FORESIGHT AND STI GOVERNANCE

ISSN 2500-2597
2024
Vol.18 No. 3

JOURNAL OF THE NATIONAL RESEARCH UNIVERSITY HIGHER SCHOOL OF ECONOMICS

IN THIS ISSUE

ABOUT THE JOURNAL

Foresight and STI Governance is an international interdisciplinary peer-reviewed open-access journal. It publishes original research articles, offering new theoretical insights and practice-oriented knowledge in important areas of strategic planning and the creation of science, technology, and innovation (STI) policy, and it examines possible and alternative futures in all human endeavors in order to make such insights available to the right person at the right time to ensure the right decision.

The journal acts as a scientific forum, contributing to the interaction between researchers, policy makers, and other actors involved in innovation processes. It encompasses all facets of STI policy and the creation of technological, managerial, product, and social innovations. *Foresight and STI Governance* welcomes works from scholars based in all parts of the world.

Topics covered include:

- Foresight methodologies and best practices;
- Long-term socioeconomic priorities for strategic planning and policy making;
- Innovative strategies at the national, regional, sectoral, and corporate levels;
- The development of National Innovation Systems;
- The exploration of the innovation lifecycle from idea to market;
- Technological trends, breakthroughs, and grand challenges;
- Technological change and its implications for economy, policy-making, and society;
- Corporate innovation management;
- Human capital in STI;

and many others.

The target audience of the journal comprises research scholars, university professors, post-graduates, policy-makers, business people, the expert community, and others who are interested in S&T and innovation analyses, foresight studies, and policy issues.

Foresight and STI Governance is published quarterly and distributed worldwide. It is an open-access electronic journal and is available online for free via:
https://foresight-journal.hse.ru/en/

The journal is included into the 1st quartile (Q1) of the Scopus Cite Score Rank in the fields:

- **History and Philosophy of Science**
- **Social Sciences (miscellaneous)**

INDEXING AND ABSTRACTING

WEB OF SCIENCE™ CORE COLLECTION EMERGING SOURCES CITATION INDEX
SCOPUS™
中国知识基础设施工 CNKI 中国知网
SHERPA/RoMEO
DRJI Directory of Research Journal Indexing
ERIH PLUS
IOI WORLD of JOURNALS
RePEc
ProQuest
ULRICHSWEB™ GLOBAL SERIALS DIRECTORY
EBSCO
Academic Search Premier
GENAMICS™ JOURNALSEEK
ECONSTOR
eLIBRARY.RU
OAJI.net Open Academic Journals Index
DOAJ DIRECTORY OF OPEN ACCESS JOURNALS

FORESIGHT AND STI GOVERNANCE

National Research University
Higher School of Economics

Institute for Statistical Studies
and Economics of Knowledge

Address:
National Research University Higher School of Economics
20, Myasnitskaya str., Moscow, 101000, Russia
Tel: +7 (495) 621-40-38
E-mail: foresight-journal@hse.ru

http://foresight-journal.hse.ru/en/

Periodicity — quarterly

ISSN 2500-2597
ISSN 2312-9972 (online)
ISSN 1995-459X (Russian print version)

Publisher:
National Research University
Higher School of Economics

CONTENTS

Vol. 18. No. 3

Sustainable Transformation in China's Agricultural Sector: From Traditional Narrow Patterns to Smart Dynamic Production

John C. G. Lee *
Adjunct Professor, johncg.lee@insead.edu
Renmin University of China, 59 Zhongguancun St, Haidian District, Beijing 100872, China

Se Tin
Senior Lecturer, se.tin@eco.maranatha.edu
Maranatha Kristian Universitas, Jl. Surya Sumantri No.65, Bandung 40164 – West Java, Indonesia

Juniati Gunawan
Professor, juniatigunawan@trisakti.ac.id
Universitas Trisakti, Jl. Kyai Tapa No.1, Grogol, Jakarta Barat 11440, Indonesia

Abstract

Technological transitions and the associated transformation of key sectors are radically changing the entire socioeconomic system. The agricultural sector, as one of its key links, today is intensively saturated with new technologies and management innovations. For the first time, there is an opportunity to "do things completely differently," to restore and develop both the natural and human potential of rural areas. This makes it possible to create smart industries with their dynamic chains, complex infrastructure, large-scale digital platforms and networks, implement the concept of sustainable development, and make a transition from productivism (exclusive focus on productivity) to post-productivism (a balance between ensuring economic interests are met and guaranteeing the healthy integrity of natural diversity). This article analyzes the current state of and prospects for China's agricultural sector from the point of view of two levels – "top-down" (state initiatives) and "bottom-up" (inputs of product manufacturers identified during a regional Foresight project, but apparently characteristic for most Chinese rural areas). The key limiting force in the development of the concepts under consideration is the too slow process of building human capital with residents living directly in rural areas and the development of related sectors in said areas.

Keyword: strategies; Foresight; forecasting; digitalization; technological transition; smart model of the agricultural sector; post-productivism; revitalization of rural areas; new technologies and competencies; China; agroecology

Citation: Lee J.C.G., Tin S., Gunawan J. (2024) Sustainable Transformation in China's Agricultural Sector: From Traditional Narrow Patterns to Smart Dynamic Production. *Foresight and STI Governance*, 18(3), pp. 6–15. DOI: 10.17323/2500-2597.2024.3.6.15

* Corresponding author

Introduction

The new stage of technological paradigm change creates a certain logic, which implies thinking in terms of delayed consequences not only for the entire complex socioeconomic structure, but also for natural ecosystems. Based on this, the role of the agricultural sector is being rethought. This field is faced with the task of mastering increasingly complex development models and forming human capital with the appropriate competencies. If in the energy sector technological transitions have long ago acquired a conceptual basis and programs with long-term horizons have been developed, then in the context of agriculture their theoretical and empirical bases are only just being shaped.

In recent years, researchers have paid great attention to these processes, revealing both the current state of rural areas and their prospects. The mainstream trajectory is the consistency of national programs with the international concept of sustainable development, which implies the restoration of the integrity of natural ecosystems, the proper, active management of the environment, and its management in line with socioeconomic processes (Sgroi, 2022). However, even developed countries are faced with the difficulty of implementing such a combination of tasks and are still searching for optimal paths to improve this sector.

The solution seems to be in complementing this track with the multifunctionality approach put forward by Geoff Wilson (Wilson, 2001). Rural areas are considered an integral dynamic organism that operates under the combination of many factors — optimal demographic balance, the formation of human capital, an abundance of jobs with decent wages, constant improvement of infrastructure, a robust technological base, management models, and, most importantly, the presence of a wide range of well-functioning land use and environmental protection regimes (Wiggering et al., 2006).

The capabilities of a multifunctional development model are maximally unleashed when natural, resource, social, human, economic, and environmental capital are equally well developed (Wilson, 2014). Its implementation implies a paradigm shift in the evolution of rural areas, including their resource, production, knowledge, and cultural bases (Liu et al., 2023). Based on this, transition processes are being formed, the roles and subjects of the agricultural industry are being revised (Wilson, 2007; Lin, Cai, 2012). Understanding the multifunctional approach and its development will make it possible to effectively manage complex interactions between various interconnected segments of a large-scale ecosystem (resources, production, markets, investments, infrastructure, etc.), which is of great importance for both decision-makers and the population (Ma et al., 2019). In this regard, it is of interest to evaluate the correlation of state efforts to implement strategic programs with the readiness of stakeholders in the agricultural sector to transition to new development models.

Using the evidence from China, this article examines the driving forces and restraining factors in the transformational transition of rural areas to new technological, digital, and knowledge foundations. The study is divided into two parts. The first looks at top-down initiatives, i.e., the efforts of the state, and the second part focuses on the case of the Jilin Province, where a Foresight study was conducted based on a stakeholder survey using the focus group method (bottom-up principle). In this way, a holistic vision of the problems and ways to solve them is formed (improving the environment, smoothing out income inequalities between cities and rural areas, increasing the attractiveness of the latter for the return of the working population, opening new lines of business, etc.).

Literature Review

Since the emergence of the concept of spatial development in 1999, European countries have applied it to stagnating agricultural regions. At one time, these territories were one of the driving forces of economic growth, but since the socioeconomic model of territorial competitiveness has changed, their importance, and, consequently, economic attractiveness have decreased significantly.

The dynamic development of technologies and management practices allows one to take a fresh look at the potential of rural areas, rethink their role in the new economic configuration, and, improve the current state of the agriculture sector. To radically change the attractiveness of rural areas as well as their resource and production base, developed countries are introducing a multifunctional approach that allows for creating something completely different from what has existed before. The literature provides different options for this transformation, taking into account natural, historical, and cultural characteristics. A wide variety of ideas and practices enriches management decisions and expands the view of how one can "unpack" the hidden capabilities of a particular territory. The concept is most actively promoted by creating synergy between rural and urban spaces to generate new economic value, within which the considered territories can create conditions for the development of innovations that unlock and expand the potential of local resources (Jiang et al., 2022). Thus, popular role-playing games based on European rural areas have paved the way for their transformation into frequently visited tourism centers.

The theoretical basis for such transformations is laid within the framework of Foresight projects.

Scenarios with different horizons are created to assess the recovery prospects for complex ecosystems that had previously been subjected to thoughtless, destructive practices of one-sided agroforestry activities.

In 2019, a development project implemented digitalization scenarios for the European agri-food sector until 2030 (Ehlers et al., 2022). The basic scenario is based on assumptions about maintaining the current pace of development, others are based on the prospects for its acceleration and spread to related sectors (for example, the food industry). Digitalization creates the preconditions for the development of radically new methods of farming. The example of the Netherlands is indicative in terms of overcoming the persistent trend of reduction in natural diversity. In 2018, two divergent alternative scenarios were modeled and tested here. A consequence of the focus on increasing dairy production is a reduction in wildlife and meadow plant diversity (Kok et al., 2020). On the contrary, an emphasis on the "diversification" of natural ecosystems makes it necessary to abandon the expansion of the food supply for domestic animals, which greatly reduces the production of dairy products of all types. Both scenarios require a trade-off between biodiversity conservation and increased production. The results of the Dutch Foresight study provide a valuable information basis for understanding the need to develop more complex strategies than before, taking into account all parts of a large, dynamic natural ecosystem, the subtle interdependencies between them, and the "hidden" but critical effects of this influence. It requires establishing a complex set of compromises between the multiple interests of different parties (Kok et al., 2020).

In the work (Polzin, 2024), using the example of Germany, a very pressing question is raised about the weak readiness of the community, upon which the prospects for agriculture depend, to accept completely new methods of agricultural management, including the concept of sustainable development. The recently launched state program "Agrarian Turnaround" (Agrarwende) is facing implementation difficulties. Its vector for promoting organic agriculture using scientific knowledge and technology is viewed with caution by wide circles due to fears of worsening market prospects and food security risks. The authors of the study reveal the difficulties of transforming entrenched sociotechnical ideas, especially when they are closely related to national identity and formalized in institutional structures. Their findings enrich ongoing discussions about the prospects for sustainable agriculture around the world, with the growing threats of climate change and biodiversity loss requiring urgent responses. Since the second half of the 20th century, land use has been transformed on a global, which has created serious problems for the further functioning of ecosystems (Weber, Sciubba, 2007; Newbold et al., 2016).

Currently, the concept of multifunctional land use serves only as a starting point for the restructuring of rural areas, while their full revitalization requires a transition to a sustainable development model (Fang, Liu, 2015). Combining these approaches into an integrated management model is a difficult task, requiring appropriate human capital living in rural areas. We are talking about the concept of post-productivism – a combination of the economic components with the interests of environmental protection. The transition to this scheme from the previous model of productivism (orientation exclusively toward economic benefits and output) implies the complex transformation of agricultural land with its transition to a multifunctional framework (Mccarthy, 2005). As with any other transformation of a large-scale system, this process requires the reservation of sufficient time and special meta-competencies to manage the change with consideration of the nonlinearity, heterogeneity, complexity, and rapid variability of the environment.

Chinese Context

China is also witnessing a shift in agricultural policies away from a productivity focus toward embracing multifunctional agriculture and its spatial development (Chen et al., 2018). Building on the work of (Wilson, 2001), some local scholars have compared studies on the transition of rural areas in Western countries from productivism to post-productivism to the modern Chinese context (Huang et al., 2022). The settlement of land issues is critical to the revitalization and integrated development of rural land, farming, and the agricultural sector in the Sannong conceptual triad (that means a holistic approach to the dealing with the three issues related to rural development in mainland China: agriculture, rural areas and farmers) (Liu, 2014). The use of an appropriate theoretical framework allows us to develop optimal ways to manage this nonlinear and heterogeneous process (Lin, Cai, 2012).

Currently, in the development practice of rural China, a search is underway for the optimal balance between productivity and non-productivity. The process is complex, as it represents a large-scale challenge in organizational, cultural, and managerial terms. The biggest problem is due to contradictions — a simple transition from a focus on economic productivity to environmentalism (the priority of sustainable development, including the protection and improvement of

the environment) poorly corresponds to the interests of many Chinese rural regions in need of revitalization. These processes are partly reminiscent of the situation occurring in Germany, but have their own specifics, which are expressed in greater income inequality and a shortage of relevant labor. In other words, considerations of short-term benefits generally continue to prevail over long-term goals. However, with this approach it is not possible to simultaneously provide food safety and mitigate destructive anthropogenic effects (Wang, Gu, 2012). Excessive emphasis on environmental protection in land use practices is becoming a threat to stable food supply for markets (Jiang et al., 2022).

Thus, a direct bet on productivism or non-productivism in the foreseeable future does not look like the optimal track for managing the development of rural areas not only in China, but around the wold. This is a bottleneck in the transition to new quality under consideration. It can be overcome by in-depth research on emerging global practices, such as regenerative agriculture or agroecology, combined with new technologies, especially digitalization (Duff et al., 2022; Husaini, Sohail, 2023; Purnhagen et al., 2021). Cultivating these concepts in public discourse will be the key to changing the established sociotechnical narrative. Mastering multifunctional models, some regions perform better, while others do worse, which corresponds with nonlinear dynamics, but in general there has been a tendency to abandon non-optimal land use that is actually or potentially harmful to overall socioeconomic development. Developing effective management and control measures to facilitate such transformations is crucial for reviving and increasing the attractiveness of the national agricultural sector, establishing a co-evolutionary model of relations between rural and urban areas (Long, 2022).

Over the past 30 years, China's agricultural growth rate has averaged 4.6% per year. Despite possessing only 8% of the world's arable land, the country managed to provide food for nearly 20% of the world's population (World Bank, 2023). A significant shift has been observed across all production categories (Li et al., 2018). In 2022, the added value of China's agriculture and related industries amounted to 19.569 trillion yuan (16.24% of the country's GDP). At the same time, further annual growth rates are projected at 5.95%.[1]

China is committed to making its agricultural sector sustainable and self-sufficient as part of its long-term national strategy. Two vectors can be traced, aimed at a single result: equipping the agricultural market with advanced technologies.[2]

National Agricultural High Technology

While remote sensing (RS) technologies, geographic information systems (GIS), and drones in themselves do not represent fundamental novelties, their transformative potential for the sector in question has not yet been fully revealed due to the slow development of these technologies, which require certain competencies. At the same time, today many things are being done in a new way. Remote sensing, GIS, and drones make it possible to quickly manage unevenly distributed arable lands located at long distances from each other, taking into account the specific needs of each landowner. Complex solutions are being created in the Software-as-a-Service (SaaS) format - adapted technologies for a population that does not fully possess the required competencies. The proliferation of these user-friendly, intuitive, practical applications is becoming a driver of sector transformation. Even small companies get the opportunity to correctly plan processes, significantly increase productivity, and reduce the impact of harmful factors on the environment. To some extent, these affordable technologies are replacing expensive drone-based monitoring systems and IoT-enabled agricultural devices. SaaS appears to be a cheaper but effective solution that allows for the timely receipt of data on soil conditions, crop yields, water supply needs, and so on (Chunjiang et al., 2021). Thanks to this, the efficiency of the agricultural sector is increased, and food supply chains are optimized. The market can expect predictability and reliability in logistics, improved quality, and lower product costs (Peng, You, 2023). Increasing transparency in manufacturing operations ensures that consumers have greater access to safe and environmentally friendly products (Cho et al., 2023).

