system. The guidelines emphasize the need to have good internal control within a corporation that will enable them to be responsible for tax compliance. However, most countries did not make tax compliance an explicit requirement in their corporate governance legislation except for three countries – Australia, the UK, and the Netherlands (OECD, 2013).

Sikka (2010) argued that in a situation where a firm engaged in both ESG (or corporate social responsibility – CSR) and tax avoidance, the firm is displaying inconsistent ethical values or “corporate hypocrisy” as termed by Sikka (2010). Organized hypocrisy constitutes inconsistencies between action, talk (rhetoric), and decisions, which arises from an environment characterized by irreconcilable normative-ideational pressures. As such, firms with sound ethical standpoints should comply with both the letter and the spirit of the law, thus not engaging in any aggressive tax avoidance activities.

Corporate hypocrisy is a situation where a firm is not consistent in its ethical standing, where the firm attempts to portray itself as having ethical and

moral values through its ESG initiatives to cover up its actual moral standard. If a firm is consistent in upholding its moral and ethical standards, the relationship between ESG and tax avoidance should be negative. Tillman et al. (2020) identified three theoretical facets of corporate hypocrisy perceptions: moral hypocrisy, behavioral hypocrisy, and hypocrisy attributions – which are derived from two sources (i) driven by firms' deceptive practices and (ii) driven by mere inconsistent behaviors.

Given the mixed results between tax avoidance and ESG as reported by prior studies (Godfrey, 2005; Godfrey et al., 2009; Jones et al., 2017; López-González et al., 2019; Ortas, Gallego-Álvarez, 2020; Yoon et al., 2021) which has only relied on secondary data sources, the main aim of this paper to evaluate the extent to which tax avoidance is associated with ESG using primary data sources within a qualitative scope and seek a better understanding of tax avoidance in relation to ESG. As such, this study will provide evidence of the concept of tax avoidance, as practiced and conceptualized by organizational actors in the taxation ecosystem within the ambit of the ESG context.

In Malaysia, the OECD MNE guidelines have been adopted and the Inland Revenue Board issued a tax corporate governance framework in April 2022. However, there is no explicit requirement in the Malaysian Corporate Governance Code. Given the implicit requirement for tax in current legislation and unsettled arguments in the literature linking ESG with tax compliance, this study attempts to explore the perception among relevant parties in the industry, including tax practitioners, ESG practitioners, consultants, and regulators as to what are the links between ESG and tax strategy (avoidance or compliance). The findings of this study will help to establish the extent to which tax compliance is perceived to be related to ESG in Malaysia. This will expose the gap that needs to be addressed by the relevant authorities to educate, enforce, and implement the necessary changes in legislation.

Literature Review

ESG

The concept of ESG was initially confined to CSR activities among firms. However, the CSR concept was further refined by the United Nations (UN) to include governance, known as ESG. In its role to promote ESG, the UN has issued the Principles of Responsible Investment (PRI)² report. The re-

¹ In two editions – 1st in 2008, and 2nd in 2011. <https://www.oecd.org/corporate/mne/>, accessed 19.06.2023.

² <https://www.unpri.org>, accessed 19.06.2023.

port recommends that investors incorporate ESG factors into their investment decisions and active ownership. This later has been embraced by governments, firms, banks, and rating agencies that had shaped the current ESG landscape in the world. ESG ratings and scores such as Global Reporting Initiative (GRI)³ were developed, adding more pressure among firms to comply with ESG requirements. As a result, it is found that ESG reporting has been made mandatory for all publicly listed firms in some countries such as the United States, the UK, Hong Kong, Malaysia, and Singapore while most countries are making it voluntary.

Past studies have shown that most firms engaged in CSR activities to showcase their ethical stance in the eyes of the public to justify the firm's continued existence (Abdul Rahman, Alsayegh, 2021). This is consistent with stakeholder theory which views the need for a firm to consider stakeholders as individuals or groups of individuals who can affect or be affected by business activities (Freeman, 1984). There is also an argument grounded in legitimacy theory that ESG initiatives are mainly driven by firms to be legally accepted by the public (Odriozola, Baraibar-Diez, 2017). Another explanation as to why firms engage in ESG practices includes conformity to the regulations as a firm is considered a subset of society. Institutional theory considers a firm to work within a given set of values norms, and assumptions which constitute reasonable economic behavior including corporate CSR and other accounting practices to the standards and values of a society (Khan, 2022).

Tax Avoidance

The corporate tax avoidance issue has gained greater attention among tax practitioners, regulators, and researchers following several prominent firms such as Apple, Starbucks, and Google⁴ getting exposed for their close to zero tax payments to the government despite earning substantial income in that particular country. This is achieved through the manipulation of legislation in multiple countries to shift income from one country to another, resulting to close to zero tax payments to the countries involved. In response to this, the OECD has launched 'Base Erosion Profit Shifting (BEPS) actions to deter and stop this aggressive tax avoidance behavior.⁵ To date, the OECD has issued 15 BEPS actions including harmful tax practices (Action 5), prevention of tax treaty abuse (Action 6), and mandatory disclosure rules (Action 12).

These BEPS actions receive support from countries around the world. On 11 July 2023, 138 countries including Malaysia pledged their commitment to the Inclusive Framework on BEPS, which will lead to a major reformation of the international tax system (OECD, 2023).

For Malaysia, in support of BEPS Action 12 and the OECD MNE guideline, Bursa Malaysia has introduced a requirement for tax compliance disclosure and the Malaysian Inland Revenue Board issued the Tax Corporate Governance Framework (TCGF, hereafter) in April 2022 and invited several companies to participate in piloting the implementation of the framework. Despite all attempts to combat corporate tax avoidance, it is still a rampant phenomenon (Kovermann, Velte, 2021; Thomsen, Watrin, 2018).

Prior literature has documented the lack of an ethical stance to be one of the reasons for tax avoidance behavior (Benkraiem et al., 2021). As tax payments are compulsory contributions imposed on individuals or corporations to the government, which will eventually be used for public welfare, tax avoidance is considered unethical behavior since the act, although considered legal, shows the irresponsible attitude of a firm with regard to giving back to country where it operates. The outcome of tax avoidance is low tax collection by the government, thus affecting the ability of the government to serve society (Freedman, 2003; Lanis, Richardson, 2015; Sikka, 2010). Corporate tax avoidance also differs between countries mainly due to the institutional environment in each country (Benkraiem et al., 2021). Studies have reported that corporate tax avoidance is associated with the level of a country's societal trust (Kanagaretnam et al., 2018) and a country's level of enforcement (Bruno, 2019). Societal trust is a concept that deals with mass compliance with moral rules; the extent to which a general level of trust toward others in the society exists (Kanagaretnam et al., 2018). Thus, a country-specific study is needed to understand corporate tax avoidance behavior and the extent to which this behavior is viewed within ethical stances as well as the specific attributes of a particular country.

ESG and Tax Avoidance

The earlier discussion pointed out that there are common factors to explain both ESG and corporate tax avoidance. Based on the ethical premise of a firm, previous studies expect a negative relationship between corporate social responsibility (CSR,

³ <https://www.globalreporting.org/>, accessed 19.06.2023.

⁴ <https://www.reuters.com/article/us-eu-tax-avoidance-idUSBRE94L0GW20130522>, accessed 15.10.2023.

⁵ <https://www.oecd.org/tax/beps/>, accessed 15.10.2023.

hereafter) and tax avoidance, where firms that engage in many CSR initiatives will also tend not to engage in tax avoidance activities. Corporate culture theory (Kreps, 1990) suggests that while most managers tend to manipulate profits to reduce the tax burden, this may not be the case for socially responsible firms. Within this theory, CSR is the belief about the “right” course of action, where a socially responsible firm considers the economic, social, environmental, and other externalized effects of corporate decisions (Yoon et al., 2021). This argument is supported by many empirical findings (Davis et al., 2016; Jones et al., 2017; López-González et al., 2019; Yoon et al., 2021).

On the contrary, some other studies found a positive relationship between ESG and tax avoidance (Godfrey, 2005; Godfrey et al., 2009; Zeng, 2019). This finding supports the argument by Sikka (2010) that firms used their ESG practices to cover up their tax avoidance behavior, displaying their inconsistent ethical stance, labeled as ‘corporate hypocrisy’. This theory highlights the management of tax avoidance as a tool to enhance a firm’s reputation for ESG practices while employing tax avoidance as a risk management tool concerning the firm’s ESG reputation. Alternatively, Zeng (2019) argued that the relationship between ESG and tax avoidance could be positive due to the inconsistent legal and institutional environment of the relevant countries. He claims that CSR and country-level governance are substitutes in the sense that for corporations to engage in tax avoidance, weak country-level governance means a firm’s CSR scores need not be high.

The third group of empirical studies found no significant relationship between ESG and tax avoidance (Davis et al., 2016; Mao, 2019). They argued that ESG and tax are independent corporate decisions. ESG managers believed that ESG practices would enhance a firm’s reputation and value and enable management to avoid legal and financial complications with legislators, thus said practices would benefit the shareholders in the long run. At the same time, tax managers viewed their actions in avoiding tax as a benefit to shareholders. This is consistent with the shareholder theory discussed in Friedman (2007), where firm managers’ main objective is to generate profit while reducing costs. However, the current efforts to link ESG and tax compliance led by the OECD may have inevitably forced cooperation between ESG and tax divisions within a firm.

The systematic literature review on the relationship between ESG and tax avoidance shows that all studies in this area employed a quantitative approach (Kovermann, Velte, 2021; Whait et al., 2018). Whait et al. (2018) argued that there are

four main reasons for the inconsistent findings in prior research – (i) limited samples of companies within a specific country; (ii) inconsistent measures of corporate tax avoidance; (iii) inconsistent measures of CSR; and (iv) the omission of control variable related to the country-specific factors that might play a significant role in that relationship such as the national culture of countries, institutional constraints, and so on. Ortas and Gallego-Álvarez (2020) also provide additional evidence that ESG and tax avoidance are moderated by national culture. They found the relationship is more negative and stronger in cultures that are characterized by individualism, long-term orientation, and indulgence. It is less negative and weaker in cultures that are characterized by power distance, masculinity, and uncertainty avoidance. Hence, we argue that there is a need to employ a qualitative approach in a specific country to explore the link between ESG and tax avoidance. The arguments put forward by the prior studies, particularly on ethical stances, need to be further examined via a qualitative approach, which facilitates a deeper understanding as to why such a relationship exists and which motives are involved.

Methodology

This study used a qualitative approach to explore the perception of firms, consultants, and regulators concerning the link between ESG and tax avoidance. The interview method is employed. Sample firms are selected from publicly listed companies in Bursa Malaysia as of 1 June 2022. The potential interviewees were approached via email and/or LinkedIn. Specifically, the study only approaches individuals that hold designations such as Finance Manager/Financial Controller, Tax Manager, Head of the Sustainability Department, Group Chief Sustainability Officer, and any equivalent designation that assumes responsibility for the company’s ESG or tax matters. The study employed snowballing sampling to increase the number of respondents including tax and ESG consultants. The authors also emailed the Inland Revenue Board to participate in this research. In total, 22 respondents were interviewed. The final respondents are presented in the Table 1 below.

The semi-structured interviews are conducted over a 10-month period during September 2022 until June 2023. Each interview runs between 45 minutes and one hour. Most of the interviews are conducted online except for one interview. Respondents are duly informed of the research objectives and were given sample questions before the interview session took place. The interviews are transcribed verbatim and analyzed.

Results

Perceptions of Publicly Listed Firms

We found that there are mixed perceptions among sustainability and tax personnel concerning the link between ESG and tax strategies. Overall, sustainability personnel at firms show limited awareness of the relationship, thus supporting the earlier studies where no relationship exists between ESG and tax avoidance (Davis et al., 2016; Mao, 2019). One of the respondents [Mr. C] considers tax compliance unavoidable and thus says it cannot be linked to ESG:

“...when you talk about tax [compliance], of course tax is an inherent business matter, right? That the company will look into, but didn't really link it to sustainability”.

On the other hand, tax personnel demonstrated awareness of the relationship. Most of the tax personnel view the link between tax strategies (compliance or avoidance) as part of the governance section of ESG. They provide an understanding as to why tax strategies are part of governance as tax is indeed an obligation to pay dues to the country where a business operates. One of the respondents, [Ms. R] commented

“... if you are as an organization really in tune with the ESG commitment, then it also means about how transparent you should be when it comes to tax methods, because taxation is not just an obligation where you calculate your revenue, your expenditure, etc. and then you come up with a value to pay to a certain country...”

We also found that tax personnel understand that tax governance and tax compliance are important elements of the broader risk management system. This is consistent with the OECD guidelines for MNE (revised) – the principle of good tax governance (OECD, 2013). One of the respondents, [Ms. D] stated that:

“our tax governance, who we have, and the importance we have in terms of making sure we have people who know the tax requirements and so on so forth so that you know, at no time at all do we compromise on the policies and compliance and so forth. I think our attitude toward tax planning, management of tax risk... So this is the minimum level of assurance that we feel we should be giving to our stakeholders in terms of giving them assurance from a governance perspective..”

We also evaluated the perception of ethics and morality in paying taxes and how it can also be linked to the social part of the ESG. While these two notions may differ in a legal context, for the purpose of this study, ethics and morality are not

viewed separately following Harper (2009) who emphasized that both are not to be considered as contrasting and separate, except for the fact that ‘ethics’ refer to the ancient view and ‘morality’ refer to the modern view. Consistently, the logic of linking tax compliance and the social aspect of ESG was not well received by sustainability personnel. This finding further supports the prior literature that found that there is no relationship between tax avoidance and ESG (Davis et al., 2016; Mao, 2019). The ESG personnel view tax as a mere payment to the government and not directly to the people, hence there is a possibility that the money is not managed properly for public welfare and such employees question the public accountability of the government arm in handling tax distribution effectively. One of the respondents, [Ms. A], stated:

“... as a corporate citizen, as a company, of course we need to do our obligation to pay the tax so that the government, the country can generate revenue as well. But again, if [only] they're spending wisely into a correct channel...”

The perception among tax personnel is mixed, where most respondents do not see the link between tax compliance [or avoidance] and social initiatives. However, we found the perception differs with tax personnel in government-linked companies, where the understanding of how tax payments are tied to the social aspect of ESG is clear. One of the respondents, [Ms. D] stated:

“..As a law abiding corporate, we have to make sure we do our part in [what's that]... returning back the pie back to the government and the people..”

This translates to the ethical stance of the firm, which also believes the ESG initiatives are to benefit the environment and society. This finding is consistent with previous studies that support a negative relationship between ESG and tax

Table 1. Sample of Respondents

Respondent	Number of organisation	Number of individuals
Public listed companies	2	2
Multinational companies	3	4
Government-linked companies	2	8
Sustainability consultant	2	2
Tax Consultant	3	3
Tax officer	1	3
Total	14	22
Source: authors.		

avoidance (Davis et al., 2016; Jones et al., 2017; López-González et al., 2019; Yoon et al., 2021).

It is also apparent that there is minimal cooperation between sustainability and the tax/finance departments. We found most firms have all representatives from different departments within the firm, including finance, but the direct link with the tax department is missing. However, the cooperation is more visible within multinational firms that operate in other jurisdictions where a tax compliance agenda was introduced much earlier. One of the respondents, [Mr. E] illustrates that cooperation does exist in the firm where sustainability and tax personnel work together in ESG matters to incorporate tax into its risk management strategy:

“In this conversation [ESG], we have not just a risk management team. We have group finance, we have tax experts as well the academicians talking about the same topic [ESG].”

We argued the above finding reflects the fact that the tax compliance framework (i.e. TCGF) is in its infancy in Malaysia. As tax compliance is very technical, it is understandable that there is minimal involvement of other team members apart from tax personnel including sustainability personnel in working toward the tax compliance framework.

Perceptions of Consultants

We found both sustainability and tax consultants are aware of and understand the link between ESG and tax strategies. This finding shows that the consultants are ahead of the firms in their understanding of the incorporation of tax compliance as part of the governance and social aspects described by ESG strategies, although tax is not explicitly mentioned in the Malaysian Code of Corporate Governance. One of the respondents, [Ms. G] who is a sustainability consultant states:

“I think it’s very important because I believe that ... good tax governance is a subset of good corporate governance. So, for me it’s very simple, you have good tax governance, it’s a subset of good corporate governance. A good tax governance framework for a company helps to identify the tax risk (...) assess your risk and sets out the actions that you need to take to mitigate the impact of those tax risks. So I think an effective tax governance framework can cultivate the level of confidence that the organization is reporting and paying the right amount of tax.”

One of the respondents, [Ms. S] who is a tax consultant explained:

“...when you pay tax, you are actually contributing to the government’s revenue, right? And the government uses the revenue also for the social part, right?”

... So the public will be able to know how much taxes the company pays, and ... this can go toward the social element because, taxes are in Malaysia, we all know right... more than 60% of the government’s total revenue. So it is really, really important for the government to ensure that they collect the right amount of taxes, and so that the revenue then can be properly spent on ... projects and the activities that the country wants”.

Based on this perception, it can be concluded that there should be a negative relationship between ESG and tax avoidance, which supports the past literature (Davis et al., 2016; Jones et al., 2017; López-González et al., 2019; Yoon et al., 2021).

Perceptions of Regulators

We found the regulators believed that tax compliance is related to governance and the social part of ESG principles. The motivation for the regulator to introduce TCGF is in line with international practices, the OECD guidelines, and BEPS action plans. The emphasis was that tax transparency should be explicitly stated in the ESG and not incorporated into general governance. One of the respondents, [Mr. J] states:

“..when we relate the tax governance with the ESG is more like you ..say it about the missing T in the ESG. What is it mean by the missing T? That [is] the tax transparency.”

The tax regulators also think that the link between ESG and tax compliance can be further enhanced if it is explicitly stated in the Malaysian Code of Corporate Governance (MCCG, hereafter). However, as TCGF is still in its early stages, where several companies have been selected to be under the TCGF program, the step to integrate governance and tax will be one of the agenda items in the future. Nevertheless, initial efforts to link the tax to corporate governance have been initiated. One of the respondents, [Mr. J] states:

“We did have several engagements with the respective bodies that are responsible for corporate governance. So far, we have received positive feedback for them to consider. This tax matter can also be included on the corporate governance agenda.”

Conclusion

There has been a long debate in the literature about linking ESG to tax avoidance (Kovermann, Velte, 2021). Unfortunately, the results are inconsistent due to the quantitative approaches used by prior researchers (Whait et al., 2018). This study attempts to address this issue by taking a direct approach in

seeking the views held by relevant parties which includes firms, consultants, and regulators by evaluating how tax avoidance is conceptualized and understood within the ESG agenda at firms. The findings show that there is a gap in the understanding of tax avoidance and ESG practices among tax regulators and consultants. Tax regulators, sustainability consultants, and tax consultants are found to be able to link ESG and tax strategy (either in the form of compliance or avoidance) while perspectives obtained from the firms sampled in this study show inconsistent understandings of the relationship. The sustainability personnel perceived no connection between ESG and tax strategy, thus supporting some of the previous findings in the literature (Davis et al., 2016; Mao, 2019).

On the contrary, views sought from tax personnel proves that they are able to appreciate the link between tax strategy and ESG. However, they are unable to describe how this is linked with the 'environmental' and 'social' aspects of ESG, but limited only to the 'governance' part. Only tax personnel in government-linked firms demonstrate an understanding of linking tax strategy to the social part of ESG, thus supporting the idea that ESG is negatively related to tax avoidance (Davis et al., 2016; Jones et al., 2017; López-González et al., 2019; Yoon et al., 2021). A possible explanation of these may relate to the culture of these respective firms

in which training and exposure of concepts of ESG engrained within these firms translated into a better understanding of these concepts.

This study also is unable to establish that ESG is being used to conceal tax avoidance behavior or corporate hypocrisy. We therefore conclude that, in the context of our study, tax avoidance and ESG concepts are not viewed to be interdependent of one another and no connections could be made between the two.

Thus, this study outlines the following implications. Firstly, more work needs to be done, by everyone in the ecosystem, in educating and enhancing awareness on how tax strategy (avoidance or compliance) affect the governance and social aspects in ESG. The focus should be on strengthening awareness and understanding among sustainability personnel. Second, there is a need to explicitly mention tax compliance in MCCG as is the practice in other countries such as the UK, the Netherlands, and Australia (OECD, 2013). By incorporating tax explicitly in the MCCG, the process of educating firms can be enhanced and necessary timeframes shortened. This study acknowledges the limitation posed by the low number of respondents involved so future research should focus on increasing the number of respondents to represent firms of different sizes, industries, and countries for better insight.

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Distributional Growth Paradigm in the Strategies of Sustainable Regional Development

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Abstract

The issue of bringing outsider regions closer to leaders in conditions of unequal distribution of assets in order to establish sustainable development is a big task, both on the part of the government and of the companies as well. The authors of the article raise the question of the choice of distribution mechanisms and their connection with the development of an optimal strategy for sustainable development. There are no universal tools in this regard, which means it is necessary to develop a complex combination of strategic decisions that takes into account the capabilities of the regions and the companies based

there. Corporate strategies could significantly augment government action. This task is especially relevant for a country with a heterogeneous distribution of natural resources, among which Russia, making the emphasis is on fiscal decentralization as an equalization tool. Assessing its impact on the economy of Russian regions, the authors state that, despite its effectiveness in other countries, it is not workable for Russia. The solution seems to be the search for unique market mechanisms, the possible attraction of dynamic companies to the region and the selection of other mechanisms that trigger sustainable development.

Keywords: sustainable development; development strategies; regional inequality; regional development; resource capabilities; fiscal decentralization.

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Introduction

Mitigating disparities in the pace of development between regions plays a key role in building national economic potential. This task is especially relevant for states with heterogeneous distribution of natural resources, which includes Russia.

In the post-Soviet regime, the Russian Federation has enjoyed an overall robust economic growth by adapting the market economic system (but with some exceptions). Economic growth mainly has been fueled by the natural resource boom, which in turn poses an imperative question regarding the distributional aspect of the Russian growth paradigm since some regions have much more natural resources than others. More precisely, in the first decade of the adoption of the market economic system, Russia had encountered unnatural economic fluctuations which are highly anchored in the mismanagement in the financial sector, the rapid privatization process, and the industrial and military policies. Eventually, economic growth along with the boom and slack had culminated with more income inequality and inter-regional economic disparity¹. Although several empirical studies stressed the income equality issue (Zubarevich, 2019; Novokmet et al., 2018), inter-regional economic disparity has remained unknown in the economic literature. In order to address this pressing issue, the government of the Russian Federation has articulated its commitment to reducing regional disparities through the implementation of a comprehensive set of strategies. These strategies encompass various measures, one of which is fiscal decentralization². Moreover, the substantial regional natural resource rent further emphasizes the need for Russian authorities to adopt a policy of fiscal decentralization, thereby mitigating the unequal distribution of resources. As fiscal decentralization is apparently the most effective tool to address the inter-regional disparity); hence, we are motivated to scrutinize its role in Russian Federation in our empirical setup.

We extend and contribute to the prior literature in several ways. First, we devise the regional economic growth disparity measure by deducting the real Gross Regional Product (GRP) per capita from the real Gross Domestic Product (GDP) per capita for Russia. The positive values indicate the regions enjoy higher economic growth compared to the country average, while negative values assert that the regionals encounter lower GRP per capita than the national level of GDP per capita. We use the measure of fiscal decentralization indicating the decentralization from federal to regional level. Second, we contextualize whether

natural resources play any mediating role in the fiscal decentralization and regional disparity linkage, given the enormous contribution of natural resources to the Russian economy. Third, we also consider whether the role of political identity of regional governments plays any role in the fiscal decentralization and regional disparity nexus, as we assume that the negotiation power of regional governments with the federation government is anchored with the ruling vs non-ruling party basis.

Fourth, given the considerable abnormality in our dataset across the regions and over time³. We then apply the Panel Quantile via Moment approach because this approach is able to eliminate the regional common correlation bias, regional heterogeneity, time lagged effect and potential endogeneity, which we have found in the data.

Finally, our empirical investigation on fiscal decentralizations and regional economic disparity in Russia provides several new insights. First, we find that fiscal decentralization further elevates the inter-regional disparity in the 10%-30% quantiles (less developed regions) of economic disparity, underscoring the existence of less developed regions where economic growth is lower. However, our empirical analysis shows no significant effect of fiscal decentralization at the upper quantiles (highly developed regions) of this disparity. When the disparity exceeds 70% (above average), the coefficient of fiscal decentralization becomes positive but is insignificant, which confirms the enhancing gap between more developed and less developed regions. We find that this statement is also true (i.e., an increase in disparity) for the regions where their governors are members of the ruling party (“United Russia”), while the governors from other parties play insignificant role in changing regional disparity in any direction. Natural resource extraction is also efficient in decreasing the disparity in the less endowed regions; however, it is counterproductive towards decreasing inter-regional disparity at the upper quantiles.

The results of this study can be conducive to designing inclusive economic growth agendas by ensuring an allocative efficiency of budget distributions towards reducing intra-regional economic disparity. The finding also intends to provide practical policy implications in allocating federal to the regional budgets in the case of the resource abundant and non-resource abundant regions. Finally, the results also aim to provide a pragmatic solution to the distribution of the national budget among the regions, thereby reducing any biases or nepotisms to ensure inclusive economic development.

¹ For instance, the range of gross regional products per capita can vary from Rub 3378000 to Rub 61000 for the Khanty-Mansiysk autonomous district and the Chechen republic in 2019, respectively. <https://rosstat.gov.ru/storage/mediabank/9Y14JKg4/vrp.xlsx>, accessed 05.07.2023.

² See also: <https://base.garant.ru/71405474/>, accessed 05.07.2023.

³ E.g., the values for the logarithm of regional real GRP per capita vary from 9.45 for the Dagestan Republic and 19.83 for the Tyumen region, while the share of natural resources extraction in GRP varies from 0 to 78% in the non-oil and oil-extracting regions.

Table 1. Positive Effects of Fiscal Decentralization

Effects	Literature
Enhancing the efficiency of public goods provision, especially educational attainment	(Barankay, Lockwood, 2007; Freinkman, 2009; Kalirajan, Otsuka, 2012).
Enhancing the accessibility of public services, and reducing poverty	(Sanogo, 2019).
More efficient government regulations and regional economic growth	(Jia et al., 2020, 2021).
Enhances regional convergence	(Kyriacou et al., 2015).
Strengthening fiscal discipline	(Bellofatto, Bestfamilie, 2021)
<i>Source:</i> authors.	

Literature Review

International experience of implementing fiscal decentralization

Fiscal federalism argues that fiscal decentralization is beneficial for economic development in many countries as it increases the authority of local governments' officials, enhances the competition of local jurisdictions, boosts the possession of precise information on regional needs (Qian, Roland, 1998; Tiebout, 1956) and improves the ability of tailoring policies to local preferences and circumstances (Oates, 1999). The political hierarchy, which considers empowering regional authorities, is still associated with sufficient management and regional economy regulation. Theoretically, fiscal decentralization can address regional disparity (Bellofatto, Besfamilie, 2021; Gradstein, 2017; Martinez-Vazquez, Timofeev, 2008). However, we distinguish between two main strands in the current literature on fiscal decentralization.

The first strand argues that fiscal decentralization leads to an enhancement of efficiency in government management since regional governments are more highly motivated by local issues (Rubinchik-Pessach, 2005). Some authors argue that fiscal decentralization is more beneficial, particularly when the central government is less competent (Barankay, Lockwood, 2007). The distribution of political power in the government hierarchy is also crucial for regional development (Markevich, Zhuravskaya, 2011; Mookherjee, 2015). The positive impacts of fiscal decentralization for regional development are summarized at Table 1.

The second strand of the literature expresses its skeptical view regarding the effectiveness of fiscal decentralization in alleviating regional economic disparity. There is a strong association between fiscal decentralization and degrees of corruption among regional authorities (Fan et al., 2009; Fisman, Gatti, 2002), which eventually decreases local economic growth (Zhang, Zou, 1998) and increases regional disparities (Prud'homme, 1995). Blanchard and Shleifer (2001)

confirm that fiscal decentralization must strike a balance with centralization, as high degrees of decentralization in transition economies result in a lack of control and lower government quality, thereby decreasing economic growth and increasing corruption. Jia et al. (2020) argue that the potential outcome of fiscal decentralization can be undermined due to poor governance or malpractices in the local officials. Therefore, the central government should increase the degrees of control over local governments. Zhang (2006) observes that fiscal decentralization spurs tax burdens on the lagging behind regions, which eventually leads to higher regional disparities in the China context. The regional disparity may induce stronger inter-regional disparities as being beneficial only for well-endowed regions (Bartolini et al., 2016; Besley, Ghatak, 2003). Besides Bellofatto & Besfamilie (2021) argue that tax decentralization somewhat may enhance fiscal discipline, but it spurs regional disparities in many countries. Given the contrasting findings, the empirical literature further motivates us to conduct this study in the case of Russia.

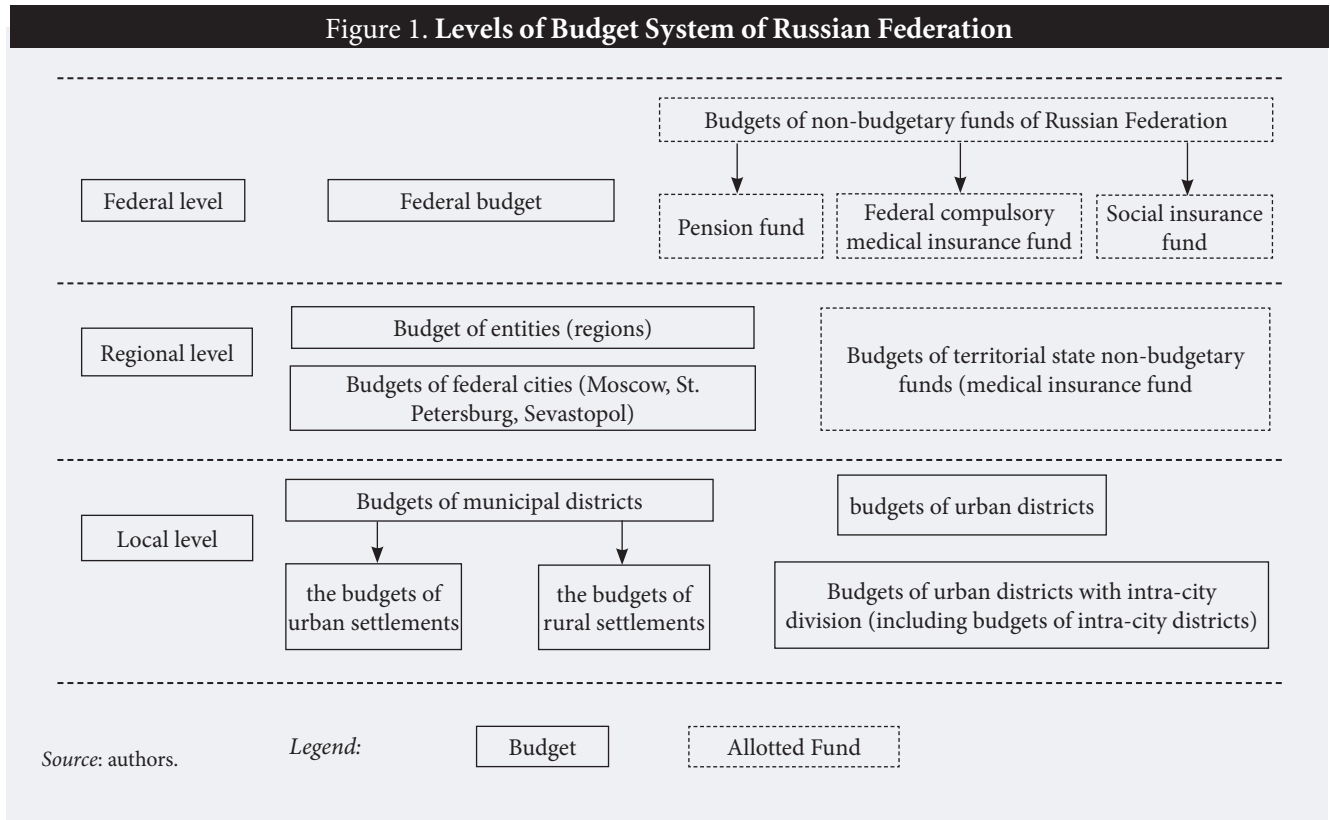
Russian context

A few studies stress the Russian federal fiscal distribution policies and local government fiscal stances (e.g., Di Bella, 2017; Markevich, Zhuravskaya, 2011).

However, the fiscal decentralization and regional disparity nexus has remained under-researched in the prior literature. For example, Zhuravskaya (2000) focuses on the reallocation of fiscal expenditures from regional governments to the local governments in Russia. Their study argues that due to a lack of independence of local governments in the fiscal execution, local private sectors encounter sluggish growth (Zhuravskaya, 2000). Further, Martinez-Vazquez & Timofeev (2008) somewhat address some of our concerns about the role of fiscal decentralization in alleviating regional disparity⁴. However, over the last 20 years, Russia has experienced a significant transformation in the economy and fiscal rules, which urges to provide new insights in this linkage. Shankar & Shah (2003) study the effects of regional policies on regional disparity on a sample of federal (including Russia) and unitary countries for the 1997-1998 period. Markevich and Zhuravskaya (2011) study the relationship of the characteristics of Soviet regional party governors and regional industrial output for the period 1951-1967. Their study finds that increasing competition among regional governors depends on economic diversification where it promotes economic growth in the more diversified regions. Prior studies somewhat helped us to enhance our understanding of the roles of fiscal policy and regional disparity but our concerns about the effectiveness of the policy remain an empirical puzzle, which further motivates us to conduct this study.

⁴ The mentioned study has considered 2000 local governments from 72 Russian regions.

Figure 1. Levels of Budget System of Russian Federation



Distinct features of Russian economy and hypothesis development

A couple of studies stress the impact of severity of regional differences on economic inequality, living standards, employment, and quality of population and so on (Zubarevich, Safronov, 2011; World Bank, 2018). Historically Russian governments have constructed the economy by narrowing down the production line to the manufacturing, military development and natural resources extraction sectors. Regional development, therefore, was highly anchored with the location of those respective sectors, which eventually has led to a high regional disparity in the economy⁵. Third, the lack of fiscal coordination among the local, regional and Federation governments often hinder economic growth and yields regional disparity (Zhuravskaya, 2000). The literature argues that Russia had continued the Soviet fashion of the economic growth paradigm in the early transition period, thereby the grown disparity remained having the same magnitude, along with poor governance (Shleifer, 1997). Given the distinct feature of the Russian economy, anecdotal evidence and theoretical underpinning, we postulate several hypotheses.

A Distinct Feature of the Russian Fiscal Structure

The budget system in Russia consists of three layers including the federal, regional and local apparatuses⁶ (Figure 1). The fiscal redistribution among the Russian regions is executed through inter-budgetary transfers in the form of equalization transfers (donations), other donations (given to regional governments for further transfer to the local levels), grants (tied⁷ transfers), other inter-budgetary transfers (non-tied) (Martinez-Vazquez, Searle, 2007).

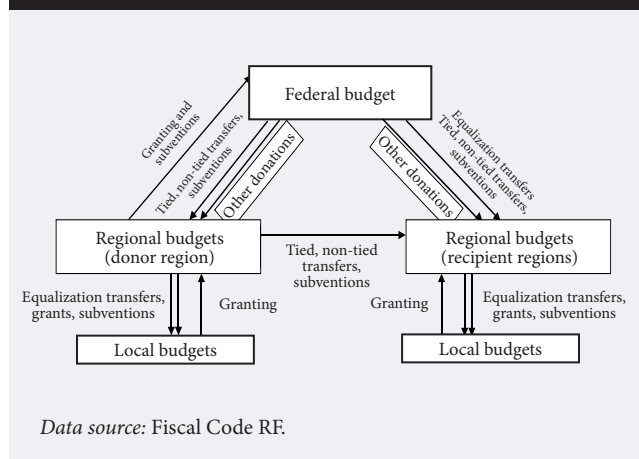
The fiscal decentralization is the distribution of power among the central and sub-national governments in making decisions at the regional and local levels including revenue aggregation and further redistribution. Ironically, the intergovernmental decentralization process makes the flow of revenue toward central government before the redistribution to the regional governments. The whole process requires more time, which creates fiscal imbalances and hinders the smooth implementation of development projects (Martinez-Vazquez et al., 2017; Martinez-Vazquez, Searle, 2007). The federal budget in Russia accumulates the revenues from taxes, fines, natural resources rent, etc. The fed-

⁵ Moreover, the Soviet regime reoriented the population settlements according to the concentrated economic activities. Thus, the rate of inter-regional migration was remarkably high. The impact of the Soviet policy has persisted until today as 12.47% of the overall Russians dwell in Moscow and Saint Petersburg (2018-2020). <https://rosstat.gov.ru/folder/313/document/166784>, accessed 14.08.2023). The abandoned industrial town of the Soviet-Era encounter severe socio-economic disadvantages and seek a considerable support from the federal government.

⁶ The Russian government introduced a Fiscal Code in 1998, which describes the budgetary system and mechanism of the inter-budgetary relations among the different layers of governments. Concerning the fiscal decentralization, the Fiscal Code classifies wealthy regions as contributors of the fiscal surplus to aid the regions with budget-deficit. The federal distribution policy also considers the per capita tax across region, size of population and level of economic activities in their allocations. http://www.consultant.ru/document/cons_doc_LAW_19702/, date of circulation 17.06.2023.

⁷ Tied transfer is an inter-budgetary transfer assigned for specific purposes. These transfers are aimed at financing mandatory responsibilities of the recipient governments. The subvention is an interregional transfer provided for a specific purpose (tied) with a delegation of responsibilities (art. 129 FC RF, 1998 (2022)).

**Figure 2. Fiscal Decentralization in Russia
(authors classification)**



eral government also obtains several forms of taxes from the regional revenues⁸. The central government provides a different form of fiscal assistance (tied, non-tied transfers and subventions) to the regional governments for implementing national projects. Sometimes, the regional governments assist the local governments to reduce their fiscal deficits by sharing the surplus amounts of the budgets.

In the case of budget surpluses, the region transfers the surplus to the federal budget in the form of grants and subventions (Figure 2).

The regional government sometimes co-finances some joint projects with other counterpart regions. The local budgets redistribute the finance to the intra-city districts, and urban and rural settlements. The local government also contributes at the regional level when the revenue exceeds a certain threshold level⁹.

Since 2010, the Ministry of Finance has pursued a large-scale reform of the public finance management system, which includes the introduction of fiscal tools, ensuring the long-term sustainability of the budget system, and implementing the budget rule and long-term budget planning. The reform aimed at improving the system of financial support to the recipients' regions, thereby emphasizing the competitiveness and the transparent procurement system to meet the state (municipal) needs and increase the openness and transparency of the budget process. Since 2017, the Russian government has implemented a policy mandating the allocation of 1% of corporate income tax to be centralized within the federal budget for subsequent redistribution in the form of non-tied equaliza-

tion transfers¹⁰. For the years 2019-2024, the Ministry of finance has identified the following problems that are to be addressed. First, is to reduce the dependence of the Russian economy and the federal budget on the resource rents and to form a sovereign fund for hedging against externally induced- fiscal deficit (Sohag et al., 2022). Eventually, this policy should promote predictability and transparency of fiscal transfers among the Russian regions and the federal budget, which will foster the national wealth. Second, is to increase the efficiency of budget expenditures by re-allocating the resources for priority projects, augmenting social welfare. The authority also aspires to achieve fiscal efficiency to reduce the gap between government revenues and expenditures by a proper implementation of development projects and programs. Third, is to develop a framework of inter-budgetary regulation based on the federal budgetary role in mitigating regional and local budget deficits.

Most of the disadvantaged regions often fail to refund the regional debt (Bulletin of Accounts Chamber, 2020). The federal government believes that a close monitoring and evaluation of the fiscal assistance to regional level can improve the effectiveness and efficiency of the execution of the budget towards sustainable development¹¹. One of the prime aims of the budget redistribution is to reduce fiscal disparity itself from the top 10 to the bottom 10 Russian regions. For this purpose, the government implements several mechanisms to stimulate economic and tax potential of the territories which include providing equalization transfers to the regions as an incentive for achieving the national development goals at regional level; provision of financial support from the federal budget for compensating the investment tax deduction resulted in reduction of regional tax revenues; and restructuring of budget loans. Figure 3 shows that 13 regions provide fiscal aid to 72 regions in the channel of federal government in 2020. The Ministry of Finance uses Equation (1) to distinguish between the donor and the recipient regions considering the balance of regional budget or fiscal capacity:

$$FC_i = ITP_i / IEP_i, \quad (1)$$

where FC is fiscal capacity of i-region, ITP is the index of tax potential, a relative (compared to the average level in the Russian Federation) assessment of tax revenues of the regional budget, determined by taking into account the level of development and the structure of the tax base of a region; and IEP is index of budget expenditures potential, relative (compared to the aver-

⁸ For instance, the regional corporates provide taxes around 20%, of which 2% is reallocated to the federal revenue and 18% to the regional revenue. Besides, the personal income tax revenue (13% of income) is redistributed between the federal budget (15%) and the regional budget (85%). For instance, if the personal income tax from an individual exceeds five million rubles, the revenue is transferred to the federal (13%), regional (74%) and local (13%) governments. https://www.nifi.ru/images/FILES/Journal/Archive/2018/2/statii_2018_2/fm_2018_2_02.pdf, accessed 16.06.2023.

⁹ Regional government sets the threshold which may vary over regions

¹⁰ The amount of equalization transfers has experienced a significant increase, rising by 40% and reaching a total of 203.7 billion Rubles in 2021 compared to the figures recorded in 2016 (https://minfin.gov.ru/common/upload/library/2023/06/main/Rezultaty_monitoringa_mestnykh_budzhetrov.pdf, accessed 19.08.2023). This upward trend highlights the government's commitment to promoting financial equity and stability across regions.

¹¹ <https://base.garant.ru/71405474/>, accessed 19.06.2023.

Figure 3. Donor and Recipient Russian Regions in 2019 (share of external aid in gross regional budget, %)



Source: authors.

age level for the Russian Federation) assessment of the expenditures of the regional budget for the provision of the same volume of budgetary services per capita, determined by taking into account objective regional factors and conditions.

One of the main challenges for the Russian fiscal policy is the increase in the effectiveness of the equalization transfers and the decrease in the number of the recipient regions¹². Therefore, Russian governmental authorities carry out the fiscal decentralization policies as follows: clearly defining the federal regulations and regional autonomy in executing regional policies achieving the national development goals at regional level; increasing the own tax revenues of the regions; federal government holds mainly the monitoring role while regional governments enjoy more autonomy in the implementation of budgetary plans; less interference of federal government in regional decision making by the local authorities. Moreover, the regional governments obtain more power in planning the budget deficit and executing the public spending aimed at anti-crises measures. The effectiveness of the fiscal decentralization process remains an empirical puzzle, which increases the disparity; hence, we aim to evaluate the effectiveness of fiscal decentralization on the inter-regional disparity among the Russian regions through hypothesis (H1):

H1: The fiscal decentralization is effective in reducing inter-regional disparity among the Russian regions.

Mediating factors that impact the link between fiscal decentralization and regional economic disparity

Role of Political Affiliation

We assume the power of negotiation of a parliament member is conditional on several factors, including the membership of the ruling opposition parties. We

partially agree with the proposition of Riker (1964), who argues that the central government has a stronger influence over the regional governments. However, the recent anecdotal evidence shows regional governors also maintain a strong liaison with the federal government in terms devising on regional policy, budget and nation plan execution. Several recent studies show that the magnitude of a regional governor's influence on the federal government plays an important role for regional development (Sohag et al., 2022; Hartwell et al., 2022).

The balance between the national goals and the compliance of the regional interests is significant for sustainable regional and country development, which is realized through the bargaining power and the distribution of the political power among the political parties (Enikolopov, Zhuravskaya, 2007; Filippov et al., 2004; Oates, 1999; Polishchuk, 1996; Riker, 1964). The anecdotal evidence shows that the national party has been dominating the parliament since 2001. Similar to the Duma, the upper House of the Russian Parliament contains 170 representatives from the regions, where 83.5% is from the United Russia, 8.2% is independent, and around 7% is from the Communist Party, Liberal Party and Just Russia. The strong national party can be successful in tailoring regional policies to national goals (Enikolopov, Zhuravskaya, 2007; Oates, 1999), thereby improving the outcomes of fiscal decentralization (regional economic growth rates, regulation quality, disparity). However, a too strong ruling party can infringe on the interests of regional leaders by influencing them, which results in a reduction in economic growth in the regions and an increase in the inter-regional disparity (Filippov et al., 2004; Polishchuk, 1996; Riker, 1964).

Nevertheless, the literature shows that regional governments can influence the federal government through the preparation of international events, the develop-

¹² <https://ach.gov.ru/upload/reports/2020.pdf>, accessed 19.06.2023.

ment of the infrastructural and tourism potential and regulation of inter-regional elite conflicts (Orlov, 2021). The governors who pursue the development policies are more successful in bargaining with the federal government in promoting regional projects and receiving the financial support for their implementation¹³.

The bargaining power of a governor results in increasing financial support from the federal government, which in its turn increases the appreciation of the governor by the citizens, thus enhancing the chances of this governor being reelected. The governor of a region in Russia is elected by the local citizens of the Russian Federation every five years. Riker (1964) argues that the election of regional government empowers the decentralized officials, by providing them more support from the local elites and citizens, which can further put higher pressures on the federal government and subordinate it. However, we assume that this is not the Russian case, as most of the governors elected in the regions are member of the ruling party¹⁴. Moreover, according to the rating of governors' influence on the federal government, the 20 governors having the strongest impact are all members of the ruling party, while other parties compile mostly the lowest ratings (Orlov, 2021). On the one hand, the regional governors from the other parties lobby their own interest, which can contradict with the national goals, thereby decreasing their bargaining power and resulting in gaining less support from the federal government. On the other hand, the members from the smaller parties have less resources to compete with members from the ruling party even during the elections.

According to Enikolopov & Zhuravskaya (2007) the strongest political party influences the policies implemented by local politicians, affecting their career prospects. During elections, members of the ruling party have a greater financial support on the PR campaign, which starts long before the elections through the mass-media and social networks (Zhuravskaya et al., 2020; Enikolopov et al., 2011), increasing their chances to be re-elected. Moreover, the national governing parties can punish the local politicians for pursuing regional interests more than the national interest.

Based on our observation, the Russian political system is quite centralized, while the governors have enough space for political maneuvers due to increasing autonomy. In particular, during the last years, the governors

gained even more autonomy in making decisions at the regional level as they obtain more precise information than the federal government. Therefore, we believe that a strong political party can play a significant role in the fiscal decentralization and the regional disparity nexus (H2).

H2: The political alliance of regional governors plays a role in the fiscal decentralization and regional disparity nexus

Role of Regional Natural Resources

The literature argues that the natural resources endowment can be either a resource curse or a blessing for the country (Al Mamun et al., 2017; van der Ploeg, 2011). Prior studies document that the concentration of natural resources has a significantly widened inter-regional disparity in Russia¹⁵. Many studies argue that post-Soviet Russia still follows the Soviet fashion of resource rents distribution (World Bank, 2018; Shleifer, 1997). The command economy was concentrated on the machine-building industry, where military production hold the lion share (Polishchuk, 1996) along with the natural resources extraction, mainly oil and gas (Bradshaw, Connolly, 2016). First, the present intensity of regional disparity can be dated back to the Soviet economic policies for the resource-abundant regions and associated industrial growth, whose footprint remains.