Drones occupy a significant place in the rapidly developing segment of agricultural high technologies. By 2020, sales of such equipment in China increased to approximately 50,000 units - more than tenfold compared to 2017 (4,250 units) (Liu, 2024). Their manufacturers began to diversify their profile and introduce unmanned technologies on ground vehicles, which illustrates the transition to integrated solutions for the automation of the agricultural sector.

In the fields of remote sensing, GIS, and drone development, a steady increase in the number of

[1] https://www.developmentaid.org/news-stream/post/179737/5-sectors-driving-the-chinese-economy, accessed 24.07.2024.

[2] "Ecological Redline Policy" (Bai et al., 2018) and "No. 1 Central Document" (Liu, 2024).

companies has been recorded over the past 10 years (Liu, 2024). Below are just a few of them.

Technology Developers

- ICAN Technology (founded in 2016). This company has created its own model for monitoring the condition of vegetation and soils based on satellite technologies. The big data platform allows one to support the full production cycle - from preliminary planning for planting crops to harvesting, storage, logistics, and marketing of crops, providing detailed management decisions.
- GAGO (2015). This organization has formed a wide network of partners and clients, including agricultural producers and government agencies. The provision of financial services has been established in regions where traditional banking infrastructure is limited. Thanks to the remote collection of data on farmland through satellite systems and a detailed analysis of their characteristics, lending to farmers is simplified (the principle of inclusive financing is implemented).
- Jiahe Information (2013). This enterprise has developed different types of technology platforms, from artificial intelligence algorithms to low-code tools. Their design in the form of simple, intuitive applications allows users to conveniently receive and analyze data.
- XAG (2007). This company is a leader in low-cost agricultural drones, it maintains profitability above 30% despite declining product costs.

Service Companies

- YiMuTian (2011). This digital integrator covers over 800,000 farms and connects producers with wholesale markets and buyers for a wide range of products. The number of users is over 50 million. It develops detailed maps of market dynamics that provide a better holistic understanding of ecosystem processes.
- BRIC Agricultural Information Technology (2014). This organization specializes in agricultural consulting, the management of digital platforms that aggregate big data across production sectors, supply chains, and sales.

Key Barriers to Transitioning Agriculture to a Sustainable Model

A natural property of any radical transformation is the manifestation of both positive and negative factors. Among the restraining forces barring the way to sustainable developmen are inequalities in income between rural villages and cities (Huang, 2020) and the exacerbation of environmental problems as a result of the rapid growth of the agricultural sector, which proceeded without taking into account the "downsides" of such speed. Agricultural ecosystems account for 7–20 % of the world's total greenhouse gas emissions, and in China this share reaches 17% (Li et al., 2018; Huang, Yang, 2017). The intensification of growing demand for food has stimulated the use of a variety of yield boosters, such as chemical fertilizers and pesticides. The downside of their overuse has been land degradation, pollution of aquatic ecosystems, and increase greenhouse gas emissions (Zhang et al., 2020). Waste disposal also poses a challenge due to heavy metals and the persistent organic substances they contain. Such substances have a devastating effect on the health of all living things.

Another basic barrier is the shortage of human resources, which are concentrated mainly in urban agglomerations. The intensive urbanization of China, which began after the launch of the "reform and opening up" policy[3] in 1979, triggered the large-scale flow of rural residents to cities. In 1980, only 19.4% of China's population lived in urban areas, while 66.2% were concentrated there by 2023.[4] When searching for career opportunities and a better quality of life, it was primarily able-bodied young men who flocked to the cities. As a result, the human potential of rural areas has been significantly weakened, which still affects the productivity of the industry and imposes significant restrictions on the development of these areas.

The rapid industrialization of the agricultural sector has also significantly affected the quality of food products in China. Although the government has launched reforms, implementation remains a challenge, resulting in weak links in the food safety chain. To solve these problems, the authorities have been implementing a set of strategies since 2004 to develop the agricultural sector and rural areas (Tung, 2016).[5] In 2021 the plans for digital[6] and green development were developed, and the target for achieving carbon neutrality has been set for 2060.[7]

[3] Gaigé kāifàng — in pin-ying transcription. This initiative continues to be implemented at the present time with the goal of optimally synthesizing the planned and market components in the national economy and increasing its openness to the outside world by maximizing trade opportunities.

[4] https://www.statista.com/statistics/278566/urban-and-rural-population-of-china/#:~:text=According%20to%20World%20Bank%2C%20a,population%20lived%20in%20urban%20areas, access date 14.07.2024.

[5] Priorities include: food security by strengthening domestic agricultural production and its modernization; increasing investment in water conservation; rural income growth; deepening rural land reform; improvement of infrastructure; improving the quality of management of the agricultural sector.

[6] The goal is to accelerate the pace digitalization in the industry. The focus is on three key areas: development of modern technological infrastructure, strengthening the digital transformation of agricultural production, business and services; improved management. To achieve them, measures have been developed: expanding the coverage of rural Internet networks; promoting the use of big data and artificial intelligence, development of e-commerce platforms; creation of centers for technical support and training of local personnel.

To control the composition of food products, the Chinese government has introduced the HACCP system (Hazard Analysis and Critical Control Points), certified by the UN Food and Agricultural Organization (FAO). It analyzes potential biological, chemical, and physical factors that arise throughout the production process, ensuring their compliance with the required standards (Lam et al., 2013).

As to bottom-up initiatives from food producers, the picture here is less clear. In order to clarify this, a team of researchers from the Renmin University of China, under the leadership of the author of this article, implemented a Foresight project in the middle of 2023. The focus group method was used, followed by thematic analysis. It was assumed that the exchange of views between the participants would stimulate a deep understanding of the external context, change the perception of its current situation and prospects as part of the transformation of the entire agricultural ecosystem, including the model employed for the sustainable development of rural regions (Braun, Clarke, 2006; Braun et al., 2022).

Methodology of the Study

Two focus groups were formed: a test group forming a representative sample of 16 discussants, and a control sample, with the same number of participants[8], whose task was to verify the saturation of the data collected by the first group (Hennink et al., 2017). Group meetings took place in Xichun (Jilin Province, northeastern China). The agenda included the selection of transformation strategy options for the considered region to achieve a healthy and economically successful ecosystem according to the sustainable development model.[9] In order for respondents to express their point of view as objectively and sincerely as possible, their privacy was guaranteed. As part of the discussion, open questions were asked, encouraging detailed and meaningful answers. The atmosphere of the meeting was conducive to stimulating a "sense of the future", motivation for deep, creative transformations, an intensive exchange of opinions, and the formation of a holistic vision of how to overcome long-standing problems and unlock existing potential. When processing the data, reflective thematic analysis was employed, as described in (Braun, Clarke, 2006; Braun et al., 2022). Three patterns of topics were identified from the discussions, which can be elaborated upon with subtopics based on their content and relevance to research questions. Let us take a closer look at them.

Results and Discussion

The discussions revealed that modern agricultural practices in China still largely follow traditional patterns, characterized by high labor intensity and an insufficient level of development of advanced technologies. Despite their openness to the consultants' recommendations, local professionals still lack specialized knowledge and competencies, and their attitudes are determined by the past. The idea of moving the sector toward a qualitatively new level of development (sustainable model) continues to be perceived as too radical and difficult to achieve, despite the current strategic initiatives of the government. Individuals in the 50+ age category showed the highest activity and interest in the discussions.

The successes and failures of current target programs were discussed. As achievements, respondents noted the government's efforts to support infrastructure and regulate prices for the sector's products. The weak points included the continuing outflow of the younger generation to urban agglomerations (despite the fact that its pace had slowed down at this time) and income inequality between the city and the countryside (Wang, Raymo, 2021).

Aiming to achieve carbon neutrality goals by 2060 is perceived by all participants as a requirement for radical transformation, the implementation of which represents a particularly complex challenge for all adaptive forces. For such a large-scale, complex, and inert system as agriculture, moving away from the past requires *more* time to rethink what is happening, abandon previous narratives, create new mental and cultural patterns that fit with long will and motivation necessary for difficult transitions to new, more complex development models.

Despite the fact that the Foresight project was local in nature and covered only two small focus groups, its undoubted advantage, in addition to addressing "big questions," was encouraging participants to deal with the future. Participants attempted to predict the impact of geopolitical tensions on the prospects for agricultural exports. All together, these factors create a significant driving force for transformative processes and the launch of new beginnings in the agricultural sector.

Conclusions and Recommendations

Thus, the discussions made it possible to produce a general idea of several options for solving current problems and overcoming limitations, and to outline a vision of a technological future. All this

[7] https://www.chinausfocus.com/energy-environment/chinas-carbon-commitment, accessed 18.05.2024.

[8] The focus groups included: rural residents (including former ones), employed both in the agricultural sector and in other industries, representatives of local governments.

fit into one basic scenario, implemented in three interconnected blocks: the transition of the sector to an entrepreneurial growth model; the development of human potential; and the contribution of the state to the transformation of the agricultural sector.

Transitioning Agriculture to the "Farm Modern Corporation" Model

The key driving force behind the transition seems to be the idea of a new social model, code-named "farmer modern corporation", the founders and shareholders of which can be all households localized in a particular region. Within its framework, all elements of the ecosystem are integrated, including agroforestry activities, infrastructure, and even related sectors that are not directly related to agriculture, but transform the lifestyle of rural areas. Strategic roadmaps are being produced for the development of priority technologies, the improvement of logistics infrastructure, the creation of centers for sharing agricultural machinery, the optimization of land use, the formation of consulting organizations, the introduction of "green financing" practices, and so on. Various options for the competency base of their implementation are being considered: developing the necessary skills among representatives of local government bodies, delegating powers to professional management companies for a certain period, or a combination of these options.

The listed measures are designed to create the prerequisites for increasing the attractiveness of rural areas for the active and working population. This idea can receive significant reinforcement from the current government digitalization program, which involves the transfer of all enterprises to a digital basis and the blockchain-based food safety control system HACCP.[10] The focus is on the relevant ministry (Ministry of Agriculture and Rural Affairs, MARA) and its pilot projects for all major Chinese provinces with a dominant agricultural sector in the structure of the regional economy.

Formation of Appropriate Human Potential

Although the income gap between urban and rural areas is gradually narrowing, urban agglomerations as a whole are still winning the competition for attracting the young Chinese population. The conditionally positive trend of "returning home" was launched by the Covid-19 pandemic forcing many people to leave the cities. However, such "pushing" drivers are temporary. In order for the "filling" of rural areas with attractive and decently paid jobs to lead to long-term effects, it is necessary to create strong driving forces of "pull". These could be modern medical and educational institutions, companies from the service sector not directly related to agriculture, local centers for the use of technologies (satellite sensing, monitoring using agro-drones, geospatial analytics), and gastronomic tourism.

The Role of the Government in the Transformation Processes

In addition to mobilizing significant intellectual and financial resources, the rural transformation will require regulatory reforms. For the previously mentioned "farmer corporation" initiative to be carried out smoothly, interdepartmental cooperation must be ensured. Joining MARA efforts to those of related departments and the National Development and Reform Commission (NDRC)[11] is seen as a possible option. This would be carried out under the overall coordination of the State Council of China, which possesses complete organizational, personnel, financial, and legal resources. The framework for the near future is the Green Agricultural Development Plan, containing a set of measures in five key areas: the use of natural resources, habitat, agricultural ecosystems, the production of environmentally friendly products, and the reduction of carbon emissions.[12]

The described study, like any other, has its methodological limitations. Some of them were taken into account during the process, others must be eliminated in the future. Among the limitations, the focus group method works only with a small amount of respondents whose opinions may not correspond to the position of the majority of the population. Convening more focus groups with different participants could increase the reach and representativeness of the sample (Fereday et al., 2006).[13]

The conclusions and recommendations presented here serve as a general foundation and are subject to contextual adaptations for decision-makers and stakeholders facing identical or similar problems.

---

[9] Including issues of environmental pollution, urban-rural income inequality and aging populations.

[10] https://cqc.com.cn/www/english/ManagementSystemCertification/OHSASyblly/CertificationScope/, access date 19.05.2024.

[11] Department of the State Council at the ministerial level, responsible for implementing national policies and decisions on development and reform.

[12] The current 14th five-year plan has been developed with a horizon until 2025. An increase of up to 60% is expected the share of agricultural land equipped with effective irrigation facilities, reducing the use of chemical fertilizers and pesticides by 20%, improving the quality of the ecological environment in rural areas, improving the provision of social infrastructure. More details: https://www.fao.org/faolex/results/details/en/c/LEX-FAOC205820/#:~:text=By%202025%2C%20China%20will%20strive,ability%20of%20emission%20reduction%20and, access date 16.07.2024.

[13] This applies both to China and other countries with significant rural populations, such as Indonesia, India or Vietnam.

References

Ahmed Z., Shew A., Nalley L., Popp M., Green V.S., Brye K. (2024) An examination of thematic research, development, and trends in remote sensing applied to conservation agriculture. *International Soil and Water Conservation Research,* 12(1), 77–95. https://doi.org/10.1016/j.iswcr.2023.04.001

Braun V., Clarke V. (2006) Using thematic analysis in psychology. *Qualitative Research in Psychology,* 3(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Braun V., Clarke V., Hayfield N., Davey L., Jenkinson E. (2022) *Doing Reflexive Thematic Analysis*. In: *Supporting Research in Counselling and Psychotherapy* (eds. S. Bager-Charleson, A. McBeath), Cham: Palgrave Macmillan. https://doi.org/10.1007/978-3-031-13942-0_2

Cai S., Zuo D., Yang H. (2023) Assessment of agricultural drought based on multi-source remote sensing data in a major grain producing area of Northwest China. *Agricultural Water Management,* 278, 108142. https://doi.org/10.1016/j.agwat.2023.108142

Carlsen A.H., Fensholt R., Looms M.C., Gominski D., Stisen S., Jepsen M.R. (2024) Systematic review of the detection of subsurface drainage systems in agricultural fields using remote sensing systems. *Agricultural Water Management,* 299, 108892. https://doi.org/10.1016/j.agwat.2024.108892

Chen X., Pan H., Liu C., Jiang Z. (2018) Agricultural Remote Sensing and Data Science in China. In: *Federal Data Science: Transforming Government and Agricultural Policy Using Artificial Intelligence* (eds. F.A. Batarseh, R. Yang), New York: Academic Press, pp. 95–108.

Chen Y.F., Huang X.J., Wang L.J. (2018) China's rural revitalization and its evaluation from the perspective of multifunctional theory. *Chinese Journal of Agricultural Resources and Regional Planning*, 39, 201–209. (In Chinese).