The regional natural resource endowment also attracted more foreign direct investment to the Russian regions, enhancing the innovation implementation and spurring economic growth rates in particular regions (Smith, Thomas, 2017). Accounting for the dependence of the Russian economy on resource rents, we assume that the natural resources endowment is counterproductive in reducing the inter-regional economic disparity, which leads us to the third hypothesis:

H3: Natural resources abundance is an essential factor in forcing up inter-regional disparity.

Conceptual Framework, Data and Methods

Concepts and data

This study examines the role of fiscal decentralization in driving the inter-regional disparity in Russia. We employ panel time series for the 83 Russian regions obtained from Federal State Statistics Services during

¹³ For instance, the governor of the Tula region received an infrastructural budget loan (more than 3 billion rubles) for bridge construction in 2021. In addition, the federal government afforded an infrastructural budget loan in 2022 to the governor of the Krasnoyarsk region for a subway construction and appreciated more the governor of the Novosibirsk region for his success in dealing with the elite conflicts during 2020-2021 (Orlov, 2021).

¹⁴ According to the VCIOM (Russian Public Opinion Research Center, 2022) analytics, the United Russia party receives more support from the people, as 42.5% of the respondents would rather vote for the governor with the United Russia membership versus 11.1% for the Communist party and 8.8% for the Liberal Party. <https://wciom.com/our-news/ratings/rating-of-political-parties>, accessed 18.05.2022.

¹⁵ According to the rating of natural resources potential in regions calculated by RAEX, the most endowed regions are the Krasnoyarsk region (timber and energy resources), the Sakha Republic (diamond deposits), the Khanty-Mansiysk and Yamalo-Nenets autonomous districts (hydrocarbon production). The Khanty-Mansiysk autonomous district is abundant with more than 300 oil fields, while more than 100 gas fields are situated in Yamalo-Nenets autonomous districts. The anecdotal evidence shows that the Khanty-Mansiysk and Yamalo-Nenets autonomous districts enjoy GRP per capita that are considerably higher than the GRP per capita of the less endowed regions. https://raex-rr.com/pro/regions/investment_appeal/investment_potential_of_regions/2020/, accessed 18.05.2022.

the period 1996-2019. In order to measure regional disparity, we have developed a series using equations (2) and (3), as prior literature offers limited guidance on the appropriate measure. The Russian Parliament¹⁶, in the Spatial Development Strategy of the Russian Federation until 2025, considers the ratio of per capita Gross Regional Product (GRP) for each specific region to the mean Gross Domestic Product (GDP) for Russia as an indicator of inter-regional inequality. Following established methodologies, we calculate the dispersion of GRP per capita from GDP per capita within a fiscal year. This absolute value difference is then divided by the national mean to derive a relative indicator, which serves as our measure of regional economic disparity.

More precisely, the series is calculated by taking the difference between the logarithms of gross regional product per capita for region i at time t and the mean value of logarithm of GDP per capita over time t (Eq. 2).

$$Disparity_i = IGRPpc_{it} - IGRPpcT_t \quad (2)$$

In order to check the robustness of our prior estimation, we devise another proxy of inter-regional economic disparity rate by using equation 3:

$$DISR_{it} = (IGRPpc_{it} - IGRPpcT_t) / IGRPpcT_t \quad (3)$$

where $DISR_{it}$ is the indicator of inter-regional disparity rate over time and cross regions, $IGRPpc_{it}$ is the gross regional product per capita (constant) over time and cross sections, $IGRPpcT_t$ is the average value of the gross regional product per capita (constant) for the whole country.

Appendix 1¹⁷ represents the graphs for the regions with a real GRP per capita higher than the mean value. We observe extreme positive values for Moscow, the Tyumen region and the main oil and gas-extracting regions, including the Yamalo-Nenets Autonomous district, the Khanty-Mansiysk Autonomous district and the Nenets Autonomous district. Appendix 2 shows the regions with the real GRP per capita that is less than the mean. We identify the less developed Russian regions as the Chechen Republic and the Republic of Ingushetiya, the Tyva Republic, and the Dagestan Republic. In addition, the graphs show that around 60% of the Russian regions have real GRP per capita less than the mean, while around 40% indicates the upper value, which confirms a high degree of inter-regional disparity in Russia.

As for fiscal decentralization, we obtain the calculated index given by the International Monetary Fund¹⁸. Fiscal decentralization is calculated as a share of own public spending in the region in general government spending (Eq. 4).

$$Fiscal\ decetralization_i = (Regional\ government\ expenditure - grants) / general\ government\ expenditures, \quad (4)$$

Accounting for the dominance of the regions with the prevailing hydrocarbon sector, we assume the share of natural resources extraction in GRP as a main factor that drives inter-regional disparity (Figure 4). As control variables, we include trade openness (ratio of sum of export and import to gross regional domestic product), share of capital investment in GRP and the logarithm of labor force. To consider the governor membership in the political party, we introduce the dummy-variable “party”, where 1 indicates the membership of the governor in the ruling party, 0 – membership in other parties. Table 2 represents the description of the variables employed in the analysis.

Methodology

According to the preliminary analysis of the data, the panel time series contain the cross-sectional dependency Table A3.1 (Appendix 3) and the heterogeneity bias Table A3.2 (Appendix 3). The test results of the cross-sectional dependency (Pesaran, 2004) is performed based on the average of the pair-wise correlations of the residuals obtained from the OLS estimations for each region in the panel data. According to the results, all variables included to do the econometric modelling contain the spatial correlation in panels. To address the cross-sectional dependency bias, we add common correlation variables calculated by the author as a mean value of an indicator for all regions in a specific time period (Eq. 5) for the logarithm GRP per capita, trade openness, the share of capital investment in the GRP and the logarithm of labor force.

$$Tx_t = mean(X_{it}), \quad (5)$$

where X_{it} is the vector of control variables (the logarithm GRP per capita, trade openness, the share of capital investment in the GRP and the logarithm of labor force).

According to the results of the heteroscedasticity test for the measures of inter-regional disparity among the Russian regions (Table A3.2), the test shows that the data contains a high degree of heteroscedasticity. The variables included to the analysis are stationary according to panel unit-root test (CIPS) developed by Pesaran (2007). To capture the strong heterogeneity, we apply the Quantile via Moment econometric approach (Machado, Santos Silva, 2019), which performs the simultaneous quantile regression under the bootstrapping standard errors and cross-sectional dependency variables (Eq. 6).

$$Q_y(\tau | X_{it}) = (a_i(\tau) + \delta_i q(\tau)) + \beta(\tau) + \gamma(\tau), \quad (6)$$

where the $a_i(\tau) + \delta_i q(\tau)$ is the quantile-t fixed effect for region i , or the distributional effect, $Q_y(\tau | X_{it})$ is the quantile of the dependent variable, $X'_{it}\beta$ is the vector of the independent variables, Z is a vector of known dif-

¹⁶ https://www.economy.gov.ru/material/dokumenty/rasporyazhenie_ot_13_fevralya_2019_g_207_r.html, accessed 12.05.2023.

¹⁷ Appenixes are represented at the separate file at the article webpage (URL will be added).

¹⁸ <https://data.imf.org/?sk=1C28EBFB-62B3-4B0C-AED3-048EEEBB684F>, assessed 02.12.2021.

Table 2. Variables Description

Variable	Definition	Source
Disparity (DSPR)	The measure of inter-regional economic disparity	Calculated by the authors using the data on GRP; retrieved from the Federal Statistic Service Data
Fiscal decentralization (FSD)	Fiscal decentralization (share of own public spending of the region in general government spending)	IMF (2020)
Trade Openness (TRO)	Trade openness (Sum of export and import divided by nominal GRP)	Calculated by the authors using the data on export, import, retrieved from the Federal Statistic Service Data
Total labor force (TLF)	Total labor force (people aged 15 years and older who are considered employed or unemployed during the review period)	Federal Statistics Service
Gross Regional Investment (INV)	Gross regional investment, share in GRP*	Federal Statistics Service
Natural resources extraction (NRS)	Natural resources extraction (share in GRP)	Federal Statistics Service
Governor's Affiliation with the political party	Dummy-variable (1 for "United Russia")	Ivanov (2019)

* Total expenditures for construction, reconstruction, including expansion and modernization of facilities that lead to an increase in their initial cost; includes machinery, equipment, vehicles, production and household inventory, investments in objects of intellectual property; cultivated biological resources.
Source: authors.

ferentiable (with probability 1) transformations of the components of X .

The quantile regression deals with heteroscedasticity in the data structure (Koenker, 1978) by modelling the relationship between a set of predictor variables and certain percentiles of the dependent variable. The basic econometric techniques often fail to address the cross-sectional and time heterogeneity bias. To account for the cross-sectional dependency model, we include time series variables to the model, since the quantile regression method does not eliminate distortions due to the CD dependency. Therefore, the econometric specification is described with the following equation:

$$Q_{disparity}(\tau | X_{it}) = (a_i + \delta_i q(\tau)) + \beta_{1i}(\tau) FDC_{it} + \beta_{2i}(\tau) TO_{it} + \beta_{3i}(\tau) LLF_{it} + \beta_{4i}(\tau) INVS_{it} + \beta_{5i}(\tau) NRS_{it} + \beta_i(\tau) Tvars + \gamma q(\tau) + \varepsilon, \quad (7)$$

where $Q_{disparity}$ is the indicator of the inter-regional disparity as measured by the authors; FDC_{it} is the indicator of fiscal decentralization; TO_{it} is trade openness; LLF_{it} is the value of the labor force; $INVS_{it}$ is fixed capital formation share in the gross regional product; NRS_{it} is natural resource extraction share in the gross regional product; $Tvars$ is the vector of cross-correlation effects. To consider the governor membership in the political party, we introduce a dummy-variable and divide the dataset in the two subsets for further analysis.

Figure 4 reflects the disparity gaps among the Russian regions. From the lower to the middle quantiles (1% < 50%) on the horizontal axis, the figure reflects the regions having GRP per capita less than the mean GRP per capita in the entire Russia. Besides, the quantiles from the middle to the top indicate the regions enjoy GRP per capita higher than average GRP in Russia in a fiscal year. The red curve intersects the vertical-zero disparity line at the median quantile (50% quantile), capturing no disparity points. Therefore, we expect the

quantile slope coefficients to be positive (+) from the 10% to 50% quantiles to reduce the regional disparity. Besides, the quantile slope coefficients should be negative from the 50% to 90% quantiles to reduce disparity.

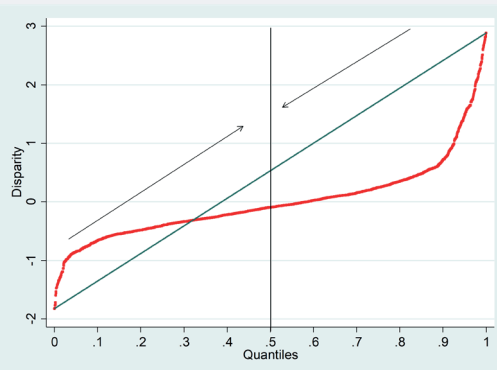
Results and Discussion

Description Analysis

We start our analysis with the descriptive statistics positioned in Appendix 4. The overall standard deviation reflects the volatility of our variables over time and across the regions. The between and within measures of standard deviation indicate the spatial ("between") and time ("within") variations of the variables. The values of "between" for the disparity, labor-force and natural resource extraction are significantly higher than the values of "within", which confirms a high regional inequality in economic growth and resource endowments. The standard deviation for fiscal decentralization does not show the between-measure as the data varies only over the time period. The trade openness varies more over time, which is explained by increasing the trade liberalization for all regions during the period 1996-2019. The gross regional investment is highly volatile over time and across the regions, which indicates that the regional inequality in expenditures for modernization follows an increasing trend over time.

Table 3 reports the estimated results for whole sample (all Russian regions). The fiscal decentralization is negative and significant at the lower quantiles (q10, q20 and q30) of the disparity, which indicates that fiscal decentralization is counterproductive in reducing economic disparity between the more developed and less developed regions. Fiscal decentralization widens regional economic growth disparity due to their heavy dependency on the federal budget, less market completion, economic inefficiency and diversification. The magnitude of the coefficients at the lower quantiles ap-

Figure 4. Distribution plot of disparity by the quantiles



Notes: the red curve represents distribution of the regional economic disparity by quantiles, while the black vertical line at the 50% quantile refers to zero disparity. Upward and downward arrows indicate convergence towards equality from both directions. The black linear line across the red line is imaginary with a 45-degree angle.

Data source: Federal Statistics Service.

pears to be higher with a negative sign, implying that fiscal decentralization worsens the lagging behind regions (q10) in terms of economic growth disparity. Besides, the coefficient of FDC is still negative but turns in to be insignificant at the 40% quantile.

Moreover, if the disparity exceeds the 70% quantile, the coefficient of FDC becomes positive but insignificant. Our empirical results violate the theoretical proposition (Oates, 1999; Qian, Roland, 1998a; Tiebout, 1956) concerning the effectiveness of fiscal decentralization in reducing the inter-regional disparity. However, our finding is consistent with Prud'homme (1995), who argues that fiscal decentralization increases the disparity as the regional governors enjoy uncontrolled fiscal expenditures. Bellofatto & Besfamille (2021) find that FDC is somewhat effective in reducing a small disparity, while it aggravates it in countries of higher disparities like Russia. Moreover, our empirical findings are in line with Zhang (2006), who finds that fiscal decentralization spurs tax burden on the less developed regions, which eventually leads to higher regional disparities in the China context.

Natural resources play an asymmetric role in explaining the regional disparity. For instance, for the regions with lower GRP per capita, the presence of the natural resources significantly reduces the gap of the inter-regional disparity. However, the estimated coefficients of natural resources are positive at the higher quantiles, indicating that the economically prosperous regions along with natural resources-augmented regional disparity at greater scale in Russia, which supports the prior investigation on Kazakhstan (Abdulla, 2021) and China (Qiang, Jian, 2020). Table A5.5 (Appendix 5) shows the quantile distribution by regions. The quantile of 90% reflects the regions with the highest resource endowment as hydrocarbon-exporters and precious metals (e.g., the Tyumen region, Khanty-Mansiysk Au-

tonomous district, Yamal-Nenets Autonomous district, Nenets Autonomous district, Kamchatka region, Chukotka Autonomous district, the Republic of Sakha).

The upper middle quantiles (70% and 80%) include most of the regions specializing with manufacturing production, metal & ore extraction, steel, and copper production. These regions enjoy a GRP per capita higher than the average in Russia and experience a decent economic performance. Therefore, resource endowment and trade openness spur economic development in the indicated regions and decrease the effect of the fiscal decentralization by worsening economic disparity. Concurrently, the parameters of regional trade, investment and labor force help to reduce regional disparity from the lower to the medium quantiles, while they spur the inter-regional disparity gap at the upper quantiles (q60-q90). The magnitude of the coefficients of trade openness and investment increase with increasing quantiles.

On the contrary, the coefficients of labor force are more efficient in reducing the gap between the less developed and more developed regions. Moreover, the magnitude of the coefficients for trade openness and natural resources reflects the dependency of the Russian economy on the natural resource rent (Gaddy, Ickes, 2013). Qiang & Jian (2020), argue that market openness in China increases the effect of the resource curse, especially for more resource-abundant areas. The empirical results show that fiscal decentralization is not efficient enough in addressing the disparity problem both for the lagging-behind-regions and more economically developed ones, which is in line with works by (Bartolini et al., 2016; Besley, Ghatak, 2003), arguing that fiscal decentralization may induce stronger inter-regional disparities as being beneficial only for the well-endowed regions. Moreover, the increasing contribution to the inter-regional disparity of natural resource extraction and trade openness makes the fiscal decentralization address the disparity at the higher quantiles.

In the next step of our analysis, we divide the sample-based governors' political attachments with the ruling party versus the non-ruling parties. Table A5.1 (Appendix 5) reports the results. They show that FDC widens regional disparity towards the negative direction at the lower to the medium quantiles (q10-q30) when regional governors are politically attached with the ruling party, which somewhat corroborates with Riker's theory (Riker, 1964). The lower quantiles represent the values of the disadvantaged regions which heavily rely on government fiscal transfers (e.g., Dagestan Republic, the Ingushetia Republic and the Chechen Republic). The literature argues that the governors from the ruling party enjoy more autonomous power in governing the regions (Enikolopov, Zhuravskaya, 2007; Zhuravskaya, 2000), thus, a lack of accountability and transparency often leads to poor bureaucracy and ultimately obstructs economic growth. The governors from the ruling party abuse the nepotism coming from the cen-

Table 3. The results of the quantile regression (all regions)

Variables	location	scale	Q10	Q20	Q30	Q40	Q50	Q60	Q70	Q80	Q90
FDC	-1.153	2.280**	-4.538***	-3.507**	-2.697**	-2.073	-1.327	-0.636	0.0609	0.906	2.315
	(-1.455)	(-1.049)	(-1.686)	(-1.455)	(-1.359)	(-1.355)	(-1.427)	(-1.557)	(-1.739)	(-2.009)	(-2.532)
TRO	5.305**	2.453*	1.664	2.772	3.643*	4.315**	5.117**	5.860***	6.610***	7.519***	9.034**
	(-2.066)	(-1.489)	(-2.394)	(-2.065)	(-1.929)	(-1.923)	(-2.025)	(-2.21)	(-2.468)	(-2.851)	(-3.592)
INV	0.002***	0.001**	0.002	0.001**	0.002***	0.0014***	0.0017***	0.0018***	0.0021***	0.002***	0.003***
	(-0.001)	(-0.0003)	(-0.0004)	(-0.0004)	(-0.001)	(-0.00039)	(-0.00041)	(-0.00045)	(-0.0005)	(-0.0006)	(-0.0007)
LLF	0.152***	-0.029**	0.196***	0.183***	0.172***	0.164***	0.155***	0.146***	0.137***	0.126***	0.108***
	(-0.019)	(-0.014)	(-0.022)	(-0.019)	(-0.0179)	(-0.018)	(-0.019)	(-0.0205)	(-0.0228)	(-0.0264)	(-0.0333)
NRS	0.029***	0.003***	0.026***	0.027***	0.0276***	0.028***	0.029***	0.030***	0.031***	0.032***	0.033***
	(-0.0013)	(-0.001)	(-0.002)	(-0.001)	(-0.0012)	(-0.0012)	(-0.0012)	(-0.0014)	(-0.0015)	(-0.0018)	(-0.0022)
Constant	-34.16	66.19**	-132.4***	-102.5***	-78.99**	-60.87*	-39.22	-19.17	1.068	25.6	66.48
	(-36.54)	(-26.33)	(-42.3)	(-36.53)	(-34.1)	(-34)	(-35.8)	(-39.05)	(-43.58)	(-50.39)	(-63.59)
Obs.	1,136	1,136	1,136	1,136	1,136	1,136	1,136	1,136	1,136	1,136	1,136

Notes. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively. Standard errors in parenthesis. FDC represents fiscal decentralization, TRO refers to open trade, INV indicates the regional investment, LLF denotes labor force, NRS defines natural resources
Data source: Federal Statistics Service.

tral government in grabbing more revenue, eventually they execute inefficient fiscal plans (Orlov, 2021). For instance, the Republic of Dagestan, the Republic of Ingushetia, and the Chechen Republic have the lowest GRP per capita; while the Ivanovo region, the Kirov region, the Transbaikal region are less business active regions.

Since 2000, the Dagestan Republic, the Tyva Republic, the Karachay-Cherkess Republic, the Kabardino-Balkarian Republic, the Ingushetia Republic and the Chechen Republic receive the equalization transfer, whose value exceeds more than 40% of their consolidated budget and compiles the highest share of equalization transfers in Russia. These regions encounter a sluggish economic growth; therefore, they often rely on the federal government and regions who have a fiscal budget surplus. Their long-term dependency on the federal government hinders them from finding market solutions to their economic problem by tapping new economic opportunities. However, the fiscal decentralization shows a negative and insignificant impact on the disparity at the 40, 50, 60 and 70 quantiles. If disparity exceeds 80%, the coefficients of fiscal decentralization turn to be positive but insignificant, reflecting an insufficiency in addressing the disparity problem.

The results for the regions, where the governor is a member of another party or self-proposed (not a member of any party), are reported in Table A5.2 (Appendix 5). We observe that fiscal decentralization has an insignificant effect on the inter-regional disparity at all quantiles, although the sign of the parameters varies over the quantiles. Trade openness has an insignificant role in explaining regional economic disparity where governors are from non-ruling party. These regions depend less on the natural resource rent; however, the resource abundance still defines the economic development and contributes more to the disparity, compared to the regions in Table A5.1 (Appendix 5). The labor force decreases the inter-regional disparity at the low-

est quantiles. As more workers join into the labor-force during depressed conditions may reduce disparity by reducing wages. The magnitude of the estimated coefficients declines with the increase in the quantiles and shows no significant parameters for higher quantiles, where economic conditions are improving, as things cancel out each other.

Our empirical results represent that Russian fiscal decentralization is ineffective in reducing the regional economic disparity, which nullifies the theory of fiscal federalism by Tiebout (1956). Moreover, the fiscal decentralization augments disparity at the lower quantiles (q10-q30). At the upper quantiles, we report no significant effect of the fiscal decentralization. Our results are consistent with Prud'homme (1995), who argues that fiscal decentralization increases the disparity as the regional governors abuse more autonomy, which fosters the uncontrolled distribution of the fiscal budget and corruption. Moreover, our empirical findings are in line with (Bellofatto, Besfamille, 2021; Zhang, 2006). The political affiliation of the regional governor in the ruling party contributes to the disparity significance, while retaining its negative effect, thereby confuting Riker's theory (Riker, 1964) stating that governor attainment to the ruling party improves the outcomes of the fiscal decentralization.

Blanchard and Shleifer (2001) confirm that fiscal decentralization must strike a balance with centralization, as high degrees of decentralization in the transition economies result in a lack of control and a lower government quality, which decreases economic growth and increases corruption. According to Riker (1964), the existence of a strong political party is an indicator of the centralized states. Currently, the Russian authorities promote the centralization tendency for increasing the control of the regional policies. For instance, in 2022, about 75% of the Russian regional governors are from the main party. Among the rest, 7 governors are from other parties and 15 are self-proposed. Self-

proposed governors still require support from a party or private business for the election campaign. The ruling party for example had supported 11 governors during the recent elections (2010-2019) and a few other governors enrolled later in the party, which reflects the strong influence of the ruling party.

Robustness check

Table 4 reports the estimation results for all Russian regions. The results are consistent with our previous findings, which is reflected by significance and signs of the estimated coefficients of the independent variables.

We run the Quantile via Moments estimation for two subsets divided by the political affiliation of the governors. Table A5.3 (Appendix 5) reports the estimation results for the regions where the governor is a member of the ruling party. The results confirm our previous findings, showing that fiscal decentralization is significant at the lower quantiles; however, promoting the disparity gap. The natural resources, trade openness, labor force and investment drive the inequality among the Russian regions at the medium to the upper quantiles, but significantly decrease the inter-regional inequality at the lower quantiles.

Table A5.4 (Appendix 5) represents the estimation results for the regions where the governor is a member of another party or self-promoted. The results coincide with Table A5.2 and confirm our previous findings.

Conclusion and Policy Implications

The transition of the Russian Federation from a community (command) system to a market economy has posed many challenges, including inter-regional disparity. During the last two decades, the Russian gov-

ernment has undertaken several fiscal measures to reduce disparity including using the fiscal decentralization policy. However, the empirical studies are limited in stressing the evaluation of the effectiveness of fiscal decentralization in reducing the inter-regional disparity in the Russian Federation.

In this study, we have scrutinized the impact of fiscal decentralization on reducing the inter-regional economic disparity among the Russian regions, contextualizing the roles of natural resource abundance and political affiliations of regional governors. Due to a considerable regional heterogeneity and oscillation over time in the data, we have applied the Quantile via Moments approach which considers the location and scale effects to capture regional economic growth differences and economic growth jumps.

Our empirical results demonstrate that fiscal decentralization is ineffective in reducing the inter-regional economic disparity among Russian regions. Besides, FDC widens regional economic disparity by pulling down from the lower to the medium quantiles and pushing up from the medium to the top quantiles. Even after receiving a considerable fiscal support from the central government, the relative economic performance of many disadvantaged regions¹⁹ are declining. Whereas FDC disproportionately hastens the wealthy regions²⁰.

Our study confirms that regional governors’ political affiliations matter in the fiscal decentralization and regional economic growth disparity. More precisely, fiscal decentralization- induced regional growth disparity is pronounced (at the lower quantiles) in the regions where the governors are affiliated to the ruling party.

The roles of natural resource, trade openness, labor force and regional investment are found to be effective

Table 4. The results of the quantile regression with the measure in Eq. (7)

Variables	location	scale	Q10	Q20	Q30	Q40	Q50	Q60	Q70	Q80	Q90
FDC	-0.0967 (0.1211)	0.2011** (0.0873)	-0.3931*** (0.1393)	-0.3026** (0.1204)	-0.2345** (0.1129)	-0.1770 (0.1126)	-0.1109 (0.1189)	-0.0529 (0.1293)	0.0081 (0.1443)	0.0855 (0.1677)	0.2073 (0.2106)
	0.4439** (0.1734)	0.2072* (0.1251)	0.1385 (0.1994)	0.2319 (0.1723)	0.3020* (0.1616)	0.3612** (0.1612)	0.4293** (0.1702)	0.4890*** (0.1851)	0.5518*** (0.2065)	0.6316*** (0.2401)	0.7571** (0.3012)
INV	0.0001*** (0.0000)	0.0001** (0.0000)	0.0001 (0.0000)	0.0001** (0.0000)	0.0001*** (0.0000)	0.0001*** (0.0000)	0.0001*** (0.0000)	0.0002*** (0.0000)	0.0002*** (0.0000)	0.0002*** (0.0000)	0.0002*** (0.0001)
	0.0127*** (0.0016)	-0.0025** (0.0012)	0.0164*** (0.0018)	0.0152*** (0.0016)	0.0144*** (0.0015)	0.0137*** (0.0015)	0.0129*** (0.0016)	0.0122*** (0.0017)	0.0114*** (0.0019)	0.0105*** (0.0022)	0.0089*** (0.0028)
NRS	0.0025*** (0.0001)	0.0002*** (0.0001)	0.0021*** (0.0001)	0.0022*** (0.0001)	0.0023*** (0.0001)	0.0024*** (0.0001)	0.0025*** (0.0001)	0.0025*** (0.0001)	0.0026*** (0.0001)	0.0027*** (0.0001)	0.0028*** (0.0002)
	-2.8520 (3.0451)	5.5009** (2.1958)	-10.959*** (3.4997)	-8.482*** (3.0266)	-6.6199** (2.8363)	-5.0471* (2.8298)	-3.2405 (2.9874)	-1.6531 (3.2478)	0.0143 (3.6211)	2.1328 (4.2122)	5.4633 (5.2949)
Obs.	1136	1136	1136	1136	1136	1136	1136	1136	1136	1136	1136

Notes: *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively. Standard errors in parenthesis. FDC represents fiscal decentralization, TRO refers to open trade, INV indicates the regional investment, LLF denotes labor force, NRS defines natural resources

Source: authors.

¹⁹ E.g., the Dagestan Republic, the Tyva Republic, the Karachay-Cherkess Republic, the Kabardino-Balkarian Republic, the Ingushetia Republic.

²⁰ E.g., the Nenets Autonomous district, the Yamal-Nenets Autonomous district, the Khanty-Mansiysk Autonomous district, the Tyumen region, the Sakhalin region, Moscow, and the Sakha Republic.

in reducing the growth disparity gap for the economically weak regions. Though, these variables accelerate regional economic growth in the wealthy regions at a faster rate, thus the overall regional economic growth disparity is augmented.

Based on the empirical investigation, we provide several policy implications. The counterproductive role of fiscal decentralization in reducing disparity for the weak regions implies that those regions should find market solutions to boost their economic performance to catch up with the wealthy regions. Besides, the fiscal support from the central government should be utilized for purely public goods and merit goods. Importantly, fiscal support should be tied with fair accountability, transparency, and budget implementation plan. Moreover, the decrease in the equalization transfer from the central budget can motivate the regions for

seeking new economic opportunities for their sustainable economic development. Since natural resources are the prime factor for a higher regional disparity, then the federal government should revise the distribution policy of resource rents for holistic economic development. Finally, the distribution of the national budget among the regions should be free from political nepotism to ensure more inclusive economic development.

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GOVERNANCE



Big Data, Machine Learning, Artificial Intelligence and Blockchain in Corporate Governance

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Abstract

The paper analyzes the dynamics of scientific research in, and the practical application of, key Industry 4.0 technologies in corporate governance, namely big data, artificial intelligence, machine learning, and blockchain. The contribution of specific authors, citations, and collaboration networks are assessed, along with that of individual countries and research organizations. A bibliometric network analysis of publications indexed in the Scopus and OpenAlex databases for

2011-2022 revealed a steady increase in the number of publications on the topic under consideration, and therefore growing interest in it. The use of the aforementioned technologies in corporate governance is expected to lead to increased performance and transparency as well as improved cybersecurity. The authors provide recommendations for various groups of users to maximize the potential of Industry 4.0 technologies for businesses and the economy as a whole.

Keywords: corporate governance; sustainable development; corporate social responsibility; technology; Industry 4.0

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Introduction

Along with increased global competition, tighter regulations, and other factors, the technological breakthroughs of the Fourth Industrial Revolution (Industry 4.0) are transforming society and radically changing the business landscape. Computer systems based on big data, machine learning, blockchain, artificial intelligence (AI), and other advanced solutions allow one to establish cause-and-effect relationships and prepare (if necessary, substantiate) recommendations (Gomber et al., 2018).

The digital transformation significantly expands companies' opportunities to develop innovative business models and streamline operations (Kajikawa et al., 2022). Platform and internet-based companies tend to be among the most valuable ones in the world (Iansiti, Lakhani, 2017). Managing technological development and innovation is becoming a strategic corporate priority and commands significant attention of researchers (Adhariani, De Villiers, 2018). However, most of the existing publications are primarily focused on specific aspects of using particular technologies in corporate governance, while attempts to generalize and structure relevant practices remain rare. The objective of our study is to bridge this gap through a comprehensive analysis of the use of key Industry 4.0 technologies (big data, machine learning, AI, and blockchain) in corporate governance and assess the practical effects for companies. The presented picture improves the information basis for making better decisions.

Literature Review

Corporate Governance: Objectives and Challenges

The principles and structures of modern corporate governance stem from the agency theory, which describes a contractual relationship between company owners (principals) and top managers (agents) (Jensen, Meckling, 1976). Principals (shareholders, investors, etc.) authorize agents to manage the company with the obligation to account for actions taken and provide complete and up-to-date information in a timely manner. The principal expects the agent to act in the former's best interests, and contribute to the creation of shareholder value.

According to the agency theory, corporate governance is a set of monitoring mechanisms required to protect investments and generate profits when ownership and control are separated, to eliminate uncertainty and information asymmetry in parties' relations (Shleifer, Vishny, 1997). The corporate

governance system includes principles, methods, and values according to which the organization is controlled and managed with the objective of increasing its value (Velnampy, 2013). An adequate quality of the corporate governance system is critical for earning the trust of shareholders, investors, and other stakeholders, achieving long-term company viability, and sustaining sufficiently high performance. Failures in this system, including information asymmetry, can result in instability, financial losses, and serious reputational damage. Applying advanced technologies increases the transparency of asset management and thus the overall corporate governance quality (Agarwal et al., 2013).

The Scope for, and Practices of, Applying Industry 4.0 Technologies in Corporate Governance

Issues with preparing and auditing corporate reports are widely discussed in the literature. For example, manually entering data increases labor costs as well as the risks of unintentional (or deliberate) distortions (Du et al., 2019; Tan, Low, 2019). Many organizations maintain records in multiple formats, which requires careful document reconciliation (Brown et al., 2016).

Big data technologies allow one to analyze information (such as, e.g., company survey results) more rapidly and more thoroughly, to identify corporate governance practices' trends, variations, and patterns in different countries. It becomes possible to generate extensive data arrays covering a certain period of time, which allows auditors to track the dynamics of management standards.

Machine learning helps create predictive corporate governance rating models based on a number of important variables including financial data, company size, and industry-specific features. This becomes possible through the automatic analysis of various types of corporate reports (Rantanen et al., 2019; Agarwal et al., 2013).

Blockchain technology improves management processes through the efficient and transparent distribution of information (participants in the chain can exchange information in real time) (Fahlevi et al., 2022). All stakeholders have access to corporate governance data, which is adequately safeguarded to ensure its integrity and reduce alteration risks (Benlian et al., 2018; Velnampy, 2013; Dai, Vasarhelyi, 2017).

AI technologies are applied to analyze complex data arrays, which helps to identify non-obvious connections between factors affecting governance

quality indicators and allows for making international comparisons. It becomes possible to predict audit results and improve management practices. Used in combination with big data technology, AI allows one to monitor financial flows in real time (Cong et al., 2018; Ivaninskiy, Ivashkovskaya, 2020). Thanks to the improved quality of data analysis, a more accurate assessment of risks and opportunities, and the automation of repetitive processes, companies can make better-informed decisions and do so more efficiently.

Research Methodology

Research Questions and Variables

We explore the trends in the application of key Industry 4.0 technologies in corporate governance. The role of specific authors and co-authorship networks are assessed, along with the contribution of particular countries and research organizations to the studying of the aforementioned topic. The sample covered the period 2011–2022.¹ The Industry 4.0 concept comprises digital technologies designed to optimize production processes, including big data, AI, machine learning, and the Internet of Things.

These four key Industry 4.0 technologies served as independent variables for the analysis, since they allow one to successfully deal with complexity in corporate governance (which was used as the dependent variable) and improve its quality.

Data Types and Sources

Bibliometric network analysis combines expert-based techniques and quantitative tools to improve the quality of interpretations and conclusions (Chichorro et al., 2022). Elements such as semantics, citation statistics, and authorship are taken into account. The obtained results are presented in the form of network maps, to facilitate the perception of information by both the scientific community and the general public (Gibson et al., 2018). Visualization of the use of particular keywords identifies research topics (clusters) in specific areas, which allows one to establish authors' affiliation with specific journals to determine the former's geographical coverage and assess institutional and international collaboration in researching emerging technologies (Tanudjaja, Kow, 2018; Erthal, Marques, 2018).

In the course of our literature review relevant research papers were identified to build the study sample. The process comprised several stages: identifying appropriate publications, structuring them by topic and year of publication, designing an analytical structure, and comparing data. A keyword search was performed in the titles, abstracts, and keywords of papers indexed in the Scopus and OpenAlex databases, based on the following criteria: “time range or year of publication,” “source type,” and “document type.” The time range was set between 2011 and 2022, the source type set as journal, and the document type as paper (article).

Figure 1. Dynamics of Scopus-indexed Publications



Source (here and below): authors, based on data from relevant databases as of 5 November, 2023.

¹ 2011 was chosen as the starting point of the study period because it was the year when the Industry 4.0 concept was first presented, at the Hannover Messe trade fair in Germany (<https://www.hannovermesse.de/de/news/news-fachartikel/technologiearten-machen-industrie-4-0-verstaendlich>, accessed on 15.10.2023).

Box 1. Stages of Bibliometric Analysis

Step 1. Formulate keyword search queries:

- „big data” OR „artificial intelligence” OR „machine learning” OR „blockchain” AND „Corporate Governance”
- “big data” AND “corporate governance”
- “artificial intelligence” AND “corporate governance”
- “machine learning” AND “corporate governance”
- “blockchain” AND “corporate governance”.

Step 2. Set sample building criteria

(Scopus and OpenAlex databases):

- time range or year of publication: 2011-2022
- source type: journal
- document type: paper (article).

Step 3. Extract data from Scopus and OpenAlex.

Step 4. Identify relevant research papers:

- generate annual statistics for relevant publications
- conduct quantitative analysis, visualise bibliographic data network.

Source: authors.

Table 1 presents the identified publications’ statistics before filtering.

Data Analysis Methods

A quantitative (statistical) method was applied in the bibliometric analysis to identify patterns in the dynamics of different types of publications on a particular topic. Two main techniques are commonly used to conduct such an analysis: performance analysis and science mapping (Cobo et al., 2011). The first uses indicators such as institution, country, and author, and assesses their impact on the basis of bibliographic data (Henderson et al., 2009). The second describes the structural and dynamic aspects of scientific publications (Borner et al., 2003). The stages of our bibliometric analysis are described in Box 1.

Results and Discussion

Annual Publication Trends

Figure 1 shows the number of papers published between 2011 and 2022 found in Scopus on the basis of the adopted research criteria. Until 2018 the number of such publications grew slowly; in 2011, 2012, 2014, 2015, and 2017 there was no growth at

all (not a single new publication appeared). After 2018 their number grew steadily. In terms of the use of keywords relevant to the technologies under consideration in combination with the term “corporate governance”, the largest number of Scopus-indexed papers turned out to be focused on AI (38 documents). Blockchain came second (30 papers), machine learning third (28), and big data fourth (26).

Figure 2 shows the growth in the number of papers published between 2011 and 2022, found on the basis of the same criteria in the OpenAlex database. In 2013, the number of publications on the use of big data technology decreased; in 2015 so did the number of papers on AI, machine learning, and blockchain. After 2015, research on all technologies under consideration sharply increased. As with Scopus-indexed publications, the most common keyword used in combination with “corporate governance” was “AI” (1,118 documents). “Big data” came second (1,004), “machine learning” third (696), and “blockchain” fourth (635).

An analysis of the dynamics of relevant publications indexed in the both databases revealed that the largest number of documents contain the keyword combination “AI” + “corporate governance”. Therefore interest in this area is growing and the volume of knowledge about the use of AI in corporate governance generated in the course of scientific research and applied by government agencies and business organizations is constantly increasing. The same goes for big data, machine learning, and blockchain.

Table 1. Publication Statistics before Filtering

Search query	Number of documents found in the databases	
	Scopus	OpenAlex
1. "big data" OR "artificial intelligence" OR "machine learning" OR "blockchain" AND "corporate governance"	324	1432
2. "big data" AND "corporate governance"	85	2018
3. "artificial intelligence" AND "corporate governance"	120	2322
4. "machine learning" AND "corporate governance"	83	1458
5. "blockchain" AND "corporate governance"	83	1432

Source: authors.

Figure 2. Dynamics of OpenAlex-indexed Publications

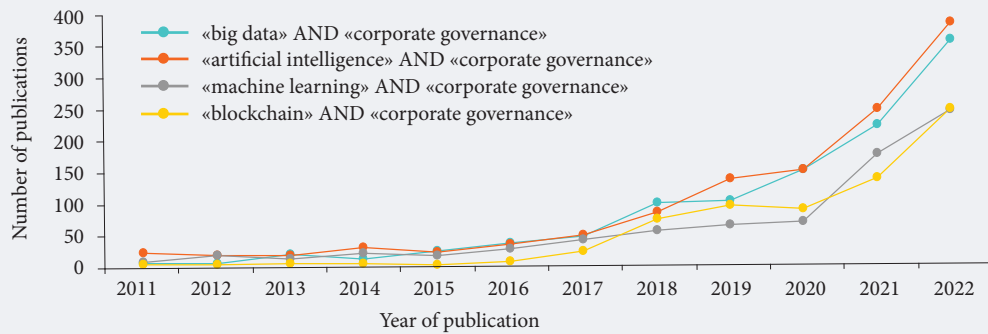
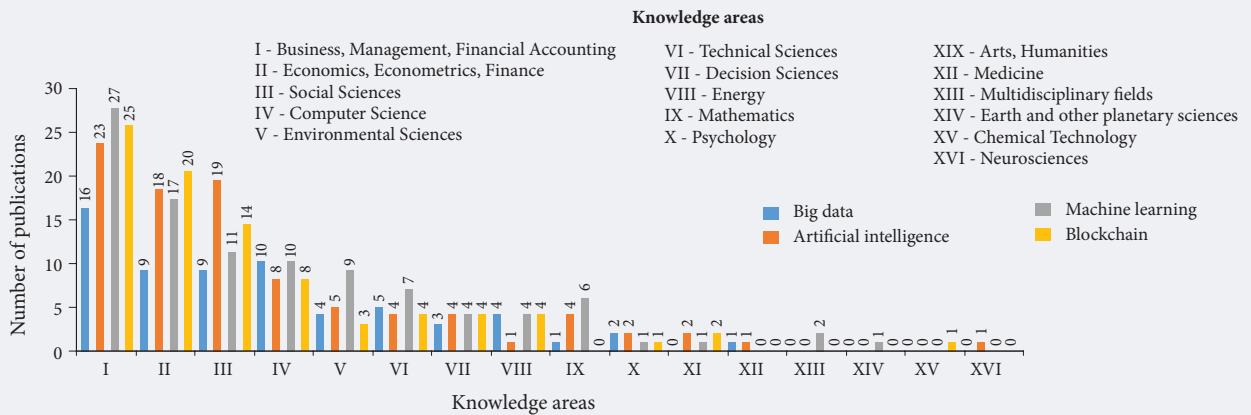


Figure 3. Number of Scopus-indexed Publications on 16 Knowledge Areas



Distribution of Publications

Figure 3 presents the results of an analysis of Scopus-indexed publications which meet the research criteria and contain the keywords “big data”, “AI”, “machine learning”, “blockchain” and “corporate governance”. A total of 3,453 documents were found and then broken down into 16 categories (business, management, accounting, economics, finance, social sciences, etc.).

As one can see in Figure 4, the largest categories are business, management, and accounting (27% of all papers), economics, econometrics, and finance (19%), and social sciences (15%). The smallest number of papers containing the keywords in question were found in the following categories: “medicine” (“big data”, “AI”), “Earth and other

planetary sciences” (“machine learning”), “chemical engineering” (“blockchain”), and neuroscience (“AI”). Their share ranges from 0.3% to 0.6%.

Figure 5 presents the results of the analysis of publications found using the same criteria and keywords in OpenAlex (17,752 in total). They were also divided into 16 categories. The largest turned out to be “Business” (27% of all papers), “Informatics” (13%), “Political Science” (10%), “Finance” (10%), and “Economics” (9%). Researchers were least interested in “Computer security” (3.2%), “Mathematics” (2.9%), “Management”, and “Politics” (2.1% each). The results indicate that studies and analysis of Industry 4.0 technologies’ application cover many different areas, but the scale of research significantly varies.

Figure 4. Distribution of Scopus-indexed Publications across 16 Knowledge Areas (%)



Researcher Co-Authorship Networks

Figure 7 shows a visualization of the co-authorship network based on the analysis of Scopus-indexed publications identified using the generalized search query formula 1 (Table 1). To be counted, each author must have co-authored at least two papers in partnership with others. Of the 449 authors in total (who have used the specified keywords), 27 participated in co-authorship.

Figure 8 shows a visualization of the co-authorship network based on the analysis of OpenAlex publications identified using the same criteria. Of the total of 1,445 authors whose papers contained the abovementioned keywords, 59 took part in co-authorship. In this visualization, author networks are not connected to each other, except for a few groups.

Distribution of Publications by Country

Figure 9 shows the top 30 countries by the number of OpenAlex-indexed publications on the use of

the technologies in question in corporate governance. These include China, the UK, the US, Italy, Australia, and Indonesia, indicating a significant interest on their part in applying the relevant tools.

Organization Co-Authorship Networks

Figure 10 presents a visualization of the organizations' co-authorship network for the papers found in OpenAlex using the general search query 1 (see Table 1). Co-authorship networks show the links between organizations or countries (Zhao et al., 2017). To be included, each organization had to have at least two papers published jointly with other ones. Out of the total of 1,050 organizations, 134 took part in co-authorship according to this criterion. The largest group of interconnected units comprises 65. The largest number of papers co-authored with researchers from other organizations were published by staff members of the University of Oxford, University of Sussex, University of Glasgow, Shanghai University of Finance and Economics, University of Technology Sydney, and University of Indonesia.

Figure 5. Number of OpenAlex-indexed Publications on 16 Knowledge Areas (%)

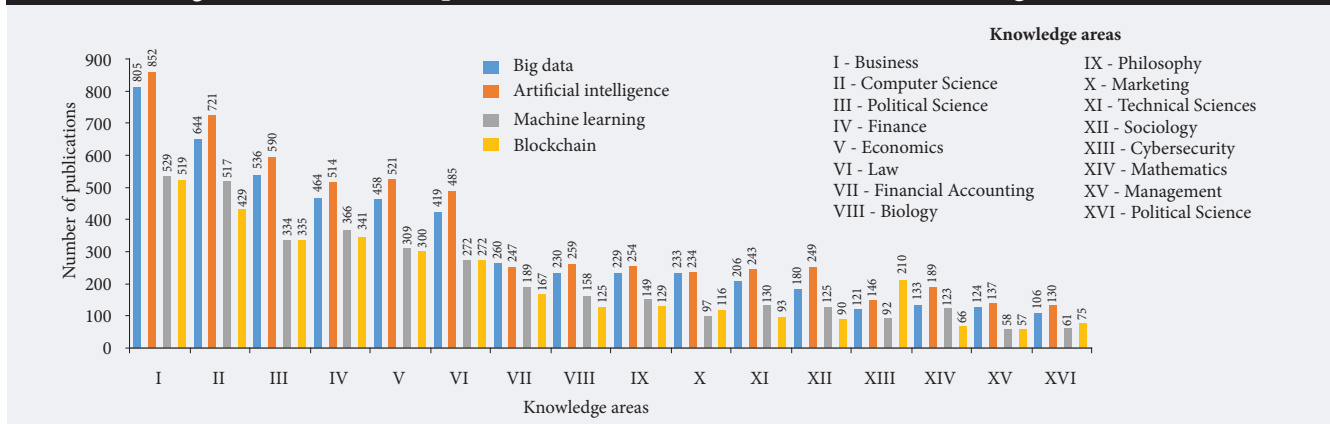


Figure 6. Distribution of OpenAlex-indexed Publications across 16 Knowledge Areas (%)

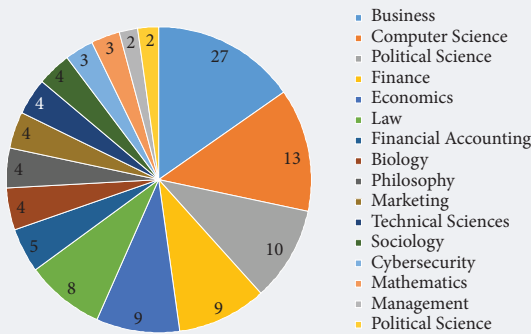
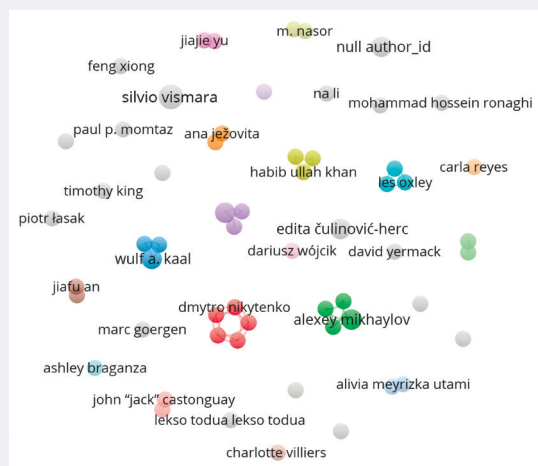


Figure 7. Visualisation of Co-authorship Networks for Scopus-indexed Publications



Note: the author's colour in the figure indicates the average year of their papers' publication. E.g. Grove, H. is displayed in purple (publication year 2019), Wang J. in blue (2020), Li J. and Jiraporn P. in green (2022).