Cho J., Kim C., Lim K.J., Kim J., Ji B., Yeon J. (2023) Web-based agricultural infrastructure digital twin system integrated with GIS and BIM concepts. *Computers and Electronics in Agriculture,* 215, 108441. https://doi.org/10.1016/j.compag.2023.108441

Chunjiang Z., Li J., Xian F. (2021) Development Strategy of Smart Agriculture for 2035 in China. *Strategic Study of CAE,* 23(4), 1-009. https://doi.org/10.15302/J-SSCAE-2021.04.001

Duff H., Hegedus P.B., Loewen S., Bass T., Maxwell B.D. (2022) Precision agroecology (Review). *Sustainability,* 14(1), 106. https://doi.org/10.3390/su14010106

Ehlers M.F., Finger R., El Benni N., Gocht A., Sørensen C., Gusset M., Pfeifer C., Poppe K., Regan A., Rose D.C., Wolfert S., Huber R. (2022) Scenarios for European agricultural policymaking in the era of digitalization. *Agricultural Systems,* 196, 103318. https://doi.org/10.1016/j.agsy.2021.103318

Fang Y.G., Liu J.S. (2015) Diversified agriculture and rural development in China based on multifunction theory: Beyond modernization paradigm. *Acta Geographica Sinica*, 70, 257–270. https://doi.org/10.11821/dlxb201502007

Fereday J., Adelaide N., Australia S., Eimear Muir-Cochrane A. (2006) Demonstrating Rigor Using Thematic Analysis: A Hybrid Approach of Inductive and Deductive Coding and Theme Development. *International Journal of Qualitative Methods,* 5(1), 80–92. https://doi.org/10.1177/160940690600500107

Hennink M.M., Kaiser B.N., Marconi V.C. (2017) Code Saturation Versus Meaning Saturation: How Many Interviews Are Enough? *Qualitative Health Research,* 27(4), 591–608. https://doi.org/10.1177/1049732316665344

Huang H. (2020) Learning from exploratory rural practices of the Yangtze River Delta in China: New initiatives, networks and empowerment shifts, and sustainability. *Journal of Rural Studies,* 77, 63–74. https://doi.org/10.1016/j.jrurstud.2020.04.019

Huang J., Yang G. (2017) Understanding recent challenges and new food policy in China. *Global Food Security*, 12, 119–126. https://doi.org/10.1016/j.gfs.2016.10.002

Huang Y., Chen L., Li X. (2022) Productivism and Post-Productivism: An Analysis of Functional Mixtures in Rural China. *Land,* 11(9), 1490. https://doi.org/10.3390/land11091490

Husaini A.M., Sohail M. (2022) Robotics-assisted, organic agricultural-biotechnology based environment-friendly healthy food option: Beyond the binary of GM versus Organic crops. *Journal of Biotechnology,* 361, 41–48. https://doi.org/10.1016/j.jbiotec.2022.11.018

Jiang B., Chen Y.Y., Zhu X.D., Cheng B. (2022) Ecosystem services research and its application in land use planning and management. *Chinese Journal of Ecology,* 41, 2263–2270 (in Chinese).

Kok A., Oostvogels V.J., de Olde E.M., Ripoll-Bosch R. (2020) Balancing biodiversity and agriculture: Conservation scenarios for the Dutch dairy sector. *Agriculture, Ecosystems & Environment*, 302, 107103. https://doi.org/10.1016/j.agee.2020.107103

Lam H.-M., Remais J., Fung M.-C., Xu L., Sun S.S.-M. (2013) Food supply and food safety issues in China. *The Lancet,* 381(9882), 2044–2053. https://doi.org/10.1016/s0140-6736(13)60776-x

Li Y., Jia L., Wu W., Yan J., Liu Y. (2018) Urbanization for rural sustainability – Rethinking China's urbanization strategy. *Journal of Cleaner Production,* 178, 580–586. https://doi.org/10.1016/j.jclepro.2017.12.273

Lin R.Q., Cai Y.L. (2012) Study on rural multifunction and landscape reformulation in the transitional period. *Human Geography*, 27, 45–49 (in Chinese).

Liu C. (2014) Population ageing in Hollow Villages: A perspective from urban rural restructuring in China. *Territorio*, 69, 134–142. https://doi.org/10.3280/TR2014-069019

Liu C., Cheng L., Li J., Lu X., Xu Y., Yang Q. (2023) Trade-offs analysis of land use functions in a hilly-mountainous city of northwest Hubei province: The interactive effects of urbanization and ecological construction. *Habitat International,* 131, 102705. https://doi.org/10.1016/j.habitatint.2022.102705

Liu N. (2024) *China's Smart Agriculture Boom Has Tech Potential but Requires Affordable Solutions*. https://geoawesome.com/chinas-smart-agriculture-boom-has-tech-potential-but-requires-affordable-solutions/, accessed 05.08.2024

Long H. (2022) Theorizing land use transitions: A human geography perspective. *Habitat International,* 128, 102669. https://doi.org/10.1016/j.habitatint.2022.102669

Ma W., Jiang G., Li W., Zhou T., Zhang R. (2019) Multifunctionality assessment of the land use system in rural residential areas: Confronting land use supply with rural sustainability demand. *Journal of Environmental Management*, 231, 73–85. https://doi.org/10.1016/j.jenvman.2018.09.053

Mccarthy J. (2005) Rural geography: Multifunctional rural geographies — Reactionary or radical? *Progress in Human Geography*, 29, 773–782. https://doi.org/10.1191/0309132505ph584pr

Newbold T., Hudson L.N., Arnell A.P., Contu S., De Palma A., Ferrier S., Hill S.L., Hoskins A.J., Lysenko I., Phillips H.R., Burton V.J., Emerson S., Gao D., Pask-Hale G., Hutton J., Jung M., Sanchez-Ortiz K., Simmons B., Whitmee S.,Zhang H, Scharlemann J.P.W., Purvis A. (2016) Has land use pushed terrestrial biodiversity beyond the planetary boundary? A global assessment. *Science,* 353, 288–291. https://doi.org/10.1126/science.aaf2201

Onwuegbuzie A.J., Dickinson W.B., Leech N.L., Zoran A.G. (2009) A Qualitative Framework for Collecting and Analyzing Data in Focus Group Research. *International Journal of Qualitative Methods,* 8(3), 1–21. https://doi.org/10.1177/160940690900800301

Parkin S., Kimergård A. (2022) A critical analysis of respondent quotes used as titles of qualitative research papers that are published in peer-reviewed journals. *Accountability in Research,* 29(2), 109–132. https://doi.org/10.1080/08989621.2021.1901224

Polzin C. (2024) The role of visions in sustainability transformations: Exploring tensions between the Agrarwende vanguard vision and an established sociotechnical imaginary of agriculture in Germany. *Global Environmental Change*, 84, 102800. https://doi.org/10.1016/j.gloenvcha.2024.102800

Purnhagen K.P., Clemens S., Eriksson D., Fresco L.O., Tosun J., Qaim M., Visser R.G.F., Weber A.P.M., Wesseler J.H.H., Zilberman D. (2021) Europe's Farm to Fork Strategy and Its Commitment to Biotechnology and Organic Farming: Conflicting or Complementary Goals? *Trends in Plant Science,* 26(6), 600–606. https://doi.org/10.1016/j.tplants.2021.03.012

Rejeb A., Abdollahi A., Rejeb K., Treiblmaier H. (2022) Drones in agriculture: A review and bibliometric analysis. *Computers and Electronics in Agriculture,* 198, 107017. https://doi.org/10.1016/j.compag.2022.107017

Sgroi F. (2022) The circular economy for resilience of the agricultural landscape and promotion of the sustainable agriculture and food systems. *Journal of Agriculture and Food Research,* 8, 100307. https://doi.org/10.1016/j.jafr.2022.100307

Tung R.L. (2016) Opportunities and Challenges Ahead of China's "New Normal". *Long Range Planning*, 49(5), 201649. https://doi.org/10.1016/j.lrp.2016.05.001

Wang X., Raymo J. (2021) The Great Migration and the Urban-Rural Divide: Lonely Life Expectancy in China. *Innovation in Aging,* 5(S1), 37. https://doi.org/10.1093/geroni/igab046.139

Wang C.W., Gu H.Y. (2012) Productivism? Post-productivism? — On the changes and choices of agricultural policy concepts in New China. *Reforming Economical Systems,* 64–68 (In Chinese).

Weber H., Sciubba J.D. (2019) The effect of population growth on the environment: Evidence from European regions. *European Journal of Population,* 35, 379–402. https://doi.org/10.1007%2Fs10680-018-9486-0

Wiggering H., Dalchow C., Glemnitz M., Helming K., Müller K., Schultz A.; Stachow U., Zander P. (2006) Indicators for multifunctional land use — Linking socio-economic requirements with landscape potentials. *Ecological Indicators,* 6, 238–249. https://doi.org/10.1016/j.ecolind.2005.08.014

Wilson G.A. (2001) From productivism to post-productivism and back again? Exploring the (un)changed natural and mental landscapes of European agriculture. *Transactions of the Institute of British Geographers*, 26, 77–102. https://doi.org/10.1111/1475-5661.00007

Wilson G.A. (2007) *Multifunctional Agriculture: A Transition Theory Perspective,* Wallingford (UK): CAB International.

Wilson G.A. (2014) Community resilience: Path dependency, lock-in effects and transitional ruptures. *Journal of Environmental Planning and Management,* 57, 1–26. https://doi.org/10.1080/09640568.2012.741519

World Bank (2023) *Four Decades of Poverty Reduction in China: Drivers, Insights for the World, and the Way Ahead, Washington*, D.C.: World Bank.

Xu T., Chen H., Ji Y., Qiao D., Wang F. (2023) Understanding the differences in cultivated land protection behaviors between smallholders and professional farmers in Hainan Province, China. *Frontiers in Sustainable Food Systems,* 7, 1081671. https://doi.org/10.3389/fsufs.2023.1081671

Xue L., Peng C., Xu D., Guo Y., Wang Q., Zheng X., Han R., You A. (2023) Agricultural land suitability analysis for an integrated rice–crayfish culture using a fuzzy AHP and GIS in central China. *Ecological Indicators,* 148, 109837. https://doi.org/10.1016/j.ecolind.2022.109837

Zang Y., Liu Y., Yang Y., Woods M., Fois F. (2020) Rural decline or restructuring? Implications for sustainability transitions in rural China. *Land Use Policy*, 94, 104531. https://doi.org/10.1016/j.landusepol.2020.104531

Zhang Y., Long H., Li Y., Tu S., Jiang T. (2020) Non-point source pollution in response to rural transformation development: A comprehensive analysis of China's traditional farming area. *Journal of Rural Studies,* 83, 165–176. https://doi.org/10.1016/j.jrurstud.2020.10.010

Adapting to Disruptive Changes in the Digital World: Management Consulting Majors

Alexey Bereznoy

Director, Centre for Industrial Market Studies and Business Strategies, abereznoy@hse.ru

Institute for Statistical Studies and Economics of Knowledge, National Research University Higher School of Economics (HSE University), 11, Myasnitskaya str., Moscow 119071, Russian Federation

Abstract

Management consulting is one of the most dynamically growing sectors of the modern global economy, characterized by a very high resilience to the fluctuations of the macroeconomic environment. Nevertheless, a number of prominent researchers note the disruptive trends in the global consulting industry and predict the disruptive effects of the realization of these trends for the traditional leaders of the consulting business due to the spread of digital technologies, especially big data analytics and artificial intelligence. In an effort to understand the validity of such assessments, the author of this article consistently analyzes the features of the evolution of the management consulting industry landscape, examines the key factors of disruptive changes that deepening digitalization brings to the consulting industry, and considers the main mechanisms used by global industry leaders to adapt to the rapidly evolving digital environment. It is concluded that, despite the challenges of the digital transformation, these leaders not only continue to grow dynamically, maintaining their dominant positions on global markets, but are also very active in penetrating new market segments emerging in the face of digital shifts.

Keywords: management consulting industry; disruptive innovation; digital transformation of consulting; factors of disruptive change

Citation: Bereznoy A. (2024) Adapting to Disruptive Changes in the Digital World: Management Consulting Majors. *Foresight and STI Governance*, 18(3), pp. 16–27. DOI: 10.17323/2500-2597.2024.3.16.27

Introduction

Management consulting became an industry in its own right in the 1950s, displaying high growth rates and resilience to external challenges.[1] However, since approximately the mid-2010s numerous researchers have noted the emergence of disruptive trends in the industry, along with growing risks to traditional business models, associated with the wide adoption of digital technologies, especially big data (BD) analytics and artificial intelligence (AI) (Christensen et al., 2013).[2] The interest in long-term shifts in the industry is not purely academic: it is largely due to the role professional consultants play in strategic decision-making by owners and top managers of the world's largest corporations and banks. Demand for consulting services is also growing in the public sector in the leading countries of the world, and at major international organizations (including the UN's specialized agencies), which increases their impact upon public policy and international relations.

In the context described above, a balanced analysis of shifts in the management consulting industry landscape seems to be very relevant. The key factors of disruptive changes that advanced digital solutions bring to global industry leaders (majors), and the main mechanisms the latter apply to adapt to digital transformation challenges, deserve particular attention. The insufficient coverage of the topic in the extant academic literature (Cerutti et al., 2019; Larsson et al., 2019) gives additional value to the study. The paper analyzes the specific features of the management consulting industry, which determine its structural dynamics. The key factors of disruptive change associated with the deepening digital transformation of the industry are considered, along with the approaches major companies take to adapt to these changes.

Disruptive Innovation in the Consulting Industry: Conceptual Framework and Industry Specifics

Developed by Harvard professor Clayton Christensen, the theory of disruptive innovation (further referred to as disruption theory) has become one of the more prominent management concepts of recent decades.[3] In general terms, it describes the structural transformation of industrial markets accompanied by the replacement of previous leaders – owners of well-known brands applying advanced management systems – by newcomer firms that find existing, or newly emerging, untapped niches and, by developing certain innovations, reshape the markets in their favor (Christensen, 1997; Christensen et al., 2018). Essentially, Christensen's concept describes how in certain situations the once-great companies fail, despite their utmost sensitivity to customer needs and their generous investments in advanced technologies.

In a typical scenario described by the theory, newcomer firms (which have much fewer resources) can not only challenge established players, but replace them as industry leaders. The key aspect of a radical transformation (disruption) of the existing market structure is the emergence of new niches open for the newcomers, while the incumbents remain passive. Disruption theory links this process to incumbents' economically determined focus on improving technologies, products, and services in the segments offering the highest profit margins, with the most stringent requirements for products' advanced functionality. As a result, less profitable segments (comprising less affluent and less demanding customers) remain relatively free from competitive pressures. That is where new players are rushing with functionally simpler and relatively cheaper products, which subsequently begin to penetrate the upper market segments by improving customer value. At the same time the newcomers maintain their price advantages, which determined their initial success. When the bulk of customers switch to the newcomers' products, one can talk about market disruption.

The validity of the disruption theory has been tested in various industries (Christensen, Bower, 1996; McKendrick et al., 2000; Danneels, 2011), but subsequent independent analysis has questioned the original conclusions (King, Baatartogtokh, 2015). More accurate testing through a series of dedicated surveys and expert interviews provided a detailed picture of all 77 cases that Christensen cited as examples of disruptive innovations (Christensen, 1997). The test results turned out to be unexpected: only seven cases (9% of the total sample) reproduced the key elements of the industry market transformation process described by the disruption theory relatively accurately. In the vast majority of cases (91%), one or more of these elements were missing, which was confirmed by further research (Si, Chen, 2020). In other words, the presence of visible signs does not mean that disruption is inevitable: in many cases, the industry specifics significantly affect both the disruptive transformation processes and their outcomes (Kharlov, 2020).

[1] https://www.mca.org.uk/press-releases/management-consultancy-sector-responds-quickly-to-recession, accessed on 15.11.2023.

[2] See also: https://www.inc.com/soren-kaplan/the-business-consulting-industry-is-booming-and-it.html, accessed on 17.12.2023.

[3] https://www.economist.com/books-and-arts/2011/06/30/aiming-high, accessed on 18.11.2023.

Looking at the management consulting industry through the lens of disruption theory raises a number of interrelated questions: How do disruptive trends develop in this industry? What industry-specific factors affect these processes? Can these factors redefine the nature of market transformation? A former professional consultant himself, Christensen could not ignore this industry, and in 2013 he co-authored a research paper on this topic (Christensen et al., 2013). According to the research, the development of the global consulting industry perfectly fits into the framework of this theory, and traditional market leaders will inevitably face the destructive consequences of disruptive innovations. Without going into details of the analysis carried out by the authors of the paper, we note that their conclusions were based on interpreting the actual changes in the global management consulting industry at the turn of the 20th and 21st centuries, and paying particular attention to its specific features, which for many decades made it immune to disruptive processes. First of all, we are talking about the low transparency of the consulting business, with clients not thoroughly understanding both the nature of services they have purchased (consulting products), and especially their pricing mechanisms. Secondly, the majors' high adaptability allows them to push customers toward solutions to an ever-growing number of management issues, thus avoiding the threats of disrupting the existing industry structure.