Figure 8. Visualisation of Co-authorship Networks for OpenAlex-indexed Publications



Discussion

Big data analytics has significant potential for application in various Indonesian sectors, organizations, and companies, especially to improve cybersecurity and infrastructure (Prasetyo, 2019). This technology opens realistic prospects to improve business performance, because valuable information extracted from large volumes of data can help entrepreneurs increase profits and productivity and create innovations (Erevelles et al., 2016). The first detailed analysis of using machine learning technology to automatically assess companies' online reputation was presented in (Rantanen et al., 2019). Reputation is critical to establishing and maintaining long-term relationships with partners. Despite the different interpretations of this concept, it generally refers to stakeholders' (customers, etc.) perception of the company in a particular context at a specific point in time. For example, machine learning was applied to predict the performance of directors of large US companies publicly traded in 2000-2011 by analyzing a large data array (Erel et al., 2019). Such algorithms can determine which directors may not be popular with shareholders.

AI can be applied to cut costs and manage risks to increase profit margins.² A number of studies noted that AI can help improve management and reduce costs through automation based on real-time big data analysis. Robotization can improve the quality of data provided to shareholders for making informed decisions (Ivaninskiy, Ivashkovskaya, 2020; Shu-Hsien, 2005).

More important benefits of blockchain include cutting transaction times, minimizing fraud risks, and streamlining complex procedures which hinder traditional trading (Fahlevi et al., 2022). Blockchain is usually associated with the popular cryptocurrency Bitcoin, since the latter is based on the former (Yermack, 2015; Crosby et al., 2016). However, this technology is applied not only in finance and securities, but also to improve food security, environmental management, and urban planning (Anascavage, Davis, 2018). It has the potential to become the basis of crowdfunding platforms in the future (Harahap et al., 2019). Currently, most such sites' security systems cannot yet adequately protect the funds of project participants. The Ethereum blockchain platform, designed to store a wide range of different data types, is positioned as a possible solution to this problem.³

² <https://cse.engin.umich.edu/stories/computer-scientists-employ-ai-to-help-address-covid-19-challenges>, accessed on 15.10.2023.

³ <https://medium.com/@feryycash/mybillcash-is-a-decentralised-microtask-platform-on-the-blockchain-2b39d69a567f>, accessed on 15.10.2023.

Figure 9. Number of Publications by Country (OpenAlex data)

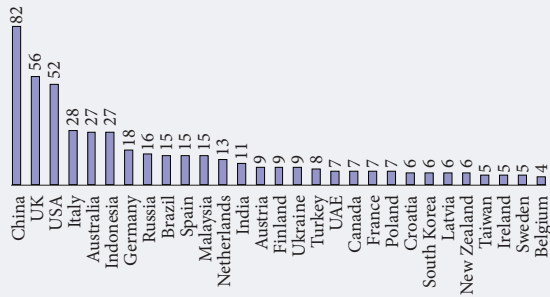
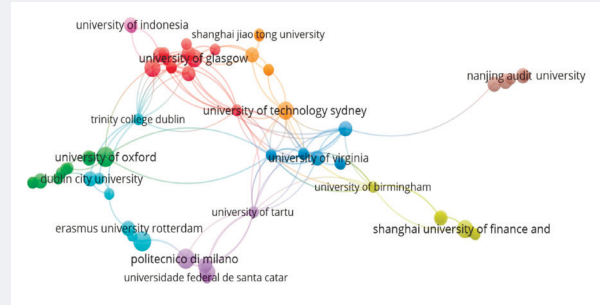


Figure 10. Visualisation of Organisations' Co-authorship (OpenAlex data)



Conclusion

This study highlights the importance of stepping up innovation and international cooperation to more fully realize the potential of Industry 4.0 technologies in corporate governance. Our results indicate that the use of these technologies has significantly increased in various areas. However, an analysis of co-authorship networks revealed that the collaboration between different groups of researchers specializing in the area under consideration remains insufficient. More comprehensive research is needed to expand the knowledge network. Comparing the situation across countries and research organizations allowed for identifying leaders in the building of the knowledge base and competencies in the application of big data, AI, machine learning, and blockchain. Coordinated implementation of these technologies in the course of digitalization helps

to optimize risks and improve the quality of corporate governance. It also increases one's ability to analyze data and make more accurate predictions and better-informed decisions. Recommendations for various user groups are summarized in Table 2.

To conclude, we would like to note that the use of advanced technologies is largely determined by organizations' size and the context of their activities. The existing studies in this area are based primarily on secondary data, which may be incomplete. As a result, it is difficult to identify and correctly compare trends, while differences in company sizes and industry specifics are not sufficiently taken into account. It is recommended that primary data is more actively used in future research (such as case studies, surveys, and experiments of specific enterprises) in order to obtain more complete and contextualized information.

Table 2. Recommendations For Applying Industry 4.0 Technologies To Improve Corporate Governance

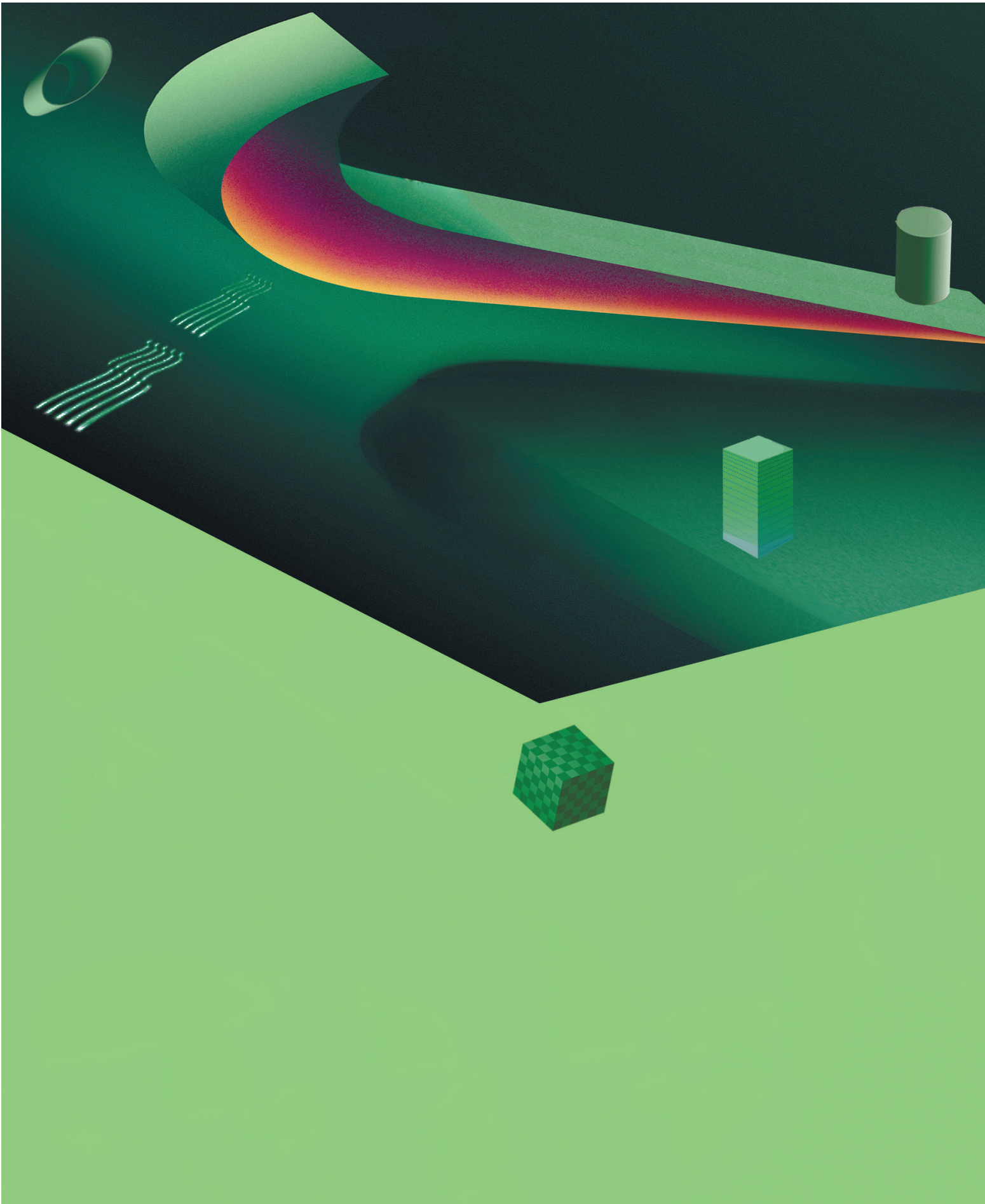
User group	Recommendations
Businesses	<ul style="list-style-type: none"> Use machine learning to automate routine and repetitive tasks (such as inventory management or customer service, identifying customer behavior patterns, forecasting sales, etc.); Use AI to better serve customers and workers (AI-powered chatbots and virtual assistants), analyze risks, manage finances, improve performance in manufacturing, logistics, and human resources.
Future researchers	<ul style="list-style-type: none"> Focus on in-depth analysis of applying blockchain in supply chain management, the use of big data to support strategic decision making, and the importance of machine learning for managing risks; Summarize the findings presented in the literature, identify trends, patterns, and context-specific features in the use of these technologies. The information can be presented in graphic visual formats.
Public authorities	<ul style="list-style-type: none"> Increase the funding for research and development of the technologies under consideration, to encourage businesses to actively adopt them; Establish an institution responsible for assessing the impact of Industry 4.0 technologies on businesses and the economy as a whole in terms of data privacy and security, and maintain a balance with the interests of society.
General public	<ul style="list-style-type: none"> The general public can obtain a better understanding of Industry 4.0 technologies by taking part in face-to-face and online training courses, seminars, etc.; The general public should be aware of the potential risks of using digital systems and procedures; The general public should develop cybersecurity skills.

Source: authors.

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History and Modern Landscape of Futures Studies

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Abstract

The challenges that futures studies face are particularly complex, interconnected, and contradictory, and cannot be resolved using linear approaches. Prognostic science needs tools matching the new contextual complexity, which would allow one to capture a much wider range of driving forces, and their potential effects, in a non-linear perspective to improve the accuracy of forecasts and quality of strategies. Through a retrospective analysis of prognostic science and Foresight studies, this paper presents the prerequisites for enriching the relevant

methodology with the concepts of complexity science. Relevant Foresight competences are identified. Case studies are presented, which can serve as practical guidelines to master the creative potential of complexity during particularly unstable periods. Special attention is paid to the emerging megatrend of the rising deglobalization, which can radically impact the implementation of previously developed strategies. The key conclusion from the presented analysis is that skilful handling of complexity opens up major opportunities for creative growth.

Keywords: corporate strategies; futures studies; Foresight; history of science; sustainable development; megatrends; science of complex systems; complexity; scenario planning; weak signals; uncertainty; competencies

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Introduction

Futures studies require advanced competences, including the ability to go beyond the “limits of the known”, take into account non-obvious driving forces, assess their combined effects, switch between different horizons. The growing complexity of modern socioeconomic and technological systems has become the new normal. The flow of “wicked” problems is growing exponentially: interconnected and inconsistent ones, which cannot be clearly defined and give rise to new challenges when one tries to apply fragmented solutions.¹ During periods of transformation, dealing with such multiple complexities creates the need to master new relevant approaches and tools borrowed from other fields, first of all, systems science. Turning to such assets allows one to capture a much wider range of factors, cause-and-effect relationships, and their potential impacts in a non-linear perspective. This, in turn, improves the ideas about the future and the accuracy of forecasts, and significantly reduces the “room for error” in decision-making. The problem is that adopting new concepts requires learning to see a broader picture of the world. One effective way to unlock the potential of and meet the growing demand for approaches enriched with advanced knowledge is to review the evolution of prognostic science, its current landscape, and examples of the practical application of tools borrowed from complexity science.

Accordingly, the objective of this study is to retrospectively review the development of futures research and analyze its “contact points” with complex systems science. The blended tools based on such relationships allow one to see complexity as a major source of transformational development potential, design next-generation strategies, and prepare more accurate forecasts.

The paper begins with an analysis of the prognostic science’s evolution. The combination of retrospective and prospective views provides a better understanding of the sequential unfolding of complexity in civilizational development, and of its impact on prognostic science and Foresight studies. Next, a classification of Foresight generations is presented; the authors’ contribution is in enriching it with theses from other sources, and with original observations. Also, we expand this classification by introducing a new Foresight generation and describe the relevant competences.

Finally, an attempt is made to assess the potential of complexity science techniques by presenting two case studies. One reflects the process of gradually “nurturing” an optimal strategy in a complex,

turbulent, and uncertain environment. The other highlights a new major trend with transformational potential, which necessitates a revision of strategies developed in a relatively recent context characterized by greater stability and predictability.

The Evolution of Futures Science

Attempts to “look into the future” began during the early stages of civilizational development. Philosophy made a significant contribution to futures science, since it focuses on the fluidity and irreversibility of time, the choice of paths, the connections between the past, present, and visions of the future, and so on. Attempts to try to influence the future were first recorded in the 13th century BC in China (Gidley, 2017). A major leap in this area was made in Ancient Greece (in the 7th-5th centuries BC), when the general shape of the (still relevant) Delphi method emerged. The first fundamental philosophical treatises on the topic under consideration appeared during the periods of the Renaissance and Enlightenment. In 1627, Francis Bacon, who laid the foundation for scientific empiricism, described a model which became prototype of the organizational structure of the present-day academies of sciences. Forty years after its publication, it became the basis for the creation of the British Academy of Sciences. As Denis Diderot noted, Bacon “wrote the history of what was to be learned” (Diderot, 1770). The co-founder of the British Academy, Samuel Hartlib, proposed an expanded scientific academy model, according to which scientists and the general public were involved in improving quality of life through the application of technology (the prototype of the modern Foresight community). In 1868 John Stuart Mill used the term “dystopia” for the first time in the British Parliament. A new literary genre with the same name subsequently developed, which has affected the thinking about the future and the creation of its visions. During the same time Auguste Comte and Herbert Spencer introduced into the scientific discourse the topic of social megatrends (McKinnon, 2010).

Futures studies became a scientific discipline in the 1970s, when Fred Polack coined the terms “prognostic science” and “image of the future” (Polack, 1972). Working with a single version of the future was envisaged initially: a linear projection of the past into the present and on into the future. But as the development context became more complex and change accelerated, the limitations of this approach became increasingly obvious. Attempts to anticipate future events largely turned out to be counterproductive.²

¹ The term “wicked problems” was originally suggested by Christopher Churchman in the second half of the 1960s (Churchman, 1967).

² E.g. an in-depth analysis of more than 80 strategic failures conducted by US researchers in the mid-2000s showed that in 82% of cases, the failure was caused by the incorrect initial assumptions about the future. In other words, plans were made for scenarios which have never become reality (Finkelstein et al., 2009).

In parallel, systems science and its branches such as “complexity science” and “systems dynamics”, which have been developing since the second half of the 20th century, have radically changed the understanding of, and approaches to, futures research. Previously, the future was perceived to be closed, pre-determined, and controlled. The new understanding reflected its true nature: openness, variability, the possibility of “adjusting” it in a desired way, and the dependence of the emerging picture upon the interplay of various competing driving forces (Miller, 2018; Patomyaki, 2006; Wilkinson, 2018). A holistic view highlights the long-term consequences of decisions, the complex web of cause-and-effect relationships, phased transitions, and other previously unrecognized phenomena, which radically affect the course of development (Miller, 2007; Heinonen, 2013).

In the early 1990s the term “Foresight” was introduced into the professional discourse to describe these shifts in prognostic science in an attempt to define its new dynamics. The most famous definition of this term was suggested by Ben Martin: “Foresight involves systemic attempts to assess the long-term prospects for science, technology, economy, and society, in order to identify strategic research areas and new technologies that can bring the greatest socio-economic benefits” (Martin, 1995). But even before the emergence of this concept, related ones, borrowed from other disciplines were incorporated into the domain of “working with the future”. In the mid-1980s Robert Rosen proposed the notion of anticipatory systems to describe a kind of “radar” for looking “beyond the horizon” (they have been implicitly used throughout the history of civilization) (Rosen, 1985). It served as a basis for the emergence of derivative concepts such as anticipatory learning (Stevenson, 2002) and anticipatory governance. Though the latter term was coined only in 2009, the relevant practices have actually been applied in the scope of the Millennium project since the early 2000s (Guston, 2014). The number of publications on these topics is steadily growing.

As a result, prognostic science has accumulated a sufficient background to reach a new level and adopt anticipation principles. However, the term *anticipation science* itself was proposed only in the mid-2010s, in an attempt to organize and structure the aforementioned concepts (Poli, 2017).

In turn, futures research, including forecasting, anticipation, and Foresight, can be attributed to a broader field: the decision-making science (or, alternatively, the behavioral science). Representatives of this discipline initially proceeded from the assumption that decision-making is primarily based on reason and aims to obtain maximum possible benefits. However, their arguments were refuted by Herbert Simon, Daniel Kahneman, and Amos Tversky, who have proved that economic behavior

frequently turns out to be rational only to a limited extent (Simon, 1957; Tversky, Kahneman, 1974; Kahneman et al., 1982). People may opt for a particular course, even if the consequences seem to be risky and unproductive, to pursue short-term (as opposed to long-term) interests due to numerous cognitive distortions (Kahneman, Tversky, 2000; Kahneman, 2011).

Thus, the area under consideration gradually incorporates new knowledge from other disciplines (cognitive sciences, complexity science, psychology, philosophy, sociology, anthropology, behavioral and affective sciences, network science). The extended toolset allows one to more accurately trace chains of upcoming events, at different time horizons. For example, cognitive science is currently exploring the underlying neural mechanisms affecting cognitive heuristics and biases, which improves future scenario building (Schirrmeister et al., 2020). Approaches are proposed which allow one to overcome limited rationality, embrace a wide variety of complex, non-obvious cause-and-effect relationships, and so on (McKiernan, 2017; Rhemann, 2019).

Transformations of Foresight Methods

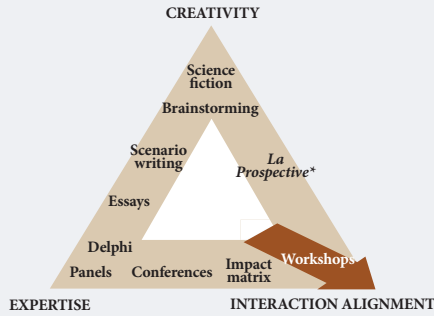
As the context changed, so did the nature and content of Foresight studies: the approaches became more diverse and multidimensional, and their classification became more complex. Figure 1 shows the evolution of classification models developed at different times by experts from the Manchester Institute of Innovation Research (UK): Luke Georghiou, Rafael Popper, Ozcan Saritas, and Dennis Loveridge as well as Alexander Sokolov and others from the Higher School of Economics Institute of Statistical Studies and Economics of Knowledge (Georghiou et al., 2008; Saritas et al., 2022; Saritas, Smith, 2011; Butter et al., 2008; Sokolov, 2007). These models provide guidelines for combining methods to match the goals and objectives of Foresight initiatives.

At different times, it was possible to more clearly anticipate forthcoming events due to the emergence of new layers of hard-to-access, difficult-to-perceive information and tacit knowledge, which contributed to the transformation of Foresight and its conceptual foundations.

This transformation stemmed from the previous practices of Foresight itself, other research areas, more general social changes, and the changing understanding of the links between science, technology, innovation, and economic development. As a result, the Foresight methodological basis was expanded and updated. A chain of generations was identified in the development of Foresight studies, reflecting their increasingly diverse objectives: from regularly reviewing the goals and practices of current activities to developing long-term strategies (Yuan et al., 2010).

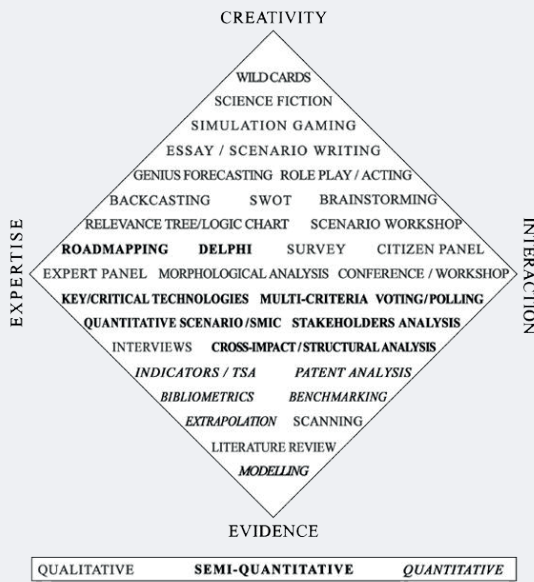
Figure 1. Evolution of Classification Models of Foresight Methods

a) Foresight Triangle (2001)

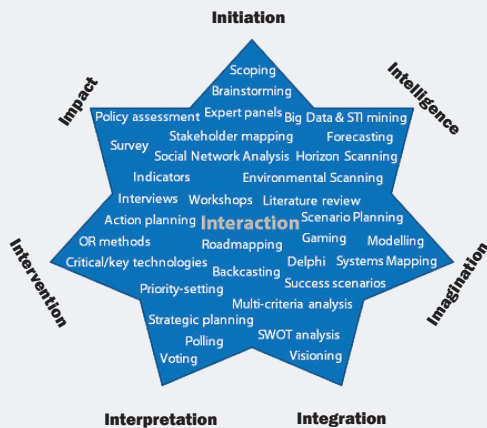


*La Prospective (the term originated from French «prospections» – studies of new areas, and «perspective») is a system of futures studie methods proposed by a French philosopher Gaston Berger (1896-1960).

b) Foresight Diamond (2008)



c) ForStar (2016)



Note: Different versions of the presented models exist.

Note: adapted by the authors from (Loveridge, 2001; Sokolov, 2007; Popper, 2008; Miles et al., 2016).

Researchers from the Danish Technical University led by Allan Dahl Andersen proposed a classification comprising five generations of Foresight studies. We adopted it as a basis for describing Foresight’s evolution in line with the objectives of this paper. We advance our Danish colleagues’ work by describing each generation in more detail, and adding a new, sixth generation whose contours began to emerge in the mid-2010s, after the publication of the original study (Andersen, 2012).

First Generation (1950-60). The prerequisites for its emergence appeared after World War II, when some of the basic methods were proposed such as Delphi and scenarios. In Europe and North America experts in natural sciences and engineering disciplines implemented technological forecasting projects. The dominant attitude was that the future and innovation can be accurately predicted. Assessing the likelihood of future events became popular: it was considered uncomplicated due to the increasing availability of ever larger amounts of data and the development of advanced predictive models. This process did not require one to rethink the established ideas about development trends and prospects. As the amount of available data increased, the image of the expected future became sharper, while specific details in the form of “unlikely” events were considered minor and ignored. The reductionist approach did not allow for predicting the chains of major crises (the oil crisis of the 1970s, the financial crisis of 2008, etc.), which came as surprise factors (Wilkinson, 2018). The risks of relying exclusively on quantitative methods became increasingly apparent. In an effort to compensate for the latter’s drawbacks, experts in the US and France in parallel began to develop new approaches to reducing uncertainty (Masini, 1993; Bell, 1997).

Second Generation (1970s). The World Future Studies Federation (WFSF) was established. The accelerated social and technological change created an interest in megatrends and in possible “future shocks” (Naisbitt, 1982; Toffler, 1970). The future began to be perceived as less predictable, and open to design. As a result, the circle of Foresight project participants became wider at the expense of the business community. A search for the right balance between innovation potential and a broader context has begun (taking into account environmental, social, and ethical issues, corporate responsibility, and technology supply and demand). The general contours of technology policy emerged. Analyzing market failures came to the fore. Attempts to calculate specific risks gave way to studying uncertainty (as an immeasurable concept, which still must be taken into account) and businesses’ ability to make use of the emerging opportunities. Since the 1980s the number of Foresight projects increased gradually, but in the 1990s it exploded (Andersen, 2012).

Third Generation (1980s-1990s). The analysis of market failures – gaps market mechanisms do not fill – has been replaced by studying the qualitative development of innovation systems in general. The creation of innovations began to be seen as a chain of integrated, interactive, and parallel processes, complex and non-linear. The circle of stakeholders expanded, who now saw Foresight not as a product (a one-time initiative culminating in the preparation of a report), but as an ongoing process (Cariola, Rolfo, 2004). Technology policy has been supplemented with an innovative one. A market of international “producers” of global future scenarios has emerged. Various players (multinational companies, national governments, intergovernmental organizations, international agencies, regional authorities, universities, professional networks, R&D organizations, transition research laboratories) started to establish partnerships, while at the same competing for leadership in setting the global science policy agenda.³ The international expert community became interdisciplinary in nature, and requirements for Foresight competences became more stringent. The larger the problem, the wider the range of factors that must be addressed, and the more complex the knots of cause-and-effect relationships that need to be untangled. As a consequence, the increased cognitive load reduced the ability to perceive and take into account multiple and diverse driving forces (Ram, Montibeller, 2013), creating the need for an in-depth study of the cerebral mechanisms (Schirmeister et al., 2020). Demand emerged for research in topics such as heuristics and overcoming bias in building future scenarios (Schoemaker, 1993; Ahvenharju et al., 2018, 2021; Rowland, Spaniol, 2021). Experts in cognitive sciences began to be involved in Foresight projects.

Fourth and Fifth Generations (2000s-2010s). The semantic diversity of Foresight studies increased; the approach began to be perceived as a distributed process. In addition to science and technology, industrial, regional, educational, infrastructure, corporate, and competency-based issues were explored. Foresight initiatives were implemented. Approaches to dealing with uncertainty were reconsidered yet again: integrated models and narratives replaced probabilistic forecasting (Alcamo, 2008). However, the more advanced big data processing and complex

modeling capabilities still did not help one to obtain a more holistic picture of forthcoming events.

Gradually an understanding arose that relying on quantitative methods increases the risk of slipping into backward-looking policies and makes one less prepared for the future (Mangalagiu et al., 2011). Despite its certain usefulness, retrospective analysis unsupported by other tools cannot be seen as a reliable source of information for decision-making. The most important knowledge about the future lies in its differences from the past. However, the more difficult-to-manage the system under study is, the harder it is to assess its future prospects without considering the past. This observation helps to explain why numerous trend-based forecasts failed, among other things, to predict the 2008 global financial crisis (Wilkinson, 2018). The Foresight methodology continued to evolve from the supply to the demand side, making the process more complex. The scenario planning method was widely adopted. While scenarios also rely on quantitative data, their purpose is not to extrapolate the past into the future, but to challenge ideas about dominant trends. Scenarios depict multiple alternatives, highlight the relationships between different, often difficult to compare problems, while solutions are chosen on the basis of a comprehensive analysis (Wilkinson, 2018).

Sixth Generation (2015 – present). A series of unpredictable global crises (financial, economic, pandemic, etc.) increases the need for new tools and approaches to working with the future. The UN has set the Sustainable Development Goals agenda (SDGs).⁴ New platforms to facilitate flexible network collaboration have emerged. Events previously considered isolated began to be seen holistically and interconnectedly. Scenario planning received new meaning: as a strategy testing technique, allowing one to see the consequences without the need to immediately make decisions. The “safe space” concept has been proposed to describe this approach, along with reframing which involved adjusting perceptions, increasing the emphasis on dealing with complexity, and broadening the coverage of diversity (Ramirez, Wilkinson, 2016).⁵ Also, scenario building is now supported by big data and artificial intelligence technologies. Scenario elements (building blocks) are prepared using ChatGPT and then fleshed out and adjusted by experts, which saves time (Kishi-

³ These include the OECD, IMF, World Bank, UN, European Commission, G20, World Economic Forum, Big Cities networks, foundations, international non-governmental structures, and regional organizations. New global participant networks, inter-organizational initiatives, cross-sector partnerships, and global change labs are also involved in shaping the global agenda.

⁴ The Sustainable Development Goals are a set of 17 interrelated programme goals that imply finding comprehensive responses to global challenges, such as protecting the environment, improving the quality of life, achieving balanced economic development and resource consumption, combating climate change, etc. (<https://sdgs.un.org/goals>, accessed on 17.11.2023).

⁵ An alternative three-generation Foresight classification proposed by the Hague Center for Strategic Studies (HCSS) is also worth mentioning (De Spiegeleire et al., 2016). In the scope of Foresight 1.0 (1950s-70s), experts built limited sets of future scenarios. The improved version, Foresight 2.0 (1980s-2010s) became interactive in nature, with interdisciplinary teams occasionally involved in the process. Foresight 3.0 (the term was proposed in 2016) is based on blending quantitative and qualitative tools.

ta et al., 2023). As a consequence, the coverage of complexity and the range of perspectives to consider future options increased with each new generation (Rowe and Wright, 2011; Schatzmann et al., 2013).

Competences Required for Sixth-Generation Foresight Studies

The new type of competences is focused on working with socioeconomic systems, based on understanding their complex nature, adaptability, interdependence, and unpredictable behavior. This topic has been actively discussed in recent years. From a comprehensive review of such skills and abilities presented in (Ahvenharju et al., 2018), the following should be noted:

- critical revision of established mental models and world views;
- switching between different levels of analysis: micro (cognitive system), meso (company, sector, etc.), and macro (global);
- extending the cognitive coverage of diverse driving forces;
- abandoning “simple solutions” and simplified polar thinking in “yes/no” or “optimism/pessimism” terms, etc.
- correctly interpreting events and processes, identifying turning points in a sufficiently early manner;
- taking into account the complex interweaving of deep cause-and-effect relationships and self-organizing processes;
- building transformational potential required for sustainable development;
- mastering the decomposition method, which allows one to study complex systems at a basic level without disrupting the relationships between their elements;
- managing the “limits to growth”; etc.

The success in acquiring the above competences depends on a number of mental and personal traits, which can be adjusted. These include individual perceptions of the current situation and the dynamics of change (Lombardo, 2016). In stable times, the future is perceived as a continuation of the past, which creates the illusion of “boundless stability”; mental models lose reflexivity, flexibility, and the ability to respond to emerging events (De Jouvenel, 1967). During periods of radical change, views of the future change also. The future is perceived to unfold non-linearly and becomes unconnected to the past (Bell, 1997). Another relevant skill is being able to create a perspective, set time horizons, and comprehensively assess the available and potential resources needed for development (Baumeister, Vohs, 2016).

The Creative Potential of Complexity

The complex systems science takes futures research to a qualitatively new level, offering a comprehensive “lens” to holistically perceive reality and solve

complex problems (Wilkinson, Kupers, 2013). It also helps one understand the sustainable development dynamics and identify emerging opportunities in a tangled, chaotic, and turbulent environment.

Dynamic organizations use complexity and turbulence as resources and as a basis for building adequate strategies. Any organization is a part of a socioeconomic system with adaptive potential, capable of maintaining dynamic equilibrium by constantly balancing between relatively unstable states. Maintaining such fluid balance in the course of development is considered to be a close-to-optimal state. Innovative transformations, new conflicts and interactions, the growing circle of actors, and other factors knock the system out of a relatively stable position and provoke a constant search for a new, balanced path. As a consequence, the system suddenly and abruptly changes its state; multiple bifurcation points appear, along with new driving forces which follow unexpected trajectories. Trying to define sustainable development, people often talk about resilience, i.e., following a flexible, supple strategic course, when possible deviations from the main direction do not undermine the progress, but open up internal opportunities to regenerate and carry on. Sustainable development can be seen as self-sustaining.

Reality is always complexly multivariant with a colossal potential for the emergence of new states, even if it is not perceived as such. Considering that all processes are in constant motion and restructuring, in the logic of complex systems, creating new and reformatting old paths does not seem to be something destructive. For example, it is hard to predict the behavior of global supply chains. Adding resources to any segment of the chain will not necessarily increase the supply at the point in space and time where it is most needed. Sustainability is created by continuous, flexible adjustment of the collaboration network by constantly coordinating and reviewing partners’ cooperation. Like any complex system, international networks are nonlinear in the sense that the effect rarely turns out to be proportional to the cause (Sterman, 2012). In some cases, even significant external impact does not affect the system state, while seemingly minor processes lead to radical changes in individual subsystems or in the system as a whole. Because of the complex interactions between participants in a socioeconomic system, individual actors’ actions, even positively motivated, often lead to unintended counter-productive results (Merton, 1936). Vision horizons, breaking points, and the scale of change must be taken into account. What is barely (if at all) noticeable over short periods of time can become critical in the long term (Sterman, 2012). Projecting the complexity science principles into management practices becomes a source of valuable ideas for developing transformational strategies.

Case Studies

Let us move on to the practical aspects of applying systems science principles in order to identify long-term trends and patterns for subsequent strategy development.

Danone

The case of the French company Danone inspires one to reconsider the classic approach to strategy building based on the belief that planning and implementation times can be precisely controlled and that a road map can serve as a guiding document. From complexity science's point of view, this logic does not take into account important factors such as the complex interweaving of cause-and-effect relationships, random coincidences, path dependence, and self-organizing processes, which significantly affect the organization's development. Meanwhile taken together, these factors can be used as a resource to achieve self-sustaining sustainable growth. This requires constant flexible improvisation, adaptation, and regular strategy adjustment. It is dynamics that make possible the strategy's gradually moving toward "perfection", despite the periodic impact of random events and path dependence (which gradually minimize). It took time to realize that a successful strategy emerges through a combination of planned steps and adequate responses to the changing external situation. In the 1980s-1990s the prevailing view was that the optimal strategy depends solely on the existing context and careful planning (Lawless, Finch, 1989; Marlin et al., 1994; Hrebiniak, Joyce, 1985). Only since the 2000s have arguments pointing out the fact that the strategic vector equally depends on the ability to take into account self-organization and correctly interpret combinations of circumstances been broadly accepted (De Rond, Thietart, 2007; MacKay, Chia, 2023). Through flexible adjustments, strategic steps over time can be integrated into the ordered configuration of a self-organizing process.

The Danone case presents a rare opportunity to trace a long chain of steps (taken over more than 40 years, in 1966-2008, and comprising over 500 strategic events⁶) using advanced quantitative methods (Thietart, 2016). Five phases can be identified in the process of the company strategy "maturing", with structural breaks between them (phase transitions). Some of these phases appear to be stable, others turbulent, and still others combine different types of system dynamics (from path dependence to emergent self-organization).

Phase 1, a calm one (1966-1969), is characterized by consistent decisions: mergers with dynamic play-

ers, adaptive internal reorganization, investing in the target industry (the glass business). In phase 2, which was highly turbulent (1970-1987), the consistency was lost: the strategy was adjusted, promising companies operating in a different sector (the food industry) were "spontaneously" bought, while the glass business (until recently considered to be the company's core one) was sold. This period is also called "random drifting". During the moderately turbulent third phase (1987-1997) strategic consistency returns: the company adapts to the new industry, partnerships are established, and investments made to accomplish the fundamental goal of becoming an industry leader. In the calmer fourth phase (1997-2004), the financial strategy was adjusted. The focus has definitely shifted to the new area: food production. The investment portfolio was structured and diversified. In the stable fifth phase (2004-2008), the sequence of strategic events becomes longer: the updating of financial strategies was followed by the restructuring of the investment portfolio, new mergers and acquisitions, and new partnership alliances. Danone has reached the elusive point of achieving self-sustaining growth.

Thus, it turns out that the more stable the development phase is, the more consistent strategic steps become. In the first phase two cycles of strategic events were identified, in the third three were identified, in the fourth four, and in the fifth eight. Only in the second, highly turbulent phase no clear connection was established between the steps taken, when the strategy was changed most radically.

The sequence of actions taken by the management serve as strategy "building blocks". The more there are of them, the faster self-organizing processes emerge. Flexibly balancing management control and self-organization, Danone has gradually moved into a zone of new stability, manifested in the growing number of strategic cycles in each subsequent development phase (from zero in phase 2 to eight in phase 5).

The first and last phases were the most ordered ones. The first phase was dominated by path dependence: the company growth was determined by the past. The second one was the most turbulent, but in the third and fourth phases, the turbulence decreased to average. There were periods of active search, research, and complex experimenting in new business areas between the first and fifth phases. However, Danone's behavior was never chaotic, though from the outside it might appear that the company grew "randomly", following no strategy at all.

During the second phase Danone made an unsuccessful attempt to take over a major competitor, but

⁶ These strategic events include the first major business deal, joining an alliance, launching a new market product, etc. Based on the collected data, Thietart (2016) defined six categories of events related to strategic action and the external shocks category.

it did not affect the chosen strategic vector, despite creating certain chaotic dynamics and losing control over the growth processes. Typically, numerous unforeseen events tend to occur at this stage, but in Danone's case there were a few of them. In times of turbulence, the company management was unable to control the timing of achieving the "preferred future", so "manual control" had to be eased in favor of "serendipity". Danone combined complex restructuring of its core glass manufacturing business with diversifying into other industries. During phases 1, and especially 3 and 4, searching for new opportunities was followed by rapid growth: major initiatives alternated with smaller ones. The process was always driven by a clear goal: in phase 1 it was achieving a leading position in the glass industry, and in phases 3 and 4 - in the food sector. When a chain of subtle strategic moves reached a certain threshold, self-organization arose, followed by a phase transition to higher, more complex development levels. During the periods of implementing "minor" actions the company acquired new capabilities and knowledge and adapted to the new developments, carefully managing its strategy.

After 35 years of transformation, adaptation, and coping with uncertainty, maximum stability was achieved during the latest phase. Danone focused on its core business. The strategy has reached "full perfection" and was generally brought under control. Moreover, Danone was never fully "path dependent" – a feat achieved by very few companies. Excessive commitment to a particular course does not leave room for flexible adjustment and adaptation, so a risk of being "stuck in a rut" arises (Burgelman, 2002). Constantly balancing in a state of dynamic equilibrium allowed the company to discover new growth sources and development paths. Plus, Danone has also mastered another elusive skill: gradually reducing the effect of random factors (from phase 2 to phase 5).

The phenomenon of self-organizing processes is difficult to understand because, at first glance, it appears to conflict with the management goals and functions. Tight managerial control undermines self-organization, which has enormous potential to create radically new opportunities.

Thus, human effort only creates preconditions for self-organizing growth, but the latter's actual emergence depends on other factors. In the case of Danone, self-organizing processes arose in the second phase and then consistently strengthened until the last, fifth one.

Reaching dynamic stability (sustainable development) can take many years, going through alternating periods of turbulence and order. Such a non-linear path requires experimentation, improvisation, and strategy adjustment. Systems science knowledge allows for guiding strategy through difficult

"rapids" into a zone where turbulence gradually reduces, along with the effects of the past and of random events. At a certain point the company reaches a state of fluid equilibrium, with self-organizing processes and strategic action coming into agreement. Danone dynamically grew in calm and turbulent periods alike due to three factors: setting major strategic goals, being ambidextrous (balancing between searching for new opportunities and using existing ones), and proactive (regularly monitoring and correctly identifying emerging opportunities). In a turbulent situation, the strategy and the timing of making and implementing strategic decisions are determined by self-organizing processes, while cautious, soft managerial interventions facilitate the strategy's "maturing to perfection". The sequences of micro-steps which served as fertile ground for the maturing of Danone's macro-decisions helped to softly and carefully supervise strategy implementation, without undue acceleration. Such tactics allowed for successfully moving on from searching for opportunities to experimenting and mastering their potential.

Deglobalization

The second case concerns the process of deglobalization and long-term corporate strategies developed during the relatively recent period of predictability. Deglobalization has significant transformational potential: for establishing cross-border technological alliances, international division of labor, etc. Discussions about the possible advent of deglobalization began as early as during the 2008-2009 financial crisis and became more active after 2018. Until that time globalization was perceived to be irreversible, which was manifested in the growing number of studies on global megatrends, global risks, and global scenarios. The view of the world as a single integrated, closely connected structure dominated all Foresight studies and forecasts. However, since 2012 a slowdown in the globalization has become apparent. Due to the growing confrontation of countries not sharing the same political and economic principles, the ties between the elements of the global system have begun to weaken. Since 2019 this process has sharply increased, with businesses facing greater turbulence and uncertainty (Petricevic, Teece, 2019; Teece, 2022).

This trend is currently being addressed by various think tanks specializing in systemic futures research. We will mention two such studies: by the US Institute for Research on World-Systems (IROWS) (Chase-Dunn et al., 2022) and the Hague Centre for Strategic Studies (HCSS, the Netherlands) (Teer et al., 2023).

In 2022, HCSS experts prepared two scenarios for European countries until 2032 based on Foresight studies' results, reflecting the possible consequences

of deglobalization: “Chinese embargo on the supply of critical raw materials to EU countries” and “Naval blockade of Taiwan by China”. The probability of their implementation was estimated at over 50%, due to the growing macrotrend of renewed competition between major powers possessing significant economic, technological, and military might. Protectionist measures in favor of local producers, trade barriers, and intellectual property protection are being stepped up. The most worrying factor is reduced global flows of raw materials, goods, and technologies for vital industries. The exchange of these resources, which form the basis of the international trading system, faces serious risks. Recent geopolitical upheavals have significantly accelerated this process. Countries – major energy consumers – have become dependent on the emerging centers of power in the Asia-Pacific region. High turbulence is noted there, which could disrupt the supply of strategic raw materials from China and of semiconductors from Taiwan – resources crucial for the energy transition, digitalization, and the operations of basic sectors including medicine, defense and security, sustainable mobility, and ICT. In response to the arising challenges, some countries started to build up an internal supply of resources to become autonomous. The globalized world based on cost optimization principles is being replaced by one where security of supply comes to the fore. According to HCSS experts, the unfolding process may span over the next decade, and beyond. Despite all efforts to become independent from Asian resources, the need for them will remain in place at least until 2032, according to Dutch experts.

Their US colleagues from the Institute for Research on World-Systems (IROWS) were more optimistic. They see globalization as a cyclical process, which over the previous two centuries has repeatedly displayed rises, plateaus, and declines. According to IROWS experts, there are no grounds yet to speak about a definite shift towards deglobalization, since the current processes are diverse in nature, unfold at different speeds, and have multidirectional vectors in different dimensions. More accurate conclusions about the trend under consideration and a better forecast of its further development can be made no earlier than in 2028.

The US experts base their arguments on the results of a longitudinal study of the growth and decline in global trade over the abovementioned period. Globalization is not just a cycle, but an upward trend, because the stages of its partial decline are followed by the waves of stronger recovery. When the globalization level remains more or less stable, a plateau appears. In 2008 the world entered into

Table 1. Globalization and Deglobalisation Cycles: 1830 – Present

Period	Beginning	End	Duration
Plateau 1	?	1848	?
Globalization wave 1	1849	1878	29
Deglobalization wave 1	1879	1901	22
Globalization wave 2	1902	1920	18
Deglobalization wave 2	1921	1944	23
Globalization wave 3	1945	1980	35
Plateau 2	1981	1993	12
Globalization wave 4	1994	2008	14
Plateau 3, or Deglobalization wave 3?	2009	?	?

Note: Question marks reflect uncertainty regarding the beginning or end of the relevant period and, accordingly, its duration.

Source: composed by the authors based on (Chase-Dunn et al., 2022).

a new deglobalization phase due to the contradictions in economic systems, trade conflicts, political disagreements, and so on. This phase is the third since the 19th century. The preceding wave of globalization arose in the late 1990s and peaked twice, in 2000 and 2007, thanks to digitalization and the relocation of production to countries with lower labor costs. In the recent past, major declines in economic activity after the acute phases of the financial and pandemic crises have been followed by periods of partial economic recovery and renewed growth. Currently, multipolarity is increasing, while the ties between countries are weakening. Noting the similarities between the most recent and earlier deglobalization periods, the authors suggest that if globalization processes have not reversed, they at least have reached a plateau. Previous deglobalization stages lasted over 20 years each, while only 15 years have passed since the 2008 recession. For this reason, more accurate conclusions about the deglobalization trend can be made only in five years. The globalization/deglobalization cycles according to IROWS are presented in Table 1.

Conclusions

Futures studies face challenges characterized by interconnectedness and inconsistency; these challenges cannot be dealt with using linear approaches, which leads to increased complexity in a variety of fields. Prognostic science requires tools matching the new contextual complexity, allowing one to capture a much wider range of driving forces and their

potential effects in a nonlinear perspective, significantly reducing the “room for error” in decision making.

This paper offers a retrospective overview of the evolution of approaches to futures studies. Prerequisites for enriching these approaches with the advances in complexity science are outlined, which convey a promising thesis: complexity has significant potential for development, which can be revealed through a skillful treatment of the former. The points of contact between prognostic science and complex systems science are shown, along with their effects on strategy development and implementation.

Six generations of Foresight studies are described, with an emphasis on the latest one and on the relevant competences. A number of practical cases were studied to demonstrate the scope for applying complex systems science knowledge to scenario building. The case of Danone illustrates how such tools helped to transform corporate strategy and helped the company reach self-sustaining growth through stages of turbulence and uncertainty. This case can

be seen as a manual for making use of new opportunities and flexibly adapting a company during particularly volatile periods.

The emerging megatrend of growing deglobalization was also addressed, which can radically affect the implementation of strategies developed in previous years. The views of two different scientific schools exploring the prospects of complex transformational processes were described.

The presented review can serve as a starting point for discussions about the latest trends in the field of Foresight methodology, the challenges of adapting it to an increasingly complex context, and building relevant competences for working with multiple futures.