According to Christensen et al., the emerging shifts in the management consulting should soften the industry specifics, opening the way to transformation processes in line with disruption theory. In particular, the business opacity factor will be eliminated by democratizing access to the knowledge and analytics which underpin consulting products. It is not only about the growing amount of various business-related data, the gathering and processing of which are becoming increasingly easy (and affordable) due to the wide adoption of broad-band internet and digital analytics. The number of highly skilled and experienced professionals in consulting firms is growing. The dissemination of knowledge about the nature of their activities allows clients to split consulting projects into specific tasks and select different companies to carry out each of those. Thus, increasingly more customers can turn to small contractors, without having to rely on industry leaders traditionally focused on big projects (such as strategic business restructuring, digital transformation, etc.). Orders may be allocated among smaller firms specializing in specific areas. This way clients promote small and medium-sized market players, often established by former staff members of industry giants. Such compact teams comprising experienced consultants are able to provide competitive services at much lower costs due to their lower overheads. Quite frequently, they move from serving small clientele to more profitable consulting market segments, thus implementing the disruption theory growth model.

Christensen and his followers saw significant potential for disrupting consulting's traditional development path in business development analytics technologies. A number of researchers noted the opportunity to automate routine elements of consulting services for which the solution development process is well-known and largely standardized (Curuksu, 2018). The advantages of such technologies, especially the high speed of processing huge amounts of data at lower costs, might help reduce entry barriers for new companies on a market dominated by the strong brands of traditional industry leaders.

Competitive Landscape and Shifts in the Industry Structure

A decade has passed since Christensen et al. published their work promising a radical and inevitable transformation of the consulting industry. This is long enough to assess not only how the actual changes in the industry match the classic scenario of disruption theory, but also the consequences of these changes for a small group of majors and the latter's prospects for maintaining their positions. In recent years, a growing number of publications have linked disruptive trends in the consulting industry with the rapid development and broad adoption of AI,[4] which demands a serious rethinking of the practical implementation of disruption theory.

Though identifying trends in management consulting poses certain challenges,[5] the available information, albeit incomplete and ambiguous, still allows one to determine the distinct characteristics of and the more significant changes in the industry landscape. First of all, despite the differences in its absolute estimates, almost all researchers note the global industry's high growth rate: until recently it grew very quickly, significantly outpacing most of the world's leading economies. While in 1991 the global revenue from management consulting services were estimated at only 25.3 billion USD (UN, 1993), in 2011, according to the most conservative estimates, it reached 107 billion USD, and in 2019 this figure already reached 160 billion USD.[6] The

[4] https://www.newyorker.com/science/annals-of-artificial-intelligence/will-ai-become-the-new-mckinsey, accessed on 17.12.2023.

[5] There are no generally accepted management consulting statistics, the available data on key industry indicators can vary significantly, sometimes by orders of magnitude. Most often this is due to major differences in defining the industry, its boundaries, and the types of services provided.

[6] https://www.consultancy.uk/news/24659/market-sise-of-the-global-consulting-industry-in-2020, accessed on 15.12.2023.

industry has successfully survived all the global economy crises of recent decades. The only exception was 2020, when the pandemic led to a one-time 17.5% annual revenue loss, but in 2021 rapid growth resumed,[7] and according to all existing forecasts, it will continue at least until the end of the current decade.[8]

The consulting industry has a distinct two-tier structure. At the lower level there are small businesses and individual entrepreneurs, distributed across many highly specialized segments, and with a short life cycle due to intense competition.[9] This is explained by low market entry barriers in terms of required investments in tangible assets and regulatory restrictions (in most countries, management consulting is an unlicensed activity). The top tier is dominated by a small group of multinational giants which control the bulk of the market: in 2018, just five global majors accounted for almost 43% of global consulting revenues, and the top ten accounted for 56.6%.[10] According to Gartner analytics, in 2022 , the 20 largest companies accounted for 68.5% of the global consulting services market, and their share continues to grow (Gartner, 2022).

Such an industry structure, combined with a high growth rate, strong competition, and a constant influx of new ambitious players at the lower levels, appears to be particularly favorable for a radical transformation in line with disruption theory. However, this does not happen in reality; on the contrary, the global majors have been effectively resisting competitive pressure from smaller market players for decades. This does not mean that the global consulting industry is somehow immune to serious structural changes; the industry's current configuration is largely determined by such transformations, but they did not occur according to the classic scheme described in Christensen's theory.

The first of these structural shifts, which have seriously shaken the majors' positions, was the massive entry of international accounting firms onto the consulting market. During the industry's initial development (in the 1950s-1960s) the group of leaders comprised only major companies specializing in strategic consulting services,[11] including McKinsey, and (somewhat later) Boston Consulting Group (BCG) and Bain. The situation started to change quickly with the leading accounting firms entering the industry in the 1970s. Offering management consulting services in addition to traditional audits, they quickly became leaders in the operations consulting segment, which soon became the most profitable part of the business. Having increased consulting services' high profit margins, they began to actively diversify into strategic consulting as well. All these developments took place along with the consolidation of the international accounting firms themselves, whose elite group, following a series of large-scale mergers and acquisitions, has consistently narrowed from the "Big Eight" in the early 1980s to "Big Six" in the early 1990s, and the "Big Four" in the 2000s (Deloitte, EY, KPMG, and PWC).

The next dramatic shift in the structure of the global consulting business occurred at the end of the 1980s and during the first half of the 1990s, caused by the introduction of the so-called integrated information systems (ERP class) into the industrial sector; many experts believe it marked the initial phase of industrial firms' digitalization. These systems allowed managers to use key company resources (material, financial and human) much more efficiently, and to do so in an integrated way. The strong demand for such software solutions resulted in the emergence of a separate IT consulting segment, which provided a new powerful growth driver for the global consulting industry.

Major international accounting firms and their corporate successors (primarily Accenture and IBM) were the first to appreciate the potential of this new business area. They already had specialists with the necessary qualifications in operational consulting and IT and captured the most profitable market segments. The Big Four's management consulting revenues during this period began to approach those of their core audit services. This group of companies quickly became the world leaders in terms of revenues from consulting services, far ahead of the Big Three leading strategic consultants (Figures 1 and 2).

The new phase of the digital revolution, which began at the turn of the 21st century, also significantly boosted demand for IT consulting services. While in 2016 the global IT consulting market was estimated at 48 billion USD, by 2023 it grew almost 50% reaching 70.7 billion USD.[12] A new segment,

[7] https://www.statista.com/statistics/936889/management-consultancies-worldwide-annual-revenue-growth/, accessed on 18.12.2023.

[8] https://www.reportlinker.com/p06193734/Management-Consulting-Services-Global-Market-Report.html, accessed on 15.11.2023.

[9] For example, according to official statistics, about 80% of the US consulting firms cease operations within the first two years, i.e. their life cycle is much shorter than in other industries (https://www.consultingbusinessschool.com/whats-with-the-high-failure-rate-of-consulting-startups/, accessed on 11.05.2024).

[10] https://www.statista.com/statistics/624204/market-share-of-leading-consulting-firms-worldwide/, accessed on 17.12.2023.

[11] Management consulting covers three main areas. These include strategic consulting: long-term planning of company development, including corporate-, functional-, and production-related strategies, industrial market studies, large-scale restructuring, etc.; operations consulting: dealing with operational management issues, including management accounting and reporting, various aspects of internal financial management, business processes re-engineering, supply chain management improvement, organizational changes, cost cutting, etc.; and information management (IT) consulting: the implementation of information (digital) systems to support core management functions, or corporate management as a whole.

digitalization-related services, was growing in recent years at a particularly high rate. In 2016-2023 its volume increased 180% from 23 to 65.4 billion USD.[13] Despite the ongoing shifts in the global consulting industry's product structure, the positions of traditional leaders in new market segments were only strengthening.

A small and stable group of major companies has emerged at the top tier of the management consulting industry, far outpacing other industry players in terms of their "market clout". This group's growth patterns clearly contradict disruption theory: the traditional leaders are not being pushed out, and the segment is growing not because of the lower-tier newcomers' improvement, but due to the entry of similar-size players from other industries. Accordingly, in the absence of new rivals capable of shaking their positions, the majors demonstrated consistently high growth rates for decades. This configuration indicates that these companies are highly capable of making use of their unique competencies to develop and apply effective strategies and tactical tools to counter disruptive trends.

Main Factors of Disruptive Change and Adaptation Mechanisms

The current consulting industry structure disproves numerous forecasts about the inevitable change of industry leaders, which forces us to take a closer look at the main drivers of disruptive change in the context of digital transformation. Previous analysis identified two types of disruptive processes (Gans, 2016). The first works on the *demand* side, when traditional industry leaders cannot meet demand in certain market segments (in line with the classic disruption theory scenario). The second process develops on the *supply* side, when emerging technologies and other innovations offered by new service providers devalue the incumbents' existing competencies and products.

An analysis of the current state of the management consulting industry indicates that its majors are affected by both types of disruptive change factors (Figure 3).

Demand-Side Factors

The main clients of consulting firms are large industrial corporations and banks; they are interested in significant cost reduction in consulting services and strive to apply various instruments of control over these activities. One such instrument is multi-sourcing (allocating consulting projects among multiple contractors on a competitive basis), with the participation of former professional consultants. Some tasks are delegated to firms' own employees, or in-house consultants. Efforts are being made to improve pricing transparency. The effectiveness of such techniques, and as a result, customers' motivation to use them, have increased significantly due to the digital transformation: information about the capabilities and competencies of specific consulting firms, and the quality of their services has become much more available (among other things through client reviews posted on social networks[14]). The market has become much more democratic due to the broad adoption of techniques for working with specialized business information. Applying various data search and processing tools is much easier allowing clients to develop their own competencies in this area.

Market demand for data-driven products, and for new service-based business models has made developing of such competencies a strategic imperative for many companies operating in traditional industries (Stahl et al., 2023). It is no coincidence that in recent years many industrial enterprises and financial institutions have stepped up the hiring of former professional consultants, especially those with specialized data-processing knowledge and skills. Such employees became the core of rapidly growing in-house consulting divisions, which perform relevant functions instead of third-party providers. Such practices have already increased competition between market players, along with industry majors' noticeably reduced ability to impose exclusive multi-year contracts worth tens, and sometimes hundreds, of millions of dollars upon clients.

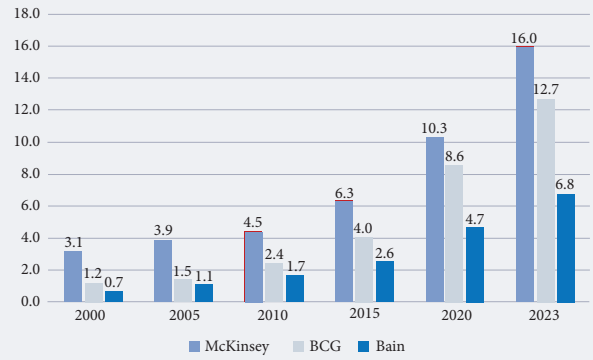
However, the disruptive potential of in-house consulting has its limitations. In the event of serious challenges, the organization's own consultants cannot replace independent professionals due to the inevitable conflicts of interest. As global experience shows, even the most experienced and qualified management consultants, once employed by an organization, cease to impartially assess its issues and suggest optimal solutions without regard to their own career prospects (Davison, 2009).

The largest consulting clients, dissatisfied with the traditional approach to the pricing of consulting services (based on fixed hourly rates and accurate recording of consultants' working hours), became the main champions of novel pricing models. The disadvantages of classic pricing include the opaque calculation of consultants' time, and the lack of a clear correlation between their remuneration and

[12] https://www.consultancy.org/consulting-industry/it-consulting, accessed on 28.12.2023.

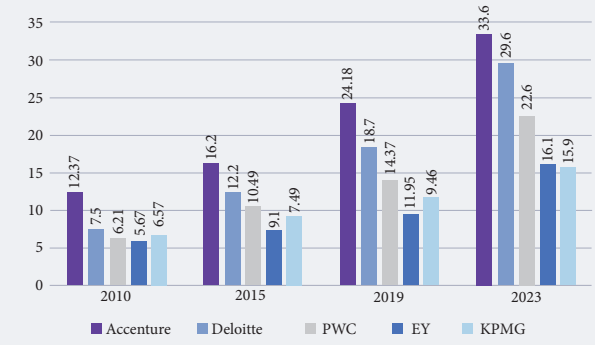
[13] https://www.preplounge.com/en/articles/digital-transformation-consulting, accessed on 17.11.2023.

Figure 1. The "Big Three" Strategic Consulting Companies' Revenue Growth, *billion USD*



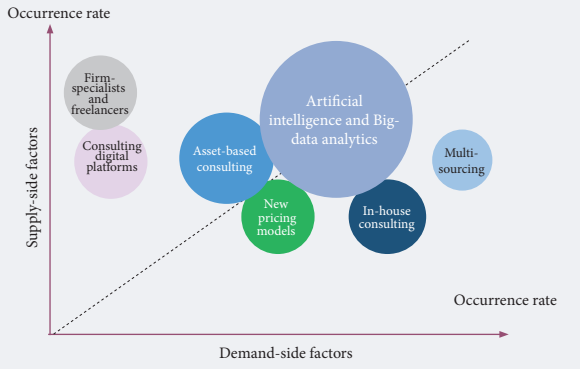
Source: author, based on data from *The Economist* (https://www.economist.com/business/2022/10/04/where-next-for-managements-consiglieri, accessed 28.12.2023; https://www.economist.com/business/2024/03/25/have-mckinsey-and-its-consulting-rivals-got-too-big, accessed 21.04.2024).

Figure 2. Accenture and the Big Four International Accounting Companies' Revenue from Management Consulting Services services, *billion USD*



Source: author, based on data from Traceview Finance and Statista (https://traceviewfinance.com/working-at-big-4-firm-a-comprehensive-guide/, accessed 28.12.2023; https://www.statista.com/statistics/327456/revenue-of-accenture-plc-by-business-line/, accessed 28.12.2023).

Figure 3. Main Factors of Disruptive Change in the Global Consulting Industry



Note: the bubble size reflects comparative assessments of specific factors' the disruptive potential.

Source: author, based on (Nissen, 2018; Birkinshaw, Lancefield, 2023).

the outcomes achieved. Trying to find alternative approaches, many large consulting firms have proposed linking service fees to client performance indicators such as costs, sales, or even market capitalization.

In most cases, such efforts tend to have limited and contradictory results, not so much due to inefficient pricing models as to the serious risks that the implementation of such schemes entails for all parties. In particular, consultants must convincingly substantiate their contribution to the changes in the client company's various performance indicators, which are also affected by many other factors such as market conditions, employees' actions taken on their own initiative, and so on. No less serious risks arise for consulting firms' customers, because performance-based schemes linking compensation to tangible results often undermine the consultants' objectivity and independence. Being financially interested in rapid gains, they may underestimate the long-term effects of their recommendations.[15]

Taking into account the above risks, it is hardly surprising that, despite growing pressure from large clients to change traditional pricing models, the share of reward-based pricing contracts remains relatively small, at 12-15%.[16]

Supply-Side Factors

A notable trend in the global consulting industry in recent years has been the growing role of supply-side disruptors, which often pose greater threats to industry leaders than demand-side factors. First of all, we are talking about the growth of specialized consulting services offered by small firms and independent individual players. Unlike the market majors who offer a wide range of services to potential clients from various industries, specialized consultants' supply is limited and focused on demand from companies in one or two sectors. This focus and low overheads allow small firms and freelancers to successfully compete oun the consulting market on the basis of their deep industry knowledge and attractive pricing.

The traditional clientele of independent players are small and medium-sized businesses, which cannot afford the expensive services of the majors. However, current demand for specialized consulting is increasingly coming from large industrial firms and financial institutions interested in deal-

[14] https://hingemarketing.com/blog/story/top-5-business-challenges-for-management-consulting-firms, accessed on 17.12.2023.

[15] https://consultantjournal.com/blog/setting-consulting-fee-rates, accessed on 11.02.2024

ing with digital transformation challenges. These issues are highly specialized and require deep industry knowledge and experience that the global leaders often lack; they can be handled by relatively inexpensive specialists with relevant qualifications (Consulting.us, 2019).

The growth of specialized consulting is also connected with the increasingly important role that freelancing plays on the skilled labor market.[17] According to a Verified Market Research (2024), in 2020 the global freelance market amounted to 3.8 billion USD, and by 2028 it is expected to exceed 12 billion USD. Another growth driver was the emergence of digital consulting platforms. Initially created to facilitate bringing performers and customers together, such platforms quickly gained popularity and became a distinct supply-side disruptive factor on the global consulting services market. As a special survey of almost 700 top managers of the largest US companies showed (Fuller et al., 2020), in 2009-2020 the number of digital platforms for freelance consultants grew from 80 to more than 330. Over 60% of the respondents reported actively using such platforms to hire consultants, and almost 50% of executives expected their use of this tool to increase in the future.[18]

However, despite the noted growing importance of specialized consulting, independent players, and freelancers, along with digital consulting platforms, they do not pose a serious threat to the hegemony of the global majors. Firstly, neither independent firms nor (especially) freelancers, even those who join forces in professional teams run by experienced managers, have the necessary competencies and, most importantly, sufficient trust of major clients to be given complex large-scale projects which represent the real target of global industry leaders.[19] Secondly, the specialized consulting market players themselves do not seek to compete with traditional leaders, preferring rather to cooperate with them, supplementing their project teams with specialist expertise in specific areas. In turn, the majors use independent consultants to strengthen their market positions, compensating for gaps in specialized knowledge (industry-related, technological, digital, etc.) as may be necessary, or simply strengthening their own resources in case they turn out to be insufficient. It is no coincidence that traditional consulting companies' demand for freelance services through recruiting platforms has recently been growing at its highest rate to date.[20]

Many researchers link the prospects of traditional major industry players losing their leadership positions to the growth of so-called asset-based consulting (ABC). Although the ABC concept remains largely debatable, a number of its elements do reflect the current changes in the industry. Unlike the classic management consulting, which mainly relies upon skilled human resources with their knowledge, experience, and creativity, ABC focuses on monetizing reusable assets: various techniques, templates, analytical approaches, digital tools, and special applications increasingly used in consulting. By transforming such codified knowledge into intellectual assets, consulting firms can use them over and over again to solve the management issues of multiple clients, thus saving significant amounts of resources and stepping up their consultants' productivity.

One of the key aspects of the ABC concept is the "productizing" of services under a new pricing model, which in effect is a new business model for consulting activities. We are talking about disaggregating consulting services into specific elements and separating their codified part into reusable knowledge as a product sold to the client. Being transformed into an ordinary alienable product (as opposed to a service whose consumption requires the direct participation of a producer), intellectual assets form the basis of a new pricing model unrelated to charging for service providers' time. The proponents of ABC consulting noted good prospects for such unconventional approaches to doing business in the early 2010s against the backdrop of rapid growth in the sales of various analytical applications and digital products based on subscription models or one-time payments (Forrester, 2015).

Current quantitative data mainly support optimistic forecasts about the growth rate of the ABC consulting segment. According to Gartner (2020), by 2025 more than 69% of consulting service providers will use such solutions to provide over half of their service portfolio (vs 13% in 2020). However, not all intellectual assets with reuse potential by far,

[16] https://www.consultancy.uk/news/1048/performance-based-pay-gaining-speed-in-consulting, accessed on 28.12.2023.

[17] The so-called "freelance revolution" happened at the "intersection" of digitalization and the impact of the global COVID-19 pandemic, during which millions of skilled professionals appreciated the benefits of remote work with a flexible schedule and optimized work-life balance, while employers took advantage of the chance to save on workplace costs.

[18] As the number of registered consulting platform users increases, customers' ability to determine freelance consultants' compensation rates increases as well by encouraging price competition between the latter. Indirect network effects in the form of the improved quality of human resources offered by platforms, due to the increased range of professional skills and qualifications of registered professionals, turn out to be no less important.

[19] As one of the most prominent experts in the consulting industry noted, "one cannot imagine that the head of a Fortune 500 company would hire freelance consultants to run a serious project, since if they fail, he risks losing his job. Trust is very difficult to build through online interaction models, but it's crucial for making a deal when the stakes are particularly high." (https://www.spencertom.com/2018/04/14/uberisation-of-consulting-a-major-disruption-or-merely-hype/, accessed on 28.12.2023).

[20] https://www.forbes.com/sites/jonyounger/2020/12/14/freelance-management-consulting-in-2021-optimism-abounds-after-a-tumultuous-year/, accessed

even those owned by the largest consulting firms, are in demand on the market. Real client demand is only visible for tools based on new-generation digital technologies, primarily BD analytics and AI, which are increasingly integrated and applied in combination with others. These products have already been demonstrating such impressive growth and functionality that they are becoming a disruptive driver in the global management consulting industry on their own.

Digital products based on BD analytics and AI have created the most promising segments of the modern global consulting market in terms of predicted growth, especially against the background of the rapid development of generative AI tools. According to the most conservative estimates, the AI consulting market should grow from 5.5 billion USD in 2022 to more than 45.6 billion in 2031, i.e., at an average annual rate of 26.5% during the forecast period (Business Research Insights, 2024). Similar growth rates are predicted for the global BD analytics consulting market. Spherical Insights estimates that it will grow from 61.4 billion USD in 2023 to 581.3 billion in 2033, or at an average annual rate of 25.2%.[21]

The disruptive potential of BD analytics and AI tools creates risks not only for the majors but for the entire consulting industry as a whole (Beck, Libert, 2018; Kaplan, 2023). AI technologies such as machine and deep learning, neural networks, natural language processing, and process robotization allow for automating many consulting functions. Thus, one of the labor-intensive and expensive components of most strategic consulting projects traditionally relates to collecting and analyzing information about client companies' business environment, industry trends, the behavior of competitors, suppliers, customers, etc. The use of BD analytics and AI tools allows one to not only significantly accelerate the implementation of these tasks and achieve more accurate results, but also do it at a significantly lower price. A good example of a firm integrating such tools is the US-based firm Palantir Technologies, which has developed a unique Foundry platform to effectively support strategic decision-making in a variety of industries.

In operations consulting projects, most often aimed at improving certain business processes and reducing costs, BD analytics and AI can help with the labor-intensive parts of the current state diagnostics, identifying bottlenecks, and streamlining business processes based on best practices. For example, a smart process mining tool developed by the German company Celonis allows one to automatically identify zones of inefficiency in the supply chain and production, thus automating the traditional management consultant work. Based on machine learning technology, the US-based firm Mosaic has developed a predictive model for maintenance of construction and mining equipment. Its implementation allowed a global manufacturer of such equipment and its customers to effectively predict equipment failure time and significantly reduce operating costs by reducing the downtime and optimizing repair schedules.

Using BD analytics and AI tools to model behavior patterns of various market participants (first of all customers), build and analyze development scenarios for a particular industry (market segment), etc. opens up wide prospects. For example, the digital product line jointly developed by the US companies Dunnhumby and Placer.ai combines expert customer data analytics with AI-based technology to provide manufacturers and users of consumer goods with unique insights into factors affecting the attraction of clients to retail locations. Netflix, a global entertainment industry leader, has adapted machine learning algorithms to analyze user preferences and develop a recommendation system for its streaming service. After several years of using the system, a significant improvement of the indicators was recorded related to the interest in content and subscriber retention.[22]

The popularity of generative AI technologies is growing at an accelerated rate. A large-scale international survey of executives at the 300 largest corporations across industries conducted in December 2023 found that by the end of 2024, 74% of these companies expect to use generative AI tools for strategic analysis and product innovation purposes (MIT, 2023).

Thus, a growing number of labor-intensive tasks previously performed by external consultants (and not just routine ones, but also more complex ones that are still amenable to formalization) are being "handed over" to new-generation digital tools. However, it would be too early to talk about an existential threat to the management consulting industry, or to traditional industry leaders' positions. The AI development prospects may be difficult to predict, but it is already evident that even the most advanced BD analytics and AI systems lack a number of key management consulting properties that are fundamentally important for making management decisions, such as creativity, critical thinking, human intuition, and empathy. AI-based systems

on 08.12.2023.

[21] https://finance.yahoo.com/news/global-data-analytics-market-sise-090000523.html, accessed on 28.02.2024.

and tools cannot adequately assess complex social interactions, especially cultural and emotional aspects of communication. Situations that require taking into account the human factor and the use of emotional intelligence turn out to be beyond AI tools' capabilities, while applying these tools in such cases can be extremely risky.

The potential to increase the beneficial impact of management consulting by replacing consultants in many labor-intensive jobs and freeing up their time to deal with more complex issues that require creativity, relevant experience, and professional intuition, makes BD analytics and AI tools unquestionably valuable. It is no coincidence that the broad adoption of such tools in almost all sectors of the economy has sharply increased the demand for consulting services to support their application. As highlighted in a recent study of the latest consulting market trends, it became very clear from 2023 that "the advancement of sophisticated technologies like data analytics and generative artificial intelligence (genAI) are not slowing demand for consulting services. In fact, the opposite is true. Companies in every industry are turning to consultants for guidance in adopting new tools and integrating them into their business strategies." [23]

The positions of global leaders are also strengthening. While at the end of the 2010s many analysts were pretty sure that dynamic technology companies will undermine the majors' dominance of the consulting industry through the massive application of new software solutions based on BD analytics and AI, at the beginning of this decade, such illusions faded. The results of a survey of consulting tenders held in 2022 by 1,222 major clients in 12 countries[24] are quite indicative of this point of view. According to its findings, global industry leaders remain undisputed favorites in terms of the number of tenders they win, and their gap with other market players is only growing.

The key strategies of the leading consulting firms' successful adaptation to the mass adoption of BD analytics and AI include M&A deals with the developers of such products, the creation of strategic alliances with technology market players, and the accelerated development of their own potential in the area. One of the first to go along the M&A path with developers of new-generation digital tools was McKinsey, who acquired QuantumBlack, the leading UK manufacturer of analytical systems, as early as in 2015. Other examples of large M&A deals in the industry include BCG's acquisition of the US developer of AI tools, Formation; Accenture's purchase of the Japanese BD analytics and AI consulting firm ALBERT; and the acquisition by Deloitte of two Canadian firms specializing in AI products and data integration, Dataperformers Company Inc and Groundswell Group Inc.

Various forms of strategic partnerships with developers of innovative digital products have become an even more widespread adaptation mechanism. Thus, Bain formed a strategic alliance first with OpenAI, one of the world's leading developers of AI solutions (including ChatGPT), and then with Microsoft, to develop collaboration on the AzureOpenAI platform. PWC partnered with Google for Work to develop a line of cloud-based digital business transformation solutions, while KPMG established a joint venture with McLaren to take advantage of its predictive analytics technologies and other products.

The consulting industry majors are actively developing their own tools based on new-generation technologies. BCG has established a special division, BCG X, to develop digital products; it already employs more than 2,500 professionals in this area, and the plan for the next three years is to increase their number to 5,000. As BCG X summed up its strategy, "We want to be the first company to be tech and consulting at the same time."[25] However, BCG's strategy is far from unique; almost all leading market players are moving in the same direction. One of the first was Accenture, which relies upon the accumulated competencies and extensive information consulting experience to develop innovative solutions, especially for the implementation of various IT systems. A 2021 benchmarking study on business software engineering performance conducted by Everest Group analysts and covering 31 of the world's top companies specializing in this area, revealed Accenture's leadership in digital product development (Everest Group, 2021). At the same time, while building up their own product development potential, the global majors do not turn into technology companies but maintain their industry specialization. Combining existing competencies with new ones (in digital development), they successfully adapt to the technological shifts accompanying digital transformation.[26]

Conclusion

Despite the distinct disruptive trends in the global management consulting industry, its structure has

[22] https://digitaltransformationskills.com/ai-for-business/, accessed on 18.04.2024.

[23] https://www.alpha-sense.com/blog/trends/consulting-industry-trends/, accessed on 28.12.2023.

[24] https://www.sourceglobalresearch.com/blog-post/how-transformation-is-transforming-the-competitive-landscape-in-consulting, accessed on 19.11.2023.

[25] https://sifted.eu/articles/tech-investments-digital-transformation-brnd, accessed on 18.12.2023.

[26] In terms of digital transformation, the consulting leaders, like incumbents in any industry, pay more attention to digitalizing value creation, and to promoting their value proposition to customers than to revising monetization models in these areas (Klos et al., 2023).

proven to be unusually resilient to transformation processes. Statistics show that traditional consulting leaders have demonstrated dynamic growth for decades, even in unfavorable years for the industry. Industry majors not only maintained their dominant positions in all key markets, but significantly strengthened them through intensive penetration into the new segments created by digitalization processes.

The destructive scenarios for the consulting industry giants put forward by the proponents of disruption theory clearly underestimate the industry's features and, above all, the majors' flexible adaptability, which has helped them to retain their positions on key markets for many years. Industry leaders demonstrated this flexibility by successfully adapting to the massive integration of new-generation digital technologies into the consulting business, through acquisitions of the developers of digital products, the creation of strategic partnerships with tech companies, and accelerating the build-up of their own technological potential in most advanced areas.

The leading players of consulting industry demonstrated exceptional dynamism, based on well-established processes and accumulated management experience in identifying and developing promising market segments. Though the concept of firms' dynamic capabilities has already received significant attention in the academic literature (Teece, 2018; Werner et al., 2022; Ellström et al., 2022; Schneider et al., 2023), it remains poorly developed regarding consulting companies, which have unique advantages in this area. Unlike businesses in other industries, the consulting majors do not need to conduct special research, create detailed customer profiles, identify their problem areas and "pain points", or develop plans to meet the emerging needs.[27] All these processes have long been established and are continuously maintained in the scope of their core consulting business, while the knowledge and experience accumulated over the years is carefully recorded and structured, circulating in corporate knowledge management systems and adding to consultants' creative arsenal (Tavoletti et al., 2022; Magistretti et al., 2021).

The dynamic capabilities of the consulting majors are reflected in their thought leadership in the area of corporate management: the continuous generation of new management concepts requiring large businesses to restructure and creating new demand for expensive consulting services to support this business transformation. Thanks to the accumulated intellectual potential and long-standing reputation as a source of advanced management ideas, industry leaders can significantly influence the strategic agendas of multinational corporations, leading financial institutions, and even government agencies. Strategic planning, business process reengineering, integrated information systems, innovative business models, digital transformation, the creation of platform ecosystems, and the application of AI technologies are all regularly updated agenda items which raise important issues for the boards of directors of the largest corporations and banks in the world, and were developed and disseminated by the global consulting industry majors. Such fundamental challenges fuel the demand for large-scale consulting projects as the main source of leading industry players' market dominance, translating their thought leadership into stable revenue flows.

The paper was prepared in the scope of the National Research University Higher School of Economics Basic Research Programme.

References

Beck M., Libert B. (2018) Management Consulting's AI-powered Existential Crisis. *MIT Sloan Management Review*, September 14. https://sloanreview.mit.edu/article/management-consultings-ai-powered-existential-crisis/, accessed 12.05.2024.

Birkinshaw J., Lancefield D. (2023) How Professional Services Firms Dodged Disruption. *MIT Sloan Management Review*, June 13. https://sloanreview.mit.edu/article/how-professional-services-firms-dodged-disruption/, accessed 17.05.2024.

Business Research Insights (2024) *Artificial Intelligence (AI) Consulting Market Size, Share, Growth, and Industry Analysis, By Type (IT services and technology, Customer service, Supply chain, Marketing and sales, Finance & Human Resources, & Others), By Application (Telecommunication, Media & Technology, BFSI, Healthcare, Retail, Manufacturing, Government, & Others), Regional Insights, and Forecast to 2032,* Pune (India): Business Research Insights.

Cerruti C., Tavoletti E., Grieco C. (2019) Management Consulting: A Review of Fifty Years of Scholarly Research. *Management Research Review*, 42 (8), 902–925. https://doi.org/10.1108/MRR-03-2018-0100

[27] https://www.socialchamp.io/blog/niche-market/, accessed on 21.04.2024.

Christensen C.M. (1997) *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*, Boston, MA: Harvard Business School Press.

Christensen C.M., Bower J.L. (1996) Customer Power, Strategic Investment, and the Failure of the Leading Firms. *Strategic Management Journal*, 17(3), 197–218. https://doi.org/10.1002/(SICI)1097-0266(199603)17:3%3C197::AID-SMJ804%3E3.0.CO;2-U

Christensen C.M., McDonald R., Altman E.J., Palmer J.E. (2018) Disruptive Innovation: An Intellectual History and Directions for Future Research. *Journal of Management Studies*, 55, 1043–1078. https://doi.org/10.1111/joms.12349

Christensen C.M., Wang D., van Bever D.C.M. (2013) Consulting on the Cusp of Disruption. *Harvard Business Review*, *91(10), 106–115.*

Curuksu J. D. (2018) *Data Driven: An Introduction to Management Consulting in the 21st Century*, Cham, Springer International Publishing AG.

Danneels E. (2011) Trying to Become a Different Type of Company: Dynamic Capability at Smith Corona. *Strategic Management Journal*, 32(1), 1–31. https://doi.org/10.1002/smj.863

Davison M.L. (2009) *The challenges we face managing those external (and internal) consultants!* (Paper presented at PMI® Global Congress 2009 — North America, Orlando, FL), Newtown Square, PA: Project Management Institute.

Ellström D., Holtström J., Berg E., Josefsson C. (2022) Dynamic Capabilities for Digital Transformation. *Journal of Strategy and Management*, 15(2), 272–286. https://doi.org/10.1108/JSMA-04-2021-0089

Everest Group (2021) *Reaching New Frontiers in Experience-centricity and Resilience: Software Product Engineering Services,* Hyderabad: Everest Group.

Forrester (2015) *Asset-Based Consulting Will Gradually Change the Consulting Revenue Model*, Cambridge, MA: Forrester Research, Inc.

Fuller J.B., Raman M., Palano J., Bailey A., Vaduganathan N., Kaufman E., Laverdière B., Lovett S. (2020) *Building the On-Demand Workforce*, Cambridge, MA: Harvard Business School Press.

Gans J. (2016) *The Disruption Dilemma*. Cambridge, MA: MIT Press.

Gartner (2020) *Market Trends: Asset-Based Managed Services,* Stamford, CT: Gartner, Inc.

Gartner (2022) *Market Share Analysis: Consulting Services, Worldwide, 2022,* Stamford, CT: Gartner, Inc.

Kharlov L. (2020) Modelling the Disruptive Innovation. *Review of Business and Economic Studies*, 8(3), 29–33. https://doi.org/10.26794/2308-944X-2020-8-2-29-33

King A., Baatartogtokh B. (2015) How Useful Is the Theory of Disruptive Innovation? *MIT Sloan Management Review*, 57(1), 77–90.

Klos C., Spieth P., Clauss T., Klusmann C. (2023) Digital Transformation of Incumbent Firms: A Business Model Innovation Perspective. *IEEE Transactions on Engineering Management*, 70(6), 2017–2033. https://doi.org/10.1109/TEM.2021.3075502

Larsson A., Andersson N., Markowski P., Nilsson M., Mayor I. (2019) Consulting in the Digital Era? The Role of Tomorrow's Management Consultants. In: *The Digital Transformation of Labor* (eds. A. Larsson, R. Teigland), London: Routledge, pp. 254–279.

Magistretti S., Pham C.T.A., Dell'Era C. (2021) Enlightening the Dynamic Capabilities of Design Thinking in Fostering Digital Transformation. *Industrial Marketing Management*, 97, 59–70. https://doi.org/10.1016/j.indmarman.2021.06.014

McKendrick D.G., Doner R.F., Haggard S. (2000) *From Silicon Valey to Singapore: Location and Competitive Advantage in the Hard Disc Drive Industry*, Stanford: Stanford University Press.

Miles I. (2020) A Disrupted Future? Foresight and STI Governance, 14(1), 6–27. https://doi.org/10.17323/2500-2597.2020.1.6.27

Milovidov V. (2018) Hearing the Sound of the Wave: What Impedes One's Ability to Foresee Innovations? Foresight and STI Governance, 12(1), 76–85. https://doi.org/10.17323/2500-2597.2018.1.76.85

MIT (2023) *Generative AI: Differentiating Disruptors from Disrupted*. Cambridge, MA: MIT Technology Review Insights.

Nissen V. (2018) *Digital Transformation of the Consulting Industry*: *Extending the Traditional Delivery Model,* Cham: Springer.

Schneider M.H.G., Kanbach D.K., Kraus S., Dabic M. (2023) Transform Me If You Can: Leveraging Dynamic Capabilities to Manage Digital Transformation**.** *IEEE Transactions on Engineering Management*, 71, 9094–9108. https://doi.org/10.1109/TEM.2023.3319406

Si S., Chen H. (2020) A Literature Review of Disruptive Innovation: What It Is, How It Works and Where It Goes. *Journal of Engineering and Technology Management*, 56, 101568. https://doi.org/10.1016/j.jengtecman.2020.101568

Stahl B., Häckel B., Leuthe D., Ritter C. (2023) Data or Business First? — Manufacturers' Transformation Toward Data-driven Business Models. *Schmalenbach Journal of Business Research,* 75(6), 303–343. https://doi.org/10.1007/s41471-023-00154-2

Tavoletti E., Kazemargi N., Cerruti C., Grieco C., Appolloni A. (2022) Business Model Innovation and Digital Transformation in Global Management Consulting Firms. *European Journal of Innovation Management*, 25(6), 612–636. https://doi.org/10.1108/EJIM-11-2020-0443

Teece D.J. (2018) Business Models and Dynamic Capabilities. *Long Range Planning*, 51(1), 40–49. https://doi.org/10.1016/j.lrp.2017.06.007

UN (1993) *Management Consulting: A Survey of the Industry and Its Largest Firms*, New York: United Nations.

Verified Market Research (2024) *Global Freelance Platforms Market Size By Type of Freelance Platform, By Mode of Operation, By Pricing Model, By Geographic Scope And Forecast*, Washington, D.C.: Verified Market Research.

Werner V., Flaig A., Magnusson T., Ottosson M. (2022) Using Dynamic Capabilities to Shape Markets for Alternative Technologies: A Comparative Case Study of Automotive Incumbents. *Environmental Innovation and Societal Transitions*, 42 (1), 12–26. https://doi.org/10.1016/j.eist.2021.10.031

Two Views on Open Innovation: The Source of Dynamic Capabilities vs the Threat to Corporate Stability

Yonas Ferdinand Riwu
Lecturer, yonas.riwu@staf.undana.ac.id
University of Nusa Cendana, Jalan Adisucipto Penfui Kupang 85001, East Nusa Tenggara, Indonesia

Andi Aris Mattunruang
Lecturer, andi.arismattunruang@unpatompo.ac.id
University of Patompo, Jl. Inspeksi Kanal No.10, Tombolo, Kec. Rappocini, Kota Makassar, Sulawesi Selatan 90233, Indonesia

Abstract

Small and medium-sized businesses make a significant contribution to the national GDP in both developed and developing countries. It is a constant focus of research; transformation processes take place here, which can affect a variety of socioeconomic aspects. In recent decades, open innovation and digital transformation have emerged as the emerging drivers encouraging companies to transform their business models. Their skillful combination allows players to move into a qualitatively different category. For small and medium-sized businesses, both new opportunities and complex challenges arise, which require a certain level of training and competencies.

Using the example of Indonesian business, this article analyzes these processes and their effects in the form of natural flows of information, ideas, knowledge, and other resources. The pitfalls of open innovation are revealed. This study enriches the information and empirical base on the creative impact of open innovation on MSMEs and its enhancing effects of communication on digital platforms.

Keywords: open innovation; strategies; new business models; digital platform; company productivity; strategic partnership; research and development

Citation: Riwu Y.F., Mattunruang A.A. (2024) Two Views on Open Innovation: The Source of Dynamic Capabilities vs the Threat to Corporate Stability. *Foresight and STI Governance*, 18(3), pp. 29–39. DOI: 10.17323/2500-2597.2024.3.29.39

Introduction

Due to the increasing dynamics of change in technological, economic, social, and other dimensions, innovation has come to be seen as a key driver of growth and a competitive advantage at different levels - from individual companies and organizations to national economies. According to McKinsey, for 2021, 84% of surveyed top managers of companies consider the development of innovation a strategic priority, but only 6% of them are satisfied with the results achieved in this direction.[1] One of the key reasons for the gap between the desire to achieve higher levels of development through innovation and the actual situation with their implementation is the lack of a holistic strategy for managing "innovation for growth", harmoniously combined with the overall culture and development goals. A systematic approach to the implementation of innovation allows one to holistically manage a set of complex multidirectional processes, enhance their effects, and find new ways of development, but its formation and support pose a difficult challenge (Naqbia et al. 2020; Psomas et al., 2018).

The development and implementation of innovations are carried out in closed or open systems. In the first model, companies or organizations rely exclusively on their own assets at all stages: from research and development (R&D) to scaling and marketing. However, in a new increasingly complex and changing context (rapid updating and complication of technologies, products, business models, etc.), "closedness" no longer allows for maintaining the necessary dynamics of development. As a result, incentives to adopt the open innovation systems model first described in 2003 (Chesbrough, 2003) are growing. especially in the context of the digital transformation (Strazdas et al., 2014). The digital environment has enormous resources for growth, which you can take full advantage of when a closed approach is impossible.

In open ecosystems, companies can flexibly adjust strategies and master emerging complex cooperation schemes (Tobiassen, Pettersen, 2018).

In closed systems, the influx of external ideas is seen as a threat from possible competitors. A radically different perspective is offered by open systems, where such ideas are perceived as a valuable source of necessary diversity in the resources for innovation, the bearers of which are different types of partners, consumers, and other stakeholders. Internal ideas remain a valuable asset, but at the same time they are enriched by "outsider" developments, which turn into a colossal driving force of innovative co-creation. This combination provides fantastic choices from a rich array of ideas, fresh views, and unexpected decisions, which leads to more sophisticated mechanisms of cooperation not previously practiced (Chesbrough, 2003).

OI research is developing rapidly, especially in areas such as collaboration tools, strategic management, productivity, attitudes toward intellectual property rights, opportunity seeking, and the adoption of open-ended approaches at micro, small and medium enterprises (MSMEs) in different sectors (Bigliardi et al., 2020).

The modern economy increasingly relies on digital platforms (cloud resources, search engines, social networks, electronic trading platforms, etc.). As a result of these platforms' close interconnections, dynamic ecosystems are formed, the participants of which jointly create customer value by flexibly responding to market changes. As a result, transaction costs are reduced, the exchange of information about clients is enhanced, internal and external logistics are optimized, and overall management efficiency is increased (Arranz et al., 2023). Sectors with significant creativity are coming to the fore (Colapinto et al., 2012). Currently, interest in OI is growing in a variety of scientific disciplines (Bigliardi et al., 2020), and governments of many countries take this into account when formulating national development strategies (West et al., 2014).

IO activity is distributed unevenly in the business environment. The degree of its concentration largely depends on the scale of the business itself. Large companies are mastering this model more easily and more quickly than other categories of enterprises. Based on their achievements and experience, reliable trajectories have emerged that many MSMEs can follow (Van De Vrande et al., 2009; Wynarczyk, 2013; Hinteregger et al., 2019). This is especially true for sectors that rely primarily on the creative component, such as intellectual services, manufacturing, architecture, electronics, design, consulting, and advertising.

Due to the small size of MSMEs, the benefits from the use of OI seem to be even greater for them compared to the large players (due to the "low start" effect). While the benefits of OI for this category of business entities

[1] https://www.mckinsey.com/capabilities/strategy-and-corporate-finance/how-we-help-clients/Strategic-Growth-and-Innovation, accessed 08.06.2024.

and their implementation in practice are described to a sufficient extent, research on the open model for smaller companies is still scarce (Hinteregger et al., 2019; Cricelli et al., 2015).

Our article fills this gap by examining the opportunities offered by digital platform communications for MSMEs. The ways of increasing their effectiveness in relation to OI are shown, allowing such firms to master more complex business models with expanded opportunities for development. The role of digital platforms in strengthening the link between OI and MSME performance is assessed.

Literature Review

Open Innovation Theory

The concept of OI has many similarities with the theory of resource dependence, according to which organizations need external assets to function successfully (Pfeffer, Salancik, 2003). Partnerships are a critical tool for attracting said assets. Furthermore, the intensity and quality of the latter lay the foundation for innovation performance and a preventive approach in corporate strategies (Fan et al., 2022; Tobiassen, Pettersen, 2018). The quality of communications is improving thanks to digital platforms as a source of additional opportunities for companies to work with external resources in order to generate new ideas, knowledge, and technologies (Hossain, Lassen, 2017; Abbate et al., 2019). Similar processes can become a catalyst for the production of products and services that better meet market needs. Effective control of internal and external ideas depends on how skillfully companies attract them, test, integrate, and convert them into implementable innovative solutions. This is an important part of a successful strategy both in open and closed innovation systems.

There are "inward", "outward", and "combined" types of OI. The first means accumulating developments "from the outside" in order to "implant" them in the internal corporate "organism" (Lichtenthaler, 2009; Bogers, Horst, 2014). The second involves the flow of internally generated ideas and other assets to other parties, while the third involves a combination of incoming and outgoing flows. All of them in one way or another involve the generation of proposals for the creation of new products or the modernization of existing ones, the improvement of business processes, and so on. (Bogers et al., 2017). To this end, alliances are being created to develop new technologies, which include start-ups, mature enterprises, universities, research centers, and proxy agencies (Chesbrough et al., 2014; Perkmann 2015; Schillo, Kinder, 2017).

The Versatility and Ambiguity of the Effects of OI are a Factor of Managerial Complexity

Open innovation is an objectively complex process, characterized by a variety of structures and forms of implementation (Dahlander, Gann, 2010; Huizingh, 2011). The risks, limitations, and opportunities associated with it have been sufficiently studied. To master OI, a certain maturity and readiness to manage complex multidirectional processes with a large degree of uncertainty are required (Cheng, Huizingh, 2014). There are enough publications reflecting the positive impact of OI on business growth (Chiang, Hung, 2010; Lichtenthaler, 2009), R&D efficiency (Chiesa et al., 2009), customer satisfaction (Chesbrough et al., 2011; Wagner, 2010), and overall success of the new product (Rohrbeck et al., 2009). At the same time, there is a lot of evidence of their "other side" that is valuable, and these ambiguous aspects are worth consideration.

According to statistics, the failure rate of OI projects is quite high (Lichtenthaler, 2011). Failure to prepare for an open model usually leads to the leveling of company assets and other discrete effects (Torkkeli et al., 2009). The most common reason is the inability to differentiate between the three above-mentioned types of OI. Particularly high risks arise from the inability to filter external data from partners, clients, competitors, consultants, research institutes, and universities (Faems et al., 2005; Tether, Tajar, 2008) and to create new combinations, combining one's own and attracted assets to increase innovative efficiency.

The concept of OI is based on the idea that in a highly competitive environment, a linear model of innovation (Von Hippel, 1988) is unable to fully explain innovation processes (Bigliardi et al., 2020). As previously noted, to increase competitiveness, companies have to open their "borders" and cooperate with external parties through the exchange of knowledge, technology, and other resources (Galati, Bigliardi, 2017).

The failure of OI projects occurs for many technical and non-technical reasons (Bigliardi et al., 2020). Problems can arise at different levels: strategic (the inability to balance openness and the protection of one's own assets) (Grimaldi et al., 2021), organizational (maturity and readiness of employees) (Natalicchio et al., 2018), operational (process integration) (Gurca et al., 2018), communication (hidden conflicts and destructive rivalry) (Malhotra et al., 2017), and individual (lack of knowledge) (Torres de Oliveira et al., 2021).

The high percentage of failures in OI is explained by the complexity of managing these processes and the uncertainty of their results. The existing literature does not sufficiently capture the nuances of the diversity of

OI aspects. Compared to others, limiting factors such as the lack of a clear vision, limited resources, improper management structure, haphazard innovation, and non-compliance with rules are revealed in comparative detail (Beck et al., 2020; Saura et al., 2022).

The most common problem in implementing OI projects is the lack of funding, which is faced by up to 70% of companies (Torres de Oliveira et al., 2021). Another significant factor is suboptimal resource allocation (Faridian, Neubaum, 2021; Urbinati et al., 2020). Like any complex system, OI requires a properly adjusted dynamic balance of all links, as well as their constant and flexible adjustment (Germonprez et al., 2020). Here, much depends on the focal point's ability to manage decentralized innovation processes involving a wide range of external parties (Gassmann et al., 2010). As the number of parties involved, activities, and technologies increases, more interactions and diversity of information appear. These complex multidimensional processes need proper management and synchronization (Gentile-Lüdecke et al., 2020). The abundance of data can either increase or decrease the effectiveness of OI. Often, due to information overload, participants lose the ability to quickly identify high-quality ideas and potential opportunities that may not initially be perceived as such (Gentile-Lüdecke et al., 2020). In such cognitive failures, it is very difficult to establish a balance between the quality and quantity of the intellectual resources involved, taking into account the specifics of the functioning of different OI platforms (Ovuakporie et al., 2021).

The attempt to manage an excessively multilateral format of cooperation poses a large-scale coordination challenge. The accumulation of intricate, complex flows of knowledge from a variety of sources in many cases causes information overload and entropy. Trying to juggle multiple parallel projects and keep participants motivated (without building the ability to do so) results in a loss of management control. A cognitive "complexity catastrophe" occurs (Kaufmann, 1993), which starts a chain of errors in decision making (Ovuakporie et al., 2021). The problem is solved by installing a kind of "filter" on incoming information flows, based on a clearly defined structure, concept, and understanding of the characteristics of the innovative product being created and needs (Gentile-Lüdecke et al., 2020; Torres de Oliveira et al., 2021; Bogers et al., 2017; Zobel, 2017).

Along with filtering incoming information flows, comprehensive security measures are needed to protect knowledge and new ideas from unauthorized use. The risks of intellectual asset leakage increase as more external participants become involved in the IP process (Bogers et al., 2017; Dahlander et al., 2021). Building and maintaining the right balance between openness and protecting confidential information is often an "unsolvable" task, giving rise to discussions about the "openness paradox" (Bogers et al., 2018; Obradović et al., 2021). This is about internal contradictions of motives between the generation of innovations and their commercialization. The OI approach to new product creation cannot be implemented without a willingness to share knowledge with external partners. However, for commercialization reasons, the development of protective measures is required (the partial concealment of information representing a source of unique competitive advantages) (Capaldo, Petruzzelli, 2011; Niesten, Stefan, 2019). This paradox is present in any processes associated with OI (Laursen, Salter, 2014; Zhong, Sun, 2020).

The next dimension in which the ambiguous properties of OI are manifested is that when co-financing and managing this process, the project team does not need to be "tied" to the strict requirements of specific investors. In a closed model, this complexity does not arise due to the clearly defined rules and standards of one or two investors. However, a wide range of alternative attractive opportunities becomes unavailable. Complex thinking is required to take into account the multitude of interdependencies with its rules, maneuver quickly, and find a balance between reliability and diversity of standards (Abhari et al., 2022; Elia et al., 2020), freedom of action, and ensuring the appropriate quality of results. Special programs for preparing for OI projects significantly reduce the risks of not taking these factors into account.

Correct timing plays a significant role. Errors in its calculation can lead to catastrophic delays at any level. Very often, time estimates for OI projects turn out to be unrealistic due to illusory expectations, which leads to resource depletion and failure (Beck et al., 2020).

A strong collaborative OI community can only be created on the basis of a well-chosen project team that combines a variety of unique abilities, talents, and competencies (Coelho et al., 2016; Forbes et al., 2019). Thus, the difficulty of providing highly qualified personnel appears to be among the most common barriers to the implementation of OI projects, especially in highly specialized sectors (Torres de Oliveira et al., 2021; Cheah et al., 2021; Chaudhary et al., 2022). The lack of robust recruitment and skills assessment procedures hinders the formation of effective project teams (Bertello et al., 2021; Obradović et al., 2021).

Despite these aspects, the success or failure of OI projects often depend not on objective complexity, but on perceived complexity (Stefan et al., 2022).

Thus, a comprehensive understanding of risks and potential problems at an early stage, as well as finding the necessary balances in relation to the paradox of openness, will greatly increase the chances of survival and productivity of OI projects.

Open Innovation and MSME Performance

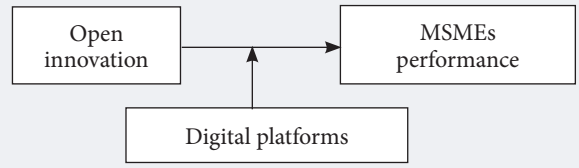
Most publications on OI focus on large and high-tech companies. These works substantiate the positive effects of OI for competitiveness in such aspects as the creation and scaling of innovations, technological superiority, expanding markets, improving organizational management, and so on. (Van De Vrande et al., 2009; Hinteregger et al., 2019; Cheng, Huizingh, 2014). In contrast, the trend of implementing OI at MSMEs is still in its initial stages. Nevertheless, this area is also attracting increased research interest. There is growing evidence that OI is also attractive and relevant to MSMEs, which have some potential to implement this model, but its deployment is hampered by the "size factor" and narrow interests for participation in OI (Cricelli et al., 2015; Hinteregger et al., 2019). Basically, MSMEs resort to OI practices only for market reasons (to increase their client base, to get ahead of competitors, etc.) (Van De Vrande et al., 2009). There is a lack of knowledge among their leaders about how the OI mechanism works and how to extract additional benefits from participation in this process.

Moving beyond a simplistic market orientation and exclusive focus on increasing profits changes a lot. Understanding broader and interconnected social and environmental issues provides the key to developing innovative proposals that can become a unique source for strengthening competitive positions (Linnenluecke, Smith, 2018).

The problem of small business size initially poses a major challenge for MSMEs in terms of attracting external resources, since when trying to build bilateral partnerships with large players, the latter would doubt the maturity and readiness of MSMEs for such complex models as OI.

Thus, the factor of resource dependence for MSMEs initially looks like a more serious barrier than for large players. However, when involved in broad IO networks, where many participants of different sizes are involved, with their own unique sets of resources and competencies, complex flows of exchange of these assets arise between all participants. From such a network, it is much easier for small players to receive the necessary "feed" (they receive more indirectly), whereas in the case of isolated bilateral partnerships such a flow would be problematic.

Figure 1. **Research Framework**



Source: authors.

Involving consumers in the product development process allows us to generate more relevant and useful solutions, strengthen customer relationships, and improve the company's image as an OI-ready player. From the above, the first hypothesis follows:

H1. *OI has a positive impact upon the performance of MSMEs.*

The Intermediary Role of DigitalPplatforms

The skillful use of digital platforms significantly increases the quality of management, focus on consumer demand, and, as a result, overall business performance (West, 2015). Sharing knowledge and new methodologies through digital platforms expands the range of entrepreneurial opportunities for MSMEs (Nambisan, Sawhney, 2007).

MSMEs are initially migrating to digital platforms to survive in an increasingly competitive environment, with the exchange of knowledge and new methodologies on these platforms expanding their entrepreneurial opportunities (Bi et al., 2017; Kontolaimou et al. al., 2017; Frishammar et al., 2018; Viglia et al., 2018). The use of digital platforms is seen as a factor in the "pre-preparation" of MSMEs for participation in OI. Its presence mitigates the potential risks for MSMEs losing their own resource base instead of acquiring additional assets when involved in OI (Ramirez-Portilla et al., 2017).

This leads to the second hypothesis:

H2. *Digital platforms strengthen the link between OI and MSME performance.*

The structure of our study is shown in Figure 1.

Research Context and Methodology

According to World Bank criteria, microenterprises are defined as companies with annual sales of less than 100,000 USD. In turn, small companies include

companies in which this figure is 100,000–300,000 USD, and medium-sized ones — 300,000–500,000 USD (Ebitu et al., 2016).

In Indonesia, MSMEs have significant potential to create new jobs - for 121 million people, a meaningful contribution to the gross domestic product (GDP), growing by 5% annually. MSMEs provide 96.9% of employment, 57.56% of GDP, and 15.68% of exports.[2] According to data for 2019, the number of microenterprises in Yogyakarta amounted to 143,385, small companies - 65,533, medium companies - 39,581, and the number of such enterprises continues to grow.[3] Nationwide, digital platforms were used to market the new products of 3.79 million MSMEs (8% of the total number of national MSMEs, which amounted to 59.2 million).[4]

Data Collection and Sampling

To achieve our research goals, we conducted a questionnaire-based survey among MSMEs in Yogyakarta (Indonesia). The selection of participants was based on criteria such as age, number of employees, and the location of companies. The sample initially included the representatives of 200 enterprises.

The questionnaire consisted of three blocks. The first was devoted to two points of interest – "inward" and "outward". The second concerned the assessment of the performance of MSMEs along four dimensions: financial, non-financial, environmental, and social. The third section, which touched on the usage of digital platforms, also relied on four indicators: internal, outgoing, and incoming communications as well as order formation. Each section of the questionnaire consisted of 10 questions, according to the methodological recommendations of the work (Cenamor et al., 2019). Responses were scored according to five-point Likert scale: from 1 – "strongly disagree" to 5 – "completely agree".

As a result of distributing questionnaires via social networks, 164 responses were received. After filtering, 14 questionnaires were eliminated due to incompleteness or respondents not meeting all the criteria on the basis of which MSMEs are identified. Eventually 150 responses were analyzed. Due to the nature of online surveys, the general number of potential participants remained unknown. Thus, response rates were calculated by dividing completed questionnaires by the number of initial responses received (Fleming and Bowden, 2009). The share of compiled suitable questionnaires amounted to 91%.

Table 1. **Demographic Characteristics of Respondents**

Demographic variable	N	%
Level of education		
Primary – Senior high school	59	88.5
Bachelor	78	117
Master	13	19.5
Business Age		
<10 years	112	168
10-16 years	20	30
>16 years	8	12
Respondent Age		
19-25 years old	27	40.5
26-35 years old	54	81
36-45 years old	36	54
>46 years old	33	49.5
Gender		
Female	50	75
Male	100	150
Demographic variable	n	%
Number of Employee		
<5 employees	96	114
6-10 employees	34	51
>10 employees	20	30
Income level		
10 – 300 million	65	97.5
300 million – 2.5 billion	73	109.5
>2.5 billion	12	18
Business sector		
Advertising	12	12
Automotive	13	2
Architecture	8	5
Craft	9	6
Culinary	43	43
Electronic	22	2
Fashion	20	10
Publisher	6	5
Service	9	9
Photography	8	6

Source: compiled by the authors.

Measurement

Efficiency is assessed by a combination of financial and non-financial factors (Jennings, Beaver, 1997). Our respondents, the MSME owners, assessed their current performance in comparison with their own achievements in the past year and the performance of competitors (increased productivity, sales, and profitability from a new product, increased market opportunities, increased customer satisfaction,

[2] https://www.bi.go.id/id/default.aspx, accessed 18.03.2024.
[3] https://bappeda.jogjaprov.go.id, access date 07.05.2024.
[4] https://satudata.kemenkopukm.go.id/, access date 24.04.2024.

Table 2. **Factor Loadings and Cronbach Alpha Value for Studied Variables**

Dimension	Load	α
Open innovation (Ili et al., 2010; Schroll, Mild, 2011; Bianchi et al., 2010; Cheng, Huizingh, 2014)		
1. Inbound	0.719	0.791
2. Outbound	0.764	
MSMEs performance (Cheng, Huizingh, 2014; Purnomo, 2019; Ketata et al., 2015)		
1. Financial	0.602	0.653
2. Nonfinancial	0.521	
3. Environment performance	0.459	
4. Social performance	0.614	
Digital platform (Cenamor et al., 2019)		
1. Internal communication	0.749	0.920
2. Inbound communication	0.836	
3. Outbound communication	0.720	
4. Order pick up	0.727	
Source: compiled by the authors.		

reduced delivery times, improved business processes, solving the waste problem).[5] Potential digital platforms in terms of the availability of external resources for companies was measured on corresponding scales of information technology functionality (*information technology capability scale)* (Rai, Tang, 2010). It largely depends upon how quickly and dynamically MSMEs develop IT resources, strategic planning, and partnership culture. The question wording in English and Indonesian was synchronized to ensure conceptual consistency, as recommended by (Brislin, 1970).

Results and Discussion

Detailed information on the demographic characteristics of respondents is presented in Table. 1. In terms of gender, their ratio was two to one in favor of men. Most often, respondents fell into the age category of 26–35 years. More than 80% of the companies covered are under 10 years of age. If we talk about the level of education of their owners, then a bachelor's degree prevails (58% of cases). Of these, 45 people were owners of micro-enterprises, 53 of small, and 52 of medium businesses. Before further analysis, the collected data was checked for reliability and validity (Table 2). Excluded items did not meet the threshold (i.e., Cronbach's alpha greater than 0.6 for reliability, r-score correlation value ≥ r-table for reliability) (Hair et al., 2019).

To check the proposed hypotheses, data were analyzed using a linear regression.[6] A significant direct positive relationship was established between OI and MSME performance. A simple regression analysis shows that the OI value is 8.247 ≥ t _ table = t(/2); n – k – 1 = t (0. 005; 98) = 2. 62693, with a significance level of 0.000 ≤ 0. 05, and a regression coefficient of 0.744. Therefore, hypothesis H1 is confirmed. OI improves the performance of MSMEs.

In this study, hypothesis H2, which suggests that digital platforms improve the link between OI and MSME performance, was tested using moderated regression analysis (MRA) to test the role of moderating variables (digital platforms). According to the results of regression analysis, at _ count = 3. 258 is greater than t_table = t (/2; n–k–1 = t(0.005; 98) = 2.62693, with a significance level of 0.002 ≤ 0.05 (moderate). Therefore, the hypothesis H2 is confirmed. The results of the analysis are presented in Table 3.

This study's findings confirm previous observations that it is not just large companies that are improved by OI (Chesbrough et al., 2014; Van De Vrande et al., 2009; Wynarczyk et al., 2013), their effects extend to smaller businesses. By becoming more open to strategic interactions, MSMEs, in co-evolution with other parties, dynamically develop their business, introduce innovations, and increase customer satisfaction. Digital platforms facilitate this process by providing companies

Table 3. **Relationships among focal variables**

Model B		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Hypothesis verification results
		Std. Error	Beta				
1	(Constant)	16.092	1.863	0.640	8.640	0.000	Supported (H1)
	Open innovation-MSMEs performance	0.744	0.090		8.247	0.000	
2	(Constant)	42.739	8.281	1.980	5.161	0.000	Supported (H2)
	Digital platform-Open innovation*MSMEs performance	0.035	0.011		3.258	0.002	
Source: compiled by the authors.							

[5] Methodological aspects of assessing incoming and outgoing resource flows in the process of OR are discussed in detail in the works (Schroll, Mild, 2011; Cheng, Huizingh, 2014), and factors for using digital platforms - in the publication (Cenamor et al., 2019).

[6] The IBM SPSS software package (version 26) was used.

with greater communication capabilities, both internally with employees and externally with customers (Li et al., 2016). This simplifies and speeds up transactions, improves service quality, and increases productivity.

Conclusion

Small and medium-sized businesses make a significant contribution to national GDP in both developed and developing countries. MSMEs are a constant focus of research; transformation processes take place here, which can affect a variety of socioeconomic aspects. In recent decades, two new driving forces have emerged that are reconfiguring the business models of all types of companies - open innovation and digital transformation. Identifying the practices of MSMEs using these factors and the resulting effects from their combination was the subject of our study in the Indonesian context.

A natural consequence of the development of any small company is a consistent increase in size. Problems arise when the internal base has been exhausted, and in order to ensure further growth, it is necessary to attract a variety of assets externally. This is a rather complicated process, since "wealthy" players mainly enter into alliances with their own kind. In order for a "newbie" to prove its attractiveness as a partner, it has to spend a long time and great effort building trusting relationships with each major player, proving its worth in terms of competencies, reputation, and other aspects. With the proliferation of digital platforms, this process is becoming easier. Since there are natural flows of information, ideas, knowledge, and other resources between participants, MSMEs can take advantage of them. At the same time, complexity is not eliminated, since in order to practice the OI model, a certain maturity and willingness to flexibly combine a variety of aspects of management are required, taking into account the risks of downsides of OI. There are enough studies that, while noting the creative power and potential of OI, at the same time they reveal the "pitfalls" associated with open innovation practices. Openness requires new thinking and behaviors, finding an optimal balance between protecting one's own intellectual assets and being receptive to external knowledge flows. Companies that are not prepared for OI risk end up in the "outgoing" OI pattern, that is, losing their sources of competitive advantage and slipping into an extremely negative scenario.

Our study enriches the knowledge and empirical base on the creative impact of open innovation on MSMEs, and the empowering effects of digital platforms (Lee et al., 2009; Bianchi et al., 2010; Hinteregger et al. al., 2019). OI provides access to knowledge, technologies, and other resources of external origin, it helps build new competencies and competitiveness, improve the quality of products and services, and helps internal potential grow. Digital platforms encourage MSME owners to take a more flexible and creative approach to business development, to study the intricacies of the co-evolution phenomenon, which allows them to reach an exponential pace of development.

The limitations of this study relate to the representation of the experience of a single local region. It would be advisable to expand it to other countries and increase the representativeness of the samples. If one takes into account that digital platforms themselves are rapidly changing and becoming more complex, their functionality is expanding, then subsequent research may reveal unexpected phenomena in this direction.

References

Abbate T., Codini A.P., Aquilani B. (2019) Knowledge Co-creation in Open Innovation Digital Platforms: Processes, Tools and Services. *Journal of Business and Industrial Marketing,* 34(7), 1434–1447. https://doi.org/10.1108/JBIM-09-2018-0276/FULL/HTML

Abhari K., Davidson E.J., Xiao B. (2022) Modeling social product development process, technology, and governance. *IEEE Transactions on Engineering Management*, 69(2), 409–422. https://doi.org/10.1109/TEM.2020.2973234

Arranz C.F.A., Arroyabe M.F., Arranz N., Juan Carlos Fernandez J.C. (2023) Digitalisation dynamics in SMEs: An approach from systems dynamics and artificial intelligence. Technological Forecasting and Social Change, 196, 122880. https://doi.org/10.1016/j.techfore.2023.122880

Beck S., Bergenholtz C., Bogers M., Brasseur T.-M., Conradsen M.L., Distel A.P., Dobusch L., Dörler D., Effert A., Fecher B., Filiou D., Frederiksen L., Gillier T., Grimpe C., Gruber M., Haeussler C., Heigl F., Hoisl K., Hyslop K., Kokshagina O., LaFlamme M., Lawson C., Lifshitz-Assaf H., Lukas W., Nordberg M., Norn M.T., Poetz M., Ponti M., Pruschak G., Pujol Priego L., Radziwon A., Rafner J., Romanova G., Ruser A., Sauermann H., Shah S.K., Sherson J.F., Suess-Reyes J., Tucci C.L., Tuertscher P., Vedel J.B., Velden T., Verganti R., Wareham J., Wiggins A., Xu S.M. (2020) The Open Innovation in Science Research Field: A Collaborative Conceptualisation Approach. *Industry and Innovation,* 29(2), 1–50, https://doi.org/10.1080/13662716.2020.1792274

Bertello A., Ferraris A., De Bernardi P., Bertoldi B. (2021) Challenges to open innovation in traditional SMEs: an analysis of pre-competitive projects in university-industry-government collaboration. *International Enterpreneurship and Management Journal,* 18, 89–104. https://doi.org/10.1007/s11365-020-00727-1

Bi R., Davison R.M., Smyrnios K.X. (2017) E-business and fast growth SMEs. *Small Business Economics*, 48(3), 559–576. https://doi.org/10.1007/S11187-016-9788-8

Bianchi M., Campodall'Orto S., Frattini F., Vercesi P. (2010) Enabling open innovation in small- and medium-sized enterprises: How to find alternative applications for your technologies. *R&D Management*, 40(4), 414–431. https://doi.org/10.1111/J.1467-9310.2010.00613.X

Bigliardi B., Ferraro G., Filippelli S., Galati F. (2020) The past, present and future of open innovation. *European Journal of Innovation Management*, 24(4), 1130–1161. https://doi.org/10.1108/EJIM-10-2019-0296/FULL/PDF

Bogers M., Foss N.J., Lyngsie J. (2018) The 'human side' of open innovation: The role of employee diversity in firm-level openness. *Research Policy*, 47(1), 218–231. https://doi.org/10.1016/j.respol.2017.10.012

Bogers M., Horst W. (2014). Collaborative prototyping: Cross-fertilization of knowledge in prototype-driven problem solving. *Journal of Product Innovation Management*, 31(4), 744–764. https://doi.org/10.1111/JPIM.12121

Bogers M., Zobel A.-K., Afuah A., Almirall E., Brunswicker S., Dahlander L., Frederiksen L., Gawer A., Gruber M., Haefliger S., Hagedoorn J., Hilgers D., Laursen K., Magnusson M.G., Majchrzak A., Mccarthy I.P., Moeslein K.M., Nambisan S., Piller F.T., Radziwon A., Rossi-Lamastra C., Sims J., ter Wal A.L.J. (2017) The open innovation research landscape: Established perspectives and emerging themes across different levels of analysis. *Industry and Innovation*, 24(1), 8–40. https://doi.org/10.1080/13662716.2016.1240068

Brislin R.W. (1970) Back-translation for cross-cultural research. *Journal of Cross-Cultural Psychology,* 1(3), 185–216. https://doi.org/10.1177/135910457000100301

Capaldo A., Petruzzelli A.M. (2011) In search of alliance-level relational capabilities: Balancing innovation value creation and appropriability in R&D alliances. Scandinavian Journal of Management, 27(3), 273–286. https://doi.org/10.1016/j.scaman.2010.12.008

Cenamor J., Parida V., Wincent J. (2019) How entrepreneurial SMEs compete through digital platforms: The roles of digital platform capability, network capability and ambidexterity. *Journal of Business Research,* 100, 196–206/ https://doi.org/10.1016/j.jbusres.2019.03.035

Chaudhary S., Kaur P., Talwar S., Islam N., Dhir A. (2022) Way off the mark? Open innovation failures: Decoding what really matters to chart the future course of action. Journal of Business Research, 142, 1010–1025. https://doi.org/10.1016/J.JBUSRES.2021.12.062

Cheah S.L.Y., Ho Y.P., Li S. (2021) Search strategy, innovation and financial performance of firms in process industries. *Technovation*, 105, 102257. https://doi.org/10.1016/j.technovation.2021.102257

Cheng C.C.J., Huizingh E.K.R.E. (2014) When is open innovation beneficial? The role of strategic orientation. *Journal of Product Innovation Management,* 31(6), 1235–1253. https://doi.org/10.1111/JPIM.12148

Chesbrough H. (2003) The Logic of Open Innovation. *California Management Review,* 45(3), 33–58. https://doi.org/10.1177/000812560304500301

Chesbrough H. (2011) Bringing open innovation to services. *Sloan Management Review*, 52, 85–90.

Chesbrough H., Vanhaverbeke W., West J. (2014) *New frontiers in open innovation.* Oxford: Oxford University Press.

Chiang Y., Hung K. (2010) Exploring open search strategies and perceived innovation performance from the perspective of inter-organizational knowledge flows. *R&D Management*, 40, 292–299. https://doi.org/10.1111/j.1467-9310.2010.00588.x

Chiesa V., Frattini F., Lazzarotti V., Manzini R. (2009) Performance measurement in R&D: Exploring the interplay between measurement objectives, dimensions of performance and contextual factors. *R&D Management*, 39, 487–519. https://doi.org/10.1111/j.1467-9310.2009.00554.x

Coelho D.A., Nunes F., Vieira F.L. (2016) The impact of crowdsourcing in product development: An exploratory study of Quirky based on the perspective of participants. *International Journal of Design Creativity and Innovation*, 6(1–2), 1–15, https://doi.org/10.1080/21650349.2016.1216331

Colapinto C., Porlezza C. (2012) Innovation in creative industries: From the quadruple helix model to the systems theory. Journal of the Knowledge Economy, 3(4), 343–353. https://doi.org/10.1007/s13132-011-0051-x

Cricelli L., Greco M., Grimaldi M. (2015) Assessing the open innovation trends by means of the Eurostat Community Innovation Survey. *World Scientific*, 20(3), 1650039. https://doi.org/10.1142/S1363919616500390

Dahlander L., Gann D. (2010) How open is innovation? *Research Policy*, 39, 699–709. https://doi.org/10.1016/j.respol.2010.01.013

Dahlander L., Gann D.M., Wallin M.W. (2021) How open is innovation? A retrospective and ideas forward. *Research Policy*, 50(4), 104218. https://doi.org/10.1016/j.respol.2021.104218

Ebitu E.T., Basil G., Alfred U.J. (2016) An appraisal of Nigeria's micro, small and medium enterprises (MSMEs): Growth, challenges and prospects. *British Journal of Marketing Studies*, 4(5), 21–36.

Elia G., Messeni Petruzzelli A., Urbinati A. (2020) Implementing Open Innovation through Virtual Brand Communities: A Case Study Analysis in the Semiconductor Industry. *Technological Forecasting and Social Change*, 155, 119994. https://doi.org/10.1016/J.TECHFORE.2020.119994

Faems D., Van Looy B., Debackere K. (2005) Interorganizational collaboration and innovation: Toward a portfolio approach. *Journal of Product Innovation Management,* 22, 238–250. https://doi.org/10.1111/j.0737-6782.2005.00120.x

Fan B., Li Z., Desouza, K. C. (2022). Interagency collaboration within the city emergency management network: A case study of Super Ministry Reform in China. *Disasters*, 46(2), 371–400. https://doi.org/10.1111/DISA.12495

Faridian P.H., Neubaum D.O. (2021) Ambidexterity in the age of asset sharing: Development of dynamic capabilities in open source ecosystems. *Technovation*, 99, 102125. https://doi.org/10.1016/j.technovation.2020.102125

Fleming C.M., Bowden M. (2009) Web-based surveys as an alternative to traditional mail methods. *Journal of Environmental Management*, 90(1), 284–292. https://doi.org/10.1016/J.JENVMAN.2007.09.011

Frishammar J., Richtnér A., Brattström A., Magnusson M., Björk J. (2018) Opportunities and challenges in the new innovation landscape: Implications for innovation auditing and innovation management. *European Management Journal,* 37(2), 151–164. https://doi.org/10.1016/j.emj.2018.05.002

Galati F., Bigliardi B. (2017) Does different NPD project's characteristics lead to the establishment of different NPD networks? A knowledge perspective. *Technology Analysis and Strategic Management*, 29(10), 1196–1209. https://doi.org/10.1080/09537325.2016.1277581

Gassmann O., Enkel E., Chesbrough H. (2010) The future of open innovation. *R&D Management*, 40, 213–221. https://doi.org/10.1111/j.1467-9310.2010.00605.x

Gentile-Lüdecke S., Torres de Oliveira R., Paul J. (2020) Does organizational structure facilitate inbound and outbound open innovation in SMEs? *Small Business Economics,* 55(4), 1091–1112. https://doi.org/10.1007/s11187-019-00175-4

Germonprez M., Levy M., Kendall J.E., Kendall K.E. (2020) Tapestries of innovation: Structures of contemporary open source project engagements. *Journal of the Association for Information Systems,* 21(3), 615–663. https://doi.org/10.17705/1jais.00615

Grimaldi M., Greco M., Cricelli L. (2021) A framework of intellectual property protection strategies and open innovation. *Journal of Business Research*, 123, 156–164. https://doi.org/10.1016/J.JBUSRES.2020.09.043

Gurca A., Bagherzadeh M., Markovic S., Koporcic N. (2021) Managing the challenges of business-to-business open innovation in complex projects: A multi-stage process model. *Industrial Marketing Management*, 94, 202–215. https://doi.org/10.1016/J.INDMARMAN.2020.05.035

Hair J.F., Sarstedt M., Ringle C.M. (2019) Rethinking some of the rethinking of partial least squares. *European Journal of Marketing,* 53(4), 566–584. https://doi.org/10.1108/EJM-10-2018-0665

Hinteregger C., Durst S., Temel S., Yesilay R.B. (2019) The impact of openness on innovation in SMEs. *International Journal of Innovation Management,* 23(1), 1950003. https://doi.org/10.1142/S1363919619500038

Hossain M., Lassen A.F. (2017) How do digital platforms for ideas, technologies, and knowledge transfer act as enablers for digital transformation? *Technology Innovation Management Review,* 7(9), 55–60.

Huizingh E.K.R.E. (2011) Open innovation: State of the art and future perspectives. *Technovation,* 31, 2–9. https://doi.org/10.1016/j.technovation.2010.10.002

Ili S., Albers A., Miller S. (2010) Open innovation in the automotive industry. *R&D Management,* 40(3), 246–255. https://doi.org/10.1111/J.1467-9310.2010.00595.X

Jahanmir S.F., Cavadas J. (2018) Factors affecting late adoption of digital innovations. *Journal of Business Research*, 88, 337–343. https://doi.org/10.1016/J.JBUSRES.2018.01.058

Jennings P., Beaver G. (1997) The Performance and Competitive Advantage of Small Firms: A Management Perspective. *International Small Business Journal,* 15(2), 63–75. https://doi.org/10.1177/0266242697152004

Kauffman S.A. (1993) *The Origins of Order: Self-Organization and Selection in Evolution*, New York: Oxford University Press.

Kontolaimou A., Tsakanikas A., Giotopoulos I., Korra E. (2017) What drives ICT adoption by SMEs? Evidence from a large-scale survey in Greece. *Journal of Business Research*, 81, 60–69. https://doi.org/10.1016/j.jbusres.2017.08.007

Laursen K., Salter A.J. (2014) The paradox of openness: Appropriability, external search and collaboration. *Research Policy*, 43(5), 867–878. https://doi.org/10.1016/j.respol.2013.10.004

Lee S.M., Olson D.L., Lee S.H. (2009) Open process and open-source enterprise systems. *Enterprise Information Systems*, 3(2), 201–209. https://doi.org/10.1080/17517570902777624

Lee Y.W. (2014) Crafting rules: Context-reflective data quality problem solving. *Journal of Management Information Systems*, 20(3), 93–119. https://doi.org/10.1080/07421222.2003.11045770

Li W., Liu K., Belitski M., Ghobadian A., O'Regan N. (2016) E-Leadership through strategic alignment: An empirical study of small-and medium-sized enterprises in the digital age. *Journal of Information Technology*, 31(2), 185–206. https://doi.org/10.1057/jit.2016.10

Lichtenthaler U. (2009) Outbound open innovation and its effect on firm performance: Examining environmental influences. *R&D Management,* 39, 317–330. https://doi.org/10.1111/j.1467-9310.2009.00561.x

Lichtenthaler U. (2011) Open innovation: Past research, current debates, and future directions. *Academy of Management Perspectives*, 25, 75–93. https://doi.org/10.5465/amp.25.1.75

Linnenluecke M., Smith T. (2018) Adaptation of MSMEs to climate change: A review of the existing literature. In: *Private-sector action in adaptation: Perspectives on the role of micro, small and medium size enterprises* (eds. C. Schaer, N. Delani), Copenhagen: DTU, pp. 19–27.

Malhotra A., Majchrzak A., Niemiec R.M. (2017) Using public crowds for open strategy formulation: Mitigating the risks of knowledge gaps. *Long Range Planning,* 50(3), 397–410, https://doi.org/10.1016/j.lrp.2016.06.004

Nambisan S., Sawhney M. (2007) A buyer's guide to the innovation bazaar. *Harvard Business Review,* June 2007.

Naqbia