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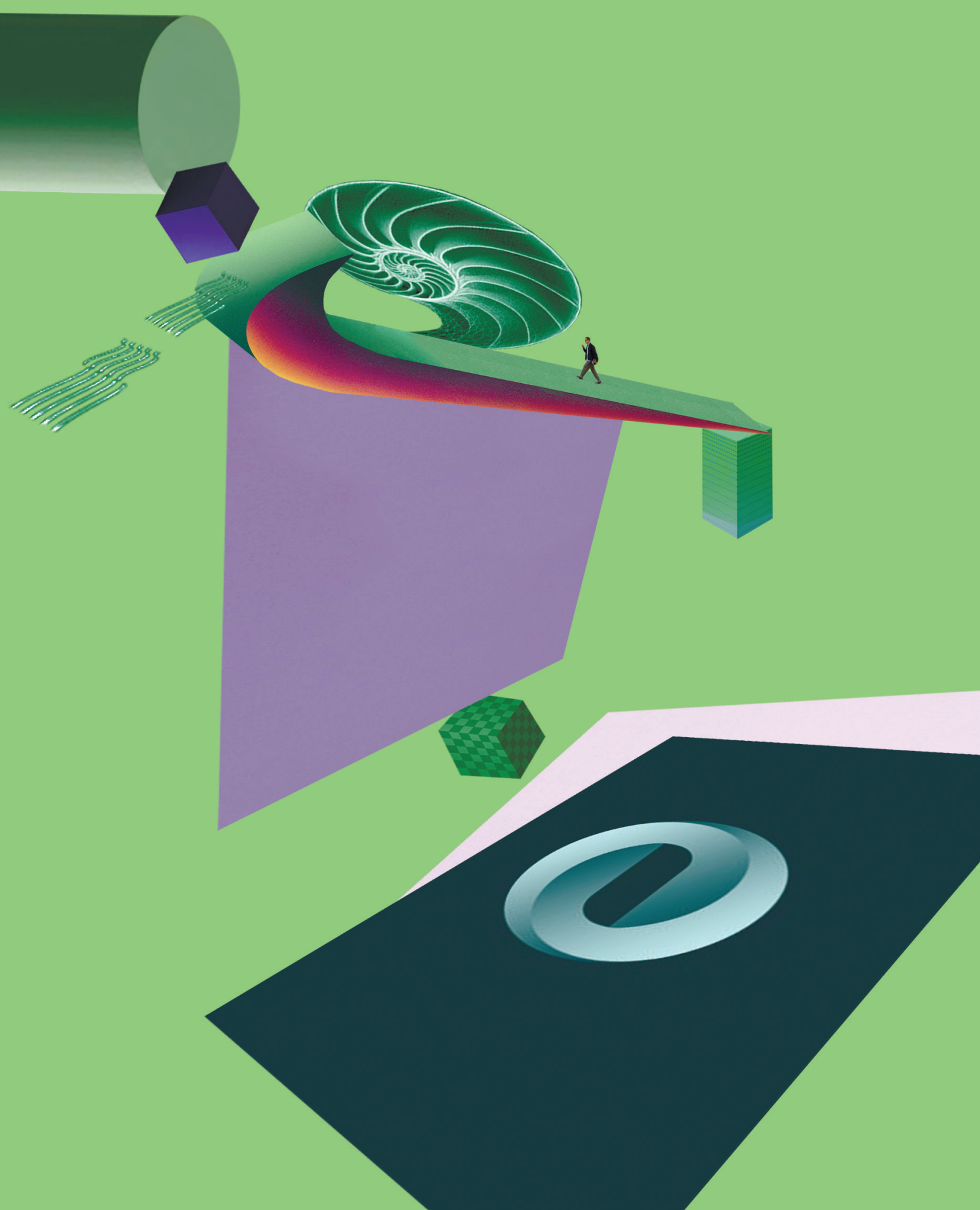
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MASTER CLASS



Genesis and Predictive Ability of Ecosystem Approach in Education

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Abstract

The landscape of education is progressively diversifying, characterized by an influx of various new participants, products, technologies, and institutional configurations. The concept of a comprehensive educational ecosystem is increasingly invoked. Yet, our understanding of the educational ecosystem phenomenon remains fragmented and lacking structure. This limitation poses obstacles to both engaging in a scholarly discourse and fully harnessing the predictive potential inherent in the ecosystem approach. The objective of this article is to delineate the practices involving interaction, knowledge exchange, and the diffusion of innovation among participants and strata within the educational realm. These practices serve as the foundation for the processes underpinning its development and transformation, culminating in the educational sphere acquiring ecosystemic attributes. This paper contributes to the conceptualization of an educational ecosystem founded upon the principles of an open and dynamic social system. It emphasizes the coevolution of stakeholders, a high degree of resource and competency complementarity, and collaborative competition in the creation of novel educational products. We expound upon the

evolutionary origins of the educational ecosystem concept, attributing its development to the emergence of new actors and the expansion of communication capabilities for information dissemination and interactive linkages. We also underscore the continuity of the educational ecosystem concept concerning the triple, quadruple, and five helix models. Consequently, we propose a methodology for applying the ecosystem approach to conduct foresight studies and engage in co-design endeavors aimed at realizing the Sustainable Development Goals within the realm of education. This methodology aligns with the foundational principles articulated in the UN Sustainable Development Goals for Education until 2030 (Strategic Development Goal 4 – SDG4). The ecosystem approach is harnessed in the selection of source materials, the interpretation of prospective indicators, and the description of foresight subjects. In doing so, we affirm the predictive capacity of the ecosystem approach in modeling novel forms of stakeholder interactions, delineating the coevolution of social, economic, technological, and cultural trajectories, and identifying equitable and collectively significant priorities for the advancement of the educational milieu.

Keywords: educational ecosystem; platform; actors in education; Foresight in education

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Introduction

Over the past decades the education system has been expanding, becoming increasingly complex and diverse all over the world. Educational programmes' content, skill sets, and specialisations become more varied (OECD, 2021) along with their delivery formats. Apart from the established, relatively closed and formalised institutions (such as schools, universities, secondary vocational and additional education organisations), there has been significant diversification of institutional formats, and approaches to delivering educational content to the expanding audiences: accelerators, learning resources offered by various thematic communities, business schools, collaboration platforms (Tomasova et al., 2021).

The growth in these trends determines the need to apply the biological and economic ecosystems metaphor in the education sphere, to more thoroughly understand the latter's characteristics and features. Since 2015, the number of publications on the ecosystem characteristics of the education domain has sharply increased. The main research topics are the novel training arrangements and interaction formats between educational institutions and students, in terms of their flexibility, versatility (De Souza Rodrigues et al., 2021), sustainability (Aguilar-Forero, Cifuentes, 2020), and social justice (Niemi, 2021). Many researchers also focus on the issues related to the inclusion of social communities and entrepreneurial structures in education ecosystems (Belitski, Heron, 2017), the development of platforms (Kerres, Heinen, 2015), and the decentralisation of educational institutions (Stensaker, Maassen, 2015; Niedlich et al., 2021). There is a growing debate on the optimal configuration of education ecosystem to responds to the demands and challenges of the changing world, develop new competencies and skills while adhering to the principles of efficiency, inclusivity, and accessibility (Wu, 2021).

A number of researchers specialising in sustainable development of education are stressing the risks of adopting a non-ecosystem approach to transforming education. These include accomplishing only superficial and short-term effects without fundamentally improving the quality of the educational experience, suboptimal use of human resources (teachers and students alike) in the situation of a hyper-intensive transformation, and disruption of traditional processes without the necessary preparation in terms of value, competences, and psychological aspects (Hargreaves, 2007). Along with this, researchers point to the contradictions inherent to narrowly focused approaches to transforming the education sphere: striving for quick solutions, and transferring best practices without taking into account ecological considerations (the instrumentalist approach); evaluating education through the prism

of economic growth, to the detriment of maintaining a fair social contract in the interconnection of social, environmental, and economic problems (Wulff, 2020).

Despite researchers' high interest in ecosystem processes in education, the conditions for, and limits of applying ecosystem optics in this area remain poorly researched. The principles and characteristics of ecosystem participants' interaction, as well as the interface of its components and levels are understood insufficiently. This results in fragmented knowledge about the education ecosystem, and complicates the analysis of how well educational service providers match students' demand and communities' needs. The research and forecasting potential of the ecosystem approach to studying the transformation of the education sphere and its transition to sustainable development cannot be implemented in the absence of the necessary conceptual apparatus.

According to the research agenda presented in UNESCO reports and working papers, only a broad view of education as a mix of the formal, non-formal, and informal sectors and all involved stakeholders will allow to accomplish the sustainable development goals through the development of new social practices, and by achieving synergies between education and other fields (Sousa, 2021). The UN Sustainable Development Goal 4 (SDG4) is based on an ecosystem vision of the educational process, suggesting sustainable formats for interacting with the environment through reflexivity in creating personal knowledge constructs, maintaining common meanings and shared socio-educational values in local communities, increasing people's social responsibility and awareness, and adopting a holistic approach to meeting global challenges (Inayatullah, 2020).

Taking into account the UNESCO strategy, and recognising the value of the ecosystem view and balanced education concept in accomplishing the sustainable development goals, the objective of this study is to reveal the essential characteristics of all the above elements. Comprehending the disparate set of concepts applied in the ecosystem discourse, reducing the fragmentation in studying the parameters, attributes, and signals of innovation in the ecosystem, identifying various paths to understanding this phenomenon, and choosing one of them as the basis for further analysis seems to be fundamentally important.

The goal of the paper is to describe the characteristics and patterns of the ecosystem to propose an adequate approach to analysing and modelling the transformation of the education domain based on a comprehensive literature review, conducted using the criteria described below. To accomplish this goal, the paper is organised as follows:

- the first section describes the genesis of the ecosystem approach, and the use of the education ecosystem concept in the context of education, innovation, and modern society research;
- the second section addresses the characteristics of education as a complex nonlinear social system, the principles of interaction between its actors, and the exchanges, cooperation, management, and leadership in education in line with complex systems' development patterns;
- the third section summarises the scope for, and limits of applying the ecosystem concept in the field of education, and proposes a comprehensive definition of the education ecosystem to clarify the general terms for describing it;
- in the fourth section, a set of principles for using the ecosystem approach to analyse and forecast the transformation in the education sphere, and co-design sustainable development principles for it are proposed.

Research methods and sources

The range of sources to conduct a conceptual review was determined on the basis of the snowball and theoretical saturation principles. Papers based on experimental data were selected (comparative and typological studies in education, case studies), along with materials presenting secondary data processing and conceptual research results. At the first stage of the study, Scopus, Web of Science, ScienceDirect, and ResearchGate databases were searched for sources whose titles or keyword lists contained the terms “education/educational” and “ecosystem”. The use of the above databases provided an international perspective for studying the education ecosystem concept, with a focus on high-quality publications. The search was supplemented with a selection of highly cited papers from the eLibrary database, to cover relevant Russian-language publications.

Next, certain inclusion and exclusion criteria were applied to all publications selected from the above-mentioned databases (papers, monographs, conference proceedings). No country, language, or release date restrictions were used. Abstract publications were excluded, including editorials and author responses, along with papers with no full-text access to them. After reviewing abstracts, publications unrelated to education were omitted (such as papers focused on natural, ecological, and biological ecosystems). Thus the first 23 publications were identified.

Their analysis revealed the main characteristics of the ecosystem development vector in the education domain, and related concepts; this allowed to con-

tinue the selection of sources. Due to the close relationship between the education ecosystem and spiral model concepts, further search was carried out using the newly identified keywords (“triple helix”, “quadruple helix”, “quintuple helix”), which yielded 14 more publications.

Since the genesis of the education ecosystem concept was traced to the concept of a complex and dynamic social system, the search for sources to study the relationship between these concepts was conducted using the keyword combinations “complex system in education / complex educational system”, and “dynamic social systems / adaptive social systems” (yielded 32 sources). Further search using the identified properties and development patterns of complex systems to assess their applicability to educational processes in terms of horizontality (keywords “horizontal ties”, “hyperconnectivity”), distributed management (keywords “distributed leadership”, “distributed responsibility”), and emergence (“emergence”, “emergent system”) yielded 28 more sources.

Another area to search for suitable sources was identified on the basis of the established continuity of the educational and innovation ecosystems; the search query with the keywords “innovative ecosystem” was used. The search continued until the identified preconditions for justifying the use of the ecosystem metaphor in the innovation economy began to repeat. A total of 14 sources were included in the review. The analysis of this set of publications completed the building of the source base for studying the use of the ecosystem approach in education; it comprised 111 sources in total.

Genesis of the ecosystem approach in education

The concept of education ecology, and the ecological approach to analysing educational processes emerged in the 1960s, in the course of developing the adaptive self-organising systems theory, and searching for ways to make them more stable (Ashby, 1956; Gardner, Ashby, 1970). Such systems are non-stationary in nature, and tend to shift towards more optimal behavioural strategies. Their dynamics are described by the law of requisite variety, according to which to effectively solve new problems and meet challenges, the system must be capable of a greater variety of responses than the variety of agitations in the environment (Klir, Ashby, 1991).

The term “education ecology” was coined in 1975 to describe the relationship between educational organisations, key stakeholders, and their social environment (Cremin, 1975). Under this approach, the educational system is seen as a complex integrated

phenomenon with a number of ecological niches. Like all living and growing systems, it maintains a dynamic equilibrium between various unstable states. Innovative transformations, the emergence of new actors, conflicts and interaction in the system disrupt this equilibrium, and push it to searching for a stable path. Sudden abrupt transitions from one state to another create multiple bifurcation points and attractors.

A detailed and structured description of the educational system ecology from within (from the student's point of view) is presented in (Bronfenbrenner, 1976, 1979). The author identifies four nested systems: microsystem - the core directly responsible for the implementation of the educational process, focused on students' interests; mesosystem - a set of environments where students actually live and act; exosystem, comprising formal and informal structures which operate at the level of local communities and set the social context for the educational process; and macrosystem which comprises political, socioeconomic, and cultural institutions (Bronfenbrenner, 1976). Education ecology is focused on both the interaction of students with the four above subsystems, and the latter's interaction with each other. For a deep and accurate understanding of what is happening in the educational system, one must take into account the ecological coherence of all elements making up the learning situation, namely its evolutionary mechanisms, actors and objects, their relationships with the socio-cultural context, and the mutual impact of all its subsystems at each level. We are talking not about changing values of particular educational system variables, but about the system's qualitative integrated transformation, the emergence of new properties and links, and changing appearance. Taken together, these aspects form an ecological model of the educational sector's development, and the ecological approach to studying it, which integrates relevant processes, persons, context, and time (Bronfenbrenner, 1979).

The understanding of interconnected subsystems of the educational process was further improved on the basis of the Enterprise Performance Management (EPM) concept borrowed from economics. Three dimensions of the education ecosystem are identified: macro-dimension, which describes the national and regional cultural context; meso-dimension comprising platforms and organisations, incubators and entrepreneurial skill centres which provide technical support for the ecosystem; and micro-dimension, i.e. individual actors bringing new initiatives into the system, including teachers, entrepreneurs, and mentors implementing grassroots innovations (McAdam, Debackere, 2018).

The search for strong and significant relationships between components of the educational and ex-

ternal environments resulted in the emergence of institutional interaction models. In the mid-1990s the Triple Helix Model was proposed: a concept explaining how universities, government agencies, and businesses work together while retaining their traditional functions (Etzkowitz, Leydesdorff, 1995). One of the key aspects of this process is the "mutual blending" of functions, when each actor takes on some of the functions of others. The role of educational institutions in the innovation ecosystem is not limited to knowledge creation, consulting, and human capital development; it's also associated with market initiatives which involve creating venture companies, commercialising useful inventions, developing innovation infrastructure, and launching investment and technology multipliers. Thus universities become regional entrepreneurship drivers (Schaeffer et al., 2018), which promotes evolution of their organisational and institutional formats and the emergence of new relations including networking, leadership, conflict, and cooperation (Etzkowitz, Leydesdorff, 2000). Thus most new ventures launched by universities arise precisely from the social context, i.e. are created in the course of universities' interaction with local actors. A key role in making the spiral effective, and in establishing sustainable cooperation plays the synchronisation of all three components' goals and development levels (De Castro et al., 2000).

Along with the institutional collaboration, the triple helix model also promotes human capital mobility (Dolfsma, Soete, 2006) by blurring the line between the professional and education spheres. The model suggests that in a mixed reality, education should share the environment, tools, skills, and products with the professional activities domain. For an individual, getting education is blended with their professional development, and with the realisation of their research or entrepreneurial interests. The microsystem, i.e. the immediate environment where the educational process is taking place becomes more diverse, and integrates elements which have previously belonged in the leisure or social interaction spheres. E.g. computer games and simulations, discussion clubs and makerspaces, excursions and travel, volunteer initiatives and crowdsourcing are now seen as elements and forms of education.

The mutual blending of, and the increasingly complex links between various dimensions of the education ecosystem, the exchange of roles between institutions (Cai, Amaral, 2021) occur as education begins to use not only physical, but also virtual environments, offering opportunities to learn a wide range of activities individually or collectively. The educational process becomes continuous in time and distributed in space, providing a high level of flexibility, personalisation, and functionality (Pi-

chugina, 2015). The educational environment is customised, and adapted to the student's specific needs and demand and to local context, thus significantly expanding both the micro- and meso-dimensions of the education ecosystem.

Subsequent studies described how the triple helix model was adapted to the regional context. In particular, researchers noted that the role and importance of the model's specific components may vary from one regional system to another: if in some systems government efforts to commercialise research and development (R&D) is the main driver, in others an endogenous strategy emerges, with a predominance of bottom-up initiatives (Khamidulin, 2018).

Over time, understanding of how education contributes to dealing with current social problems developed, and social variables were introduced into the model, not explicitly mentioned previously (Afonso et al., 2012). An example is the incorporation of "grand challenges" in educational content, and in the targeted development of students' practice-oriented experience (Yun, Liu, 2019). After the initial experience was accumulated (Berger et al., 2013), a growing interest in integrating teaching strategies with practical activities to solve current global problems has emerged. This promotes the development of social links, and immerses learners in the complex dynamics of the real world (Nowell et al., 2020). The phenomena which in the original model (Bronfenbrenner, 1976, 1979) belonged in the macro-system and affected the educational process only indirectly (by influencing students' perceptions and values), "in one click" became an integral part of the actual reality, were integrated into educational content and woven into everyday communication.

The Quadruple Helix model takes into account the role of society as a separate component. The society gets an opportunity to express itself in the education ecosystem; it no longer remains just a consumer of educational products, or a stakeholder whose interests are taken into account when educational policies are shaped, but becomes an actor offering and disseminating new solutions (Carayannis, Campbell, 2006). Society is directly involved in the promotion of the knowledge and innovation culture, and maintaining the infrastructure for creation, transfer, and commercialisation of knowledge and innovations (Colapinto, Porlezza, 2012). Against this background, educational organisations are increasing their role in the implementation of innovations based on social values and needs through network interaction (García-Terán, Skoglund, 2019). Acting as both co-developers and collaborators, communities lay the foundation for user-centred design, facilitate and accelerate dynamic processes, and promote open innovation policies. At the same time collective responsibility for improving the education ecosystem

comes to the fore: social development in a specific territory becomes the responsibility of partner networks, which include educational service providers (Kremneva et al., 2020). The partnership education ecosystem type implies the presence of such important aspects as knowledge transfer in an open environment, and fair allocation of results across the entire ecosystem (Karalash, Baumöl, 2019).

One of the consequences of society's participation is grassroots innovations, or bottom-up initiatives by individual actors reflecting their personal needs, motives, and interests in the educational field (Miller et al., 2018). Such initiatives contribute to the ecosystem by increasing the awareness of local needs, facilitating attraction of resources and provision of support at the community and local network levels. Balanced development of the education ecosystem requires synchronisation, and mutual adaptation of top-down and bottom-up initiatives, to make it (the ecosystem) dynamic, non-linear, and organisationally wholesome (Schophuisen, Kalz, 2020).

Thus compared to the triple helix and earlier approaches, the quadruple helix model shifts the focus from system elements' functions to their interaction, and through this to the introduction and dissemination of innovations.

The subsequent development of institutional models is associated with the inclusion into the education ecosystem of the environment in the broadest sense, in the form of environmental requirements, demand for sustainable development of the biological system, and taking into account the interests of environmental organisations and activists. This leads to the emergence of the Quintuple Helix model (Carayannis et al., 2012), where the ecological subsystem, while not seen as a component of the education ecosystem as such, is integrated into the learning and knowledge transfer mechanism in the form of sustainable development goals for the external (biological) and internal (social) environments (Crilly et al., 2020). By integrating these issues into educational programmes, the education ecosystem responds to increased public attention to the human impact on the environment.

The development of spiral models reflects the rapid advancement of the views on the education ecosystem components. If initially only the three most obvious actors directly involved in the knowledge creation, transfer, and commercialisation processes were included in this ecosystem, over several decades the model was extended to integrate many new, unobvious players, one way or another interested in the results of the innovative educational process, and willing and able to contribute to this process. The principles of increasing ecosystem diversity described above allow to suggest that the emergence of

new actors is immanent in the education ecosystem, while its structure cannot remain constant. Due to its complexity and variability, educational system tends to become more diverse in response to changing demand. The roles originally played by traditional institutions are being taken over by new actors who, through the use of digital educational platforms, are transforming educational mechanisms making them more open and transparent. Building up the spiral by mechanically adding new players to the education ecosystem has demonstrated its limitations, so a more comprehensive approach is required to describe the growing number of its participants.

Though the spiral models focus on actors, they describe not just the growing complexity of the latter's objectives, roles, and functions, but also the new emerging connections between them. The density of these actors' interactions increases in n-dimensional progression, describing which requires modelling an n-dimensional interaction environment where n is an unknown number of elements. One approach to describing the changing relationships between actors not specified in advance is to apply the complex systems theory, discussed below in the context of the education system.

Complexity, emergence, and openness in educational systems

The complexity theory has proven its effectiveness in explaining novelty, order, and evolution in various domains and systems, including socioeconomic ones (Eve et al., 1997). It analyses relations in all their complexity, mutual conditionality, and emergence, i.e. the ability to generate new phenomena and specific organisational forms (Harvey, Reed, 1997; Wan, 2016). To assess the applicability of the complex systems theory to education, we will consider their key properties and roles in the educational environment. This will allow us to link such systems' development patterns to the changes in the education domain.

The first property of complex systems is nonlinearity, i.e. sensitivity to minor random fluctuations, and the ability to radically change the development path in response to external impact. The system state cannot be fully predicted based on the initial conditions due to nonlinear effects such as crises and bifurcations. In the field of education, at the micro-level we can talk about nonlinear academic paths and successes of individual students due to the so-called butterfly effect in the scope of overall academic performance (Akmansoy, Kartal, 2014). The educational path is set by minor deviations in the completion of specific educational modules, taken together (Newell, 2008). At the meso-level, educational institutions, responding to the social context, change their organisational form and the contours

of their activities in such a way that their success cannot be predicted on the basis of the initial conditions. E.g. university funding arrangements depend not only on the immediate changes in educational policy and accreditation systems, but also on the dynamics of socio-economic inequality, student debt, and the labour market. At the macro-level, the division of resources between individual segments of the education sector is equally uneven, since some of them benefit from globalisation, international cooperation, and mobility, the emergence of new media, and changing demand for competences by the society (Navarro-Bringas et al., 2020).

The second property of complex systems is information asymmetry: uneven distribution of knowledge between the system parts which have different information certainty about the interaction subject. The education domain provides numerous examples of information asymmetries between organisations and target audiences, caused by unequal access to information sources and self-presentation opportunities in the system (Teichler, 2006). In particular, in the "student-university-employer" triangle the latter does not really know how accurately university diplomas reflect the actual quality of the graduates' training, which can demotivate universities to make effort to improve students' skills. As a result, universities prefer to invest in promoting their status and brand, which are more visible to employers and therefore increase graduates' chances to find jobs (Tagarov, Tagarov, 2018).

The third property of complex systems is openness, i.e. the ability and inclination to continuously interact with the external environment, and exchange resources and information via weak links with individuals and organisations operating in other contexts and activity areas. All this promotes diversity, and the emergence of alternative and interdisciplinary approaches to problem solving. At the same time intrasystem processes become dependent on the system elements' interaction with the external environment, and cannot be adequately explained without taking into account outside developments. Educational systems belong in the open systems group since their boundaries are permeable to the external environment: they expand through content providers' use of technological tools, taking into account the social context of learning, areas of leisure and professional development, and a wide range of stakeholders (Cunningham, 2001). Educational platforms take over some of the functions associated with assessing students' progress and providing feedback to them, while cultural venues are responsible for their socialising. The role of technological educational platforms (edtech) in schools' and universities' operations has significantly increased with the massive transition to distance learning during the COVID-19 pandemic.

Another openness attribute is the active interaction of the educational system with the periphery: processes, phenomena, and objects not directly related to education but capable of influencing the changes occurring in this sphere (Danilina, Rybachuk, 2018). E.g. practitioner communities (employers, professionals) can provide quick support in developing new skills, while makerspaces facilitate exchange of experience between technology enthusiasts and customers - spontaneous transfer of specialised skills and abilities to creatively solve specific problems.

The fourth property of complex systems is hierarchy and structural complexity, i.e. numerous levels, linked elements on each of them, and protocols for their interaction (Snowden, 2003). Hierarchies and subordination levels in the educational system reflect the order of municipal, regional, and federal levels of government, structures, the taxonomy of educational units' formal types, and the regulation of their activities based on strict educational standards. The educational system is permeated with interdependent ranking, certification, licensing, and accreditation algorithms constantly supplemented by new protocols for collaboration, regulation, control, and reporting, which explains its structural complexity.

Thus the educational system belongs in the complex systems category due to having certain properties, namely nonlinearity, openness, information asymmetry, and hierarchy. This suggests it can develop in accordance with complex systems laws which explain the transformations occurring in it.

One of the key development patterns of a complex system is the constant growth of its hyperconnectivity: rapid direct contacts between participants. At the same time numerous and varied weak links emerging in a centralised system increase its stability and flexibility (Osberg, 2002). Weak links are manifested in the interaction with peripheral parts of the education domain, such as, e.g.. employer communities, makerspaces, and cultural venues, and involve informal or sporadic emergence of common initiatives. Hyperconnectivity is determined by the quality of horizontal information flows, their content, and the ability to overcome the segments' and subsystems' boundaries. Feedback loops between all actors are of particular importance.

Hyperconnectivity in the educational system involves multilateral knowledge transfer, joint learning (Cai et al., 2020), and the constant involvement of professionals with unique competencies (Barokas, Barth, 2018). This creates a shared vision; facilitates the development (and forecasting) of the educational environment, enables peer coaching and professional growth of teachers, and promotes the transformation of school or university practices; collec-

tive reflection arises, along with exchange of views and exploration of new approaches. Moreover, these activities do not necessarily occur in the framework of methodological associations in a single educational institution, but can bring together teachers from different institutions on voluntary basis. Hyperconnectivity makes possible rapid implementation of best educational practices through a network of interpersonal and interorganisational interactions (Koul, Nayar, 2021), quickly achieving results in terms of rapid and effective solving of emerging problems, and application of innovations by all process participants including the management, teachers, and parents (Lemke, Sabelli, 2008).

The growth of hyperconnectivity is associated with such complex systems property as the emergence of ordered structures through self-organisation of agents (Törnberg, 2017). Each element of the system has a fluid identity: its role and behaviour change when it comes in contact with other elements, triggering a chain of changes in the response behaviour of other links, and provoking the emergence of unplanned patterns (Audouin et al., 2013). Subsystems and clusters of elements are spontaneously created, and develop their own lines of behaviour (Kuosa, 2016). Emergence is a process of ordering chaos: the birth of properties and structures which could not be expected or predicted based on the known attributes of individual system components and external forces (Iansiti, Levien, 2004). In contrast to an emergent one, an ordinary structurally complex system can be precisely defined at any level: each of its elements can be accurately described, and the cause-and-effect relationships between them can be modelled and predicted (Törnberg, 2017). The emergent complexity of educational systems is evident in the presence of numerous self-organising groups within them, which pursue different goals in often unpredictable ways. These include individual actors (students, teachers, managers), communities (classes, schools, universities, teacher associations, etc.), and external structures (research centres, consulting and other companies) (Rogers et al., 2013). Students' activities are affected not just by the curriculum and assessment systems, but also by cooperation with other students. This co-creation yields new ideas, leads to educational projects taking unplanned development paths, and even to changes in educational paths or specialisation.

At a higher level, complex systems are characterised by distributed leadership and responsibility. The distributed management phenomenon is associated with changing the principles of process regulation in the system whose transformational potential is hampered by excessive centralisation and unidirectional transfer of initiatives, goals, guidelines, and rules from the management to lower levels. In a

complex and heterogeneous environment, it is the decentralisation elements which contribute to increased involvement of all stakeholders in making important decisions (García, 2019). Educational systems on the one hand have channels for formalised top-down transfer of codified knowledge and attitudes, while on the other, students, teachers, and managers act as links in the social chain which develops and reassembles educational formats, thus promoting innovation and diversity (Erçetin et al., 2015). This achieves a balanced distribution of management functions between different levels of the system, and helps to balance national, regional, and local interests.

Distributed management can also be done by specialised non-governmental organisations. They create special communities to support and disseminate initiatives with a strong social dimension, find authors of socially important educational projects and provide them with financial or expert support, and build networks of organisations for joint development of solutions that change the educational landscape. Such initiatives are implemented jointly with schools, universities, corporations, public associations, the media, and other influencers, provide consulting support to them, and lead to the emergence of an extensive network of leaders and ambassadors of change (Wu, Lin, 2020). Maintaining the right centralisation/decentralisation balance is an important aspect of implementing educational reforms. Involving teachers in planning, empowering school management and local authorities facilitates targeted meeting of community demand, and promotes dynamic, high-quality cooperation between stakeholders and authorities. E.g. in Finland in the course of regular national-level curricula revision only the core of the curriculum (the basic framework for all hierarchy levels) is determined, while the final standards and procedures are set locally (most often at the city level) jointly with teachers, parents, and other stakeholders, taking into account the local context (Niemi, 2021).

The allocation of management functions is closely related to the distributed responsibility and distributed leadership concepts. The first arises from facing complex and systemic challenges, dealing with which requires not just mobilising the available resources, but allocating them across the system in the most effective way. In education, these complex tasks include, among others., ensuring fair and equal access to education, which implies preventing early dropout, increasing the attractiveness of higher and specialised secondary education, and facilitating a smooth transition between levels, i.e. increasing the importance and responsibility of various structures (Flynn, 2020). Distributed leadership is based on the interaction of formal and informal leaders at all

levels of the hierarchy (Rikkerink et al., 2016), and setting an egalitarian vector for the development of the system. This principle takes into account the diversity of individuals with leadership potential who understand the essence of ongoing changes and can make decentralised decisions (Şentürk, Kılıçoğlu, 2016). In education, distributed leadership provides the basis of a participatory approach to involving local communities in the activities of educational organisations (Hoppe, Holley, 2014). It can take the form of encouraging the exchange of tacit knowledge and skills, helping to organise and equip the learning process, and implementing practice-oriented projects (Hautamäki, 2006; Herselman et al., 2019). Researchers especially focus on the allocation of responsibilities for accomplishing strategic sustainable development goals in education between individuals, institutions, and regulatory authorities (Boeren, 2019).

Thus development patterns of complex systems provide a key to describing the transformation of the education sphere. However, a complex system is not yet an ecosystem since the interaction of actors in it remains atomic, their mutual adaptation may remain low, and the coevolution mechanism may not be fully implemented. This section described basic properties and patterns of complex systems in education; now we'll move on to the ecosystemic transition, specifically the signs of an educational system's transition to the education ecosystem and, accordingly, the limits for applying ecosystem optics to studying the education domain.

Ecosystemic transition in the education sector

The key to a comprehensive and structured description of an ecosystem in terms of the interaction in the socio-economic sphere is provided by the innovation economy (Adner, Kapoor, 2010). An "innovation ecosystem" is focused on the creation of innovations, and based on the community's links with a focal firm or platform (Talmar et al., 2020). These links emerge due to actors' joint participation of in value creation, and affect the use of resources, information flows, and the allocation of roles (Jacobides et al., 2018). As a result, actors' specialisation increases, and their functionality adapts to the objectives of affiliated structures. The relationships between people, their use of knowledge and resources are constantly adjusted in the test-and-trial manner, leading both to incremental changes and deep transformations (Oksanen, Hautamäki, 2015). Such mutual adaptation in a certain spatial context is a necessary condition for the existence of an ecosystem, which ensures the accelerated knowledge creation and technology development, and ultimately leads

to joint creation of innovative value by specialised actors which would be impossible without the collective effort (Hage et al., 2013). Meanwhile each individual actor's value is not realised outside the ecosystem, so their survival depends on others (co-creation and joint survival) (Clarysse et al., 2014).

Evolving systems are based on high modularity, and resource and competency parallelism; these traits facilitate rapid adjustment of actors to each other (McKelvey et al., 2012) and their complementarity, i.e. cohesion of interests and productive interaction. Complementarity implies having, maintaining, and creating new co-specialised assets in the course of value creation. Complementarity can be universal (the actor is integrated into the operations of a wide circle of people), or specialised (the actor's resources and competences only match the needs of a highly specialised group) (Kapoor, 2018; Ganco et al., 2020). An example of universal complementarity in education is organising educational video conferences and webinars regardless of the nature of the educational event. Solutions such as learning management system (LMS) platforms can be adapted to a certain training level, or customised to meet the needs of a particular institution.

The widely diverse affiliations of actors and organisations, and specialised complementarity speed up the evolution of ecosystems (Kapoor et al., 2021). Because of complementarity, each actor is involved in many different, partially overlapping structures and different types of relationships (relational pluralism), and plays several roles simultaneously. The knowledge and skills, goals and behaviour patterns inherent in different roles increase the diversity of actors, while the ecosystem itself becomes more heterogeneous due to the involvement of representatives of various industries (Nambisan et al., 2019) including culture, entertainment, technological innovation (edtech), open environments, etc. Its further transformation is determined by the institutional, cultural, regional diversity and various kinds of cooperation it facilitates.

Researchers emphasise that in innovation ecosystems cooperation and competition take place at the same time (Bogers et al., 2019); the balance between them is determined by how much the actors' personal goals match or contradict each other. Cooperative interaction stems from complementary efforts to create value, while competitive motives arise from the desire to maintain market niches. Each actor in the ecosystem must find not only ways to contribute to the joint value creation, but also means to appropriate their share of the value (Radziwon et al., 2017; Chesbrough et al., 2018).

Taking into account the above assumptions, one can conclude that the term "ecosystem" is applicable to

the education sphere; its particularly important aspect is mutually beneficial cooperation of individuals, institutions, and educational structures – members of joint creativity networks. At the same time competition increases in all segments of the educational market, due to diversity of its participants and their behaviour strategies.

The presented conceptual analysis, and the assessment of the ecosystem approach's applicability in education allow us to suggest an original definition of education ecosystem: it's a complex, dynamic, and open social system the participants in which evolve and join efforts to create new educational products, making use of a wide diversity and high complementarity of their resources and competences. Many direct links quickly arise between the actors in the education ecosystem at different levels (hyperconnectivity), leading to the emergence of new educational formats and products which transform the system as a whole (emergence). Effective regulation of the education ecosystem is based on the distribution principle (of leadership, responsibilities, and management).

Now let us consider how the above properties of the education sphere, and the features of its actors' interaction determine the productivity of the integrated ecosystem approach for studying innovation processes occurring within it.

Ecosystem approach to studying and forecasting innovation processes in education

The interconnection of properties and patterns of the education sphere determines the characteristics of innovation processes taking place in it, and the need to adopt an ecosystem approach to study them.

First, present-day educational systems show a tendency towards radical transformation, going beyond their boundaries (Lane, Maxfield, 2018). Technological and social innovations are redefining the scope of sectors, pushing the players to dynamically diversify their activities; an example is edutainment (blending educational and entertainment content) which promotes partnership of public spaces and cultural venues with educational organisations, and developers of mobile application and VR solutions with teachers. New mechanisms for delivering educational products to students are emerging, such as art residencies, case championships, living labs, etc., which in turn give new roles to the education ecosystem actors. All these processes must be analysed in their dynamics.

Second, new educational solutions often emerge bottom up, while qualitative transformations occur when sufficient diversity is accumulated at the lower levels of the system (Vanhaverbeke, Cloudt, 2006;

Zhai et al., 2021). Combining the organic growth of innovations in grassroots communities with providing structured support from the top helps to implement initiatives sustainably (Hung et al., 2019). It would be impossible to study innovation dynamics without considering both these vectors (top-down and bottom-up), and their relationship.

Third, due to the inertial factor in complex systems' development, the diffusion of innovations in education is accompanied by the formation of ecological niches around new products (West, Wood, 2013). Around any technology or solution emerges a system of interconnected services, providers, and stakeholders. The more stable these emerging niches are, the higher the innovation's chances to take root in the ecosystem (Civís, Díaz-Gibson, 2021). Studying transformations in the education sphere, one must consider how different subsystems comprising various actors simultaneously obtain a new development vector.

Fourth, there is a connection between participation, sustainability, and solving complex innovation-related problems in education. It is impossible to make human-centric decisions if a significant proportion of stakeholders are excluded from the transformation process, and no institutional cooperation occurs (Schnack, 2008). The study of integrated innovation in education implies participatory approach, i.e. taking into account the opinions and interests of specific actors when implementing changes and making decisions (Mahoney et al., 2021). Multi-stakeholder partnerships play a key role in operationalising education for sustainable development, involving the community in lifelong learning (Collective, 2020), and companies - in meeting the green economy demand, making practice-oriented educational programmes more accessible (Bonal, Fontdevila, 2017), and making policy shaping more evidence-based, transparent, and accountable. Participation plays an equally important role in monitoring the progress in achieving sustainable development goals in education by the community, and its more active members, on bottom-up basis. Such monitoring allows the community to identify sensitive areas, find out whether various initiatives are actually implemented, assess marginalised groups' situation, and draw attention to the level of human rights compliance (Krupar, Taneja, 2020).

Thus studying innovation in the education sphere involves analysing its ecosystem characteristics, and promotes the application of ecosystem optics. This approach is simultaneously the object of research, a principle for building the source base for it, and a tool for analysing and interpreting the identified patterns and assessing their social significance. However, the cognitive potential of the ecosystem approach has a number of limitations.

Ecosystem approach to building a source base for research

The ecosystem approach implies involving experts, experienced users, community representatives, and platforms in the identification, selection, and evaluation of signals about innovative changes taking place. The quality of results is determined not only by the amount and reliability of the analysed information, but also by the variety of its sources and perspectives from which data was selected and accumulated. The key to solving complex organisational problems often turns out to be in broadening the range of contextual information about the object under study (Davis, Sumara, 2014). Reaching out to a wider community of practitioners, especially non-metropolitan ones, also appears to be a productive approach in terms of generating more diverse ideas, and detecting signs and signals of change (Kim et al., 2013). Analysing weak links enriches the study of educational innovations, since they allow to discover unobvious drivers of change and connect signals from numerous related fields. The platform principle also plays an important role in building a source base: it allows for a controlled and structured collection of observations from participants sharing certain common characteristics (Hiltunen, 2011).

From a methodological point of view, it is important not only to involve stakeholders with different backgrounds in the study, but also structure their input in such a way that each of them would complement the common information base (Warnke, Schirrmeyer, 2016). The inclusive evidence principle helps to solve this problem, according to which actors must independently determine their position in the ecosystem; a circle of third parties with similar interests emerges, cooperating with whom seems to be in order. The overall structure unfolds as the actors discover new links, which allows them to gradually overcome the fragmentation of the source base (Nugroho, Saritas, 2009).

The use of ecosystem approach to select research sources has a number of limitations associated with excessive amount of information, possible duplication and irrelevance of data and signals. This raises the issues of labour-intensive monitoring, and the need to filter the collected materials when the amount of incoming data begins to exceed researchers' cognitive abilities. Also, people have different ideas about what sample size should be considered sufficient, which can lead to conflicting approaches to signal filtering by different researchers.

Ecosystem approach to interpreting patterns, trends, and signals

The ecosystem approach allows to outline the contours of an in-depth multidimensional analysis of

the connections between trends, signals, and patterns under study, including the use of sociograms and conducting cluster and network analysis of the diffusion of innovations.

Profound changes in education are caused not so much by new products and solutions as by actors' attitude towards them. These changes affect different subsystems, each with its own set of established social practices, goals, management styles, and perspective (Carbonell et al., 2015). Some initiatives are implemented by horizontal communities and through informal interaction. The same innovations applied in different systems of actors' relations lead to different developments, so incoming signals cannot be adequately interpreted without understanding the interconnection of interests, resources, and functions in the education ecosystem.

The ecosystem approach to interpreting information allows to identify and summarise communities' aspirations and demands and hidden but important motives for resisting trends, and also reveal the links between surface signals and deep motives and attitudes of ecosystem participants (Milojević, Inayatullah, 2015). It also provides a range of analytical tools needed to adequately respond to external complexity. According to the postulated principle of studying complex systems (McKelvey, 2022), only internal diversity can provide an adequate response to heterogeneous external conditions; only internal degrees of freedom can overcome external ones; internal complexity balances external one, while internal fractality compensates for that of the external environment. Thus multiple interpretations of information coming from outside of the ecosystem allow to eliminate, and integrate into the analysis its inconsistency, redundancy, and ambiguity.

The main limitation of applying the ecosystem approach to interpret signals is the difficulty of weaving varied motives, metaphors, and descriptions into a single narrative. Each participant's individual narrative directly depends on the ecosystem niche they occupy, so forging a dominant frame on their basis is fraught with losing unique insights while the result will still remain fundamentally subjective. Along with this, some participants' deep-rooted but outdated attitudes conflict with the current sociocultural, technological, and economic realities, which also complicates the interpretation.

Ecosystem approach to describing the object of study

The main result of studying innovation processes is forging an image of the future education ecosystem, including its ecological niches (sets of related services, products, channels, and distributors) that will emerge around innovative educational solutions; their consumers and providers; the mechanisms for

meeting local communities' demand; and the evolution of roles of, and links between all actors in the event a particular trend is implemented. Different scenarios can lead to the emergence of new interaction environments in the ecosystem, new ways of applying, adapting, and disseminating new solutions, new platforms and communities emerging around them, and their development paths (Rogers, Euchner, 2022). This thesis is presented in a number of studies whose authors note the need to track the dynamics of innovation clusters and map the links between them, including visualising actors' positions and roles on a systemic map of changes, new niches and collaborations in the innovation ecosystem (Borch et al., 2013).

A limitation of applying the ecosystem approach to describe the object of forecasting is the fleeting nature of the latter. The future scenarios we build constantly change when they are not static and collide with each other. Feedback loops force stakeholders to reframe problems, and rethink their future roles and niches in the ecosystem; all this makes the forecasts extremely labile, requiring constant revision and addition, which complicates making managerial decision.

Discussion

The paper aimed to contribute to the development of ecosystem optics for analysing transformations in the education sphere. The borrowing of the ecosystem metaphor was due to the need for an integrated approach to these transformations, against the background of increased cohesion, horizontality, and adaptability of the education sphere. At the same time, studying the transition of a complex adaptive system into an ecosystem remains a non-trivial task: the very scientific viability of using the term "education ecosystem" to refer to a special case of an innovation ecosystem is often called into question. Critics of this approach point to the vagueness of the term, and of using it in relation to various entities ranging from corporate and university ecosystems to regional innovation clusters and digital platforms (Isenberg, 2016). In particular, it is noted that the "innovation ecosystem" concept is extended to cover areas which have traditionally been adequately described in terms of clusters, triple helixes, or innovation systems, without sacrificing either meaning, or research productivity (Oh et al., 2016).

Nevertheless, it appears that intentionally designing socio-economic systems does not come into conflict with seeing them as randomly developing biological ecosystems guided only by the forces of natural selection, where innovations are random, and evaluated solely from the point of view of their benefits for specific individuals (Kuckertz, 2019). On the

contrary, in social systems competition is regulated by norms, values, and institutions, which shift the effects of actors' interaction towards greater benefits for the system as a whole (Mars, Bronstein, 2018). Finally, if in a biosystem engineering solutions are always local, in a social system successful practices and innovations can be disseminated and adapted for the benefit of other institutions, scaled from the local to the global level, or reconfigured for a different sociocultural context (Papaioannou et al., 2007).

The noted incompleteness of the metaphor, and the vagueness of concepts make the cognitive value of the ecosystem concept in the field of education debatable, while our objective was to highlight the ecosystem optics' components which can improve the research toolset. We argue that for the purposes of describing artificial ecosystems, the ecological axiom can be partially modified and adapted (Ritala, Almpantopoulou, 2017). Meanwhile the education ecosystem concept can be equally divorced from both the classic complex system and the biological ecosystem, and described as an independent phenomenon (Peltoniemi, 2006). The intermediate position between being intentionally designed, and having an evolutionary nature makes the innovation ecosystem concept a productive tool for studying social phenomena, provided there is a clear understanding of which of its elements can be designed, and which are self-organising in nature and develop according to the co-evolution logic. It must also be understood which ecosystem characteristics should be preserved in the new concept, and integrated into its toolset as reflecting current education trends. First of all these properties include high diversity and horizontality.

The increased horizontality manifests in the development of the open innovation system in education: crowdsourcing, open licenses, various agreements which allow to combine different ideas to develop new products and services (Megahed, Ghoneim, 2022). This can also include actors' focus on finding external partners to create value, the strengthening of horizontal links in the scope of collaborations, exchange of experience, development of personal brands, etc. (Nadler, 2019). When the role of education in achieving the sustainable development goals is assessed, emphasis is also placed on local horizontal interaction, both in terms of involving students in peer-to-peer solving of social problems (Westheimer, 2020), and joint implementation of educational innovation initiatives aimed at achieving sustainability in the local community (Raj et al., 2022).

Increased diversity becomes key in the situation of high uncertainty and dramatic socio-economic and technological shifts, and at the early stages of implementing new projects when various alternatives and

points of attraction still exist - i.e. in typical conditions for the transformation of the education sphere. According to the quintuple helix model, innovation processes in education are affected not just by actors directly involved in the creation, transfer, and commercialisation of knowledge (universities, government, and businesses). Other players (such as communities, social infrastructure developers, cultural figures, etc.) also contribute to, and are interested in the emergence of new solutions for the educational sector. This interaction network increases diversity, and accelerates change. The latter, in turn, hinders the operation of selection mechanisms: rapid emergence of innovations does not allow any of them to become a paradigm, a part of the routine process, and create stable and effective activity patterns. Since diversity and novelty become the norm for the work of any researcher, ecosystem properties of the education domain give rise to many contradictions, both at the level of studying and understanding, and managing and developing it.

In the situation described above, applying the ecosystem approach allows to answer a number of complex questions. How sensitive is the education ecosystem in its current state and condition to diversity? Would increasing diversity at the grassroots level be sufficient for (re)launching evolutionary mechanisms, or would it require implementing an active support and promotion policy? What exchange arrangements must be made to accelerate innovation? What are the costs of over-supporting some areas at the expense of others? Can a favourable level of the educational environment's permeability be determined, and of actors' integration into the system from its periphery? How to achieve the adequate degree of participation in carrying out educational reforms, and implementing innovations?

Conclusion

Modern models assign major roles in the innovative educational process not only to actors directly involved in knowledge creation, transfer, and commercialisation (universities, government, and businesses), but also to other players (such as communities, developers of social infrastructure, and cultural figures) who contribute to, and have an interest in the development of new phenomena in education. The education domain is increasingly acquiring complex social systems' features (which follow development patterns characteristic of various other similar systems) including nonlinearity, information asymmetry, emergence, structural complexity, openness to external environment, distributed responsibility, and hyperconnectivity. At the same time the education sphere also has ecosystemic properties manifested in its participants' interaction, namely

co-evolution of actors, obvious complementarity of resources and competencies, grassroots dynamics, highly permeable boundaries, increased participation, and the emergence of ecological niches.

Taken together, all these characteristics set the transformational vector of the education system, and profoundly change the principles of interaction between participants in innovation activities: their agency increases, while geographical and disciplinary boundaries lose relevance, which dictates the need to apply new approaches to researching it. Firstly, one must understand what configuration the modern education ecosystem is obtaining to be able to project it into the future and increase value for all stakeholders; and secondly, how the ecosystem view of the transformational processes in the education sphere helps to predict its future state, and take an active part in the joint mapping of sustainable development paths.

The ecosystem approach to studying innovation processes and forecasting changes in education is proposed as a new toolset, expressed in the trinity of principles: for building research source bases, interpreting patterns, trends, and signals of change, and describing the object of study. At the same time one must strive to increase the diversity of sources, and

analysis tools by involving the periphery, through deeper contextualisation taking into account multiple layers, strengthening the incorporated structure mechanisms, and considering weak links. Maintaining diversity becomes a key research principle, since it allows to identify deep and unobvious relationships between individual, institutionally autonomous phenomena in education. Diversity does not give rise to, but on the contrary, overcomes the fragmentation of visions of the future, because it helps to trace the co-evolution of social, economic, technological, and cultural trends.

The study may be concluded by acknowledging the productivity of the ecosystem approach for setting fair and universally important priorities for the education ecosystem development, and more comprehensive understanding of the innovation agenda. It encourages greater participation in building alternative future scenarios, ultimately increasing their likelihood and viability.

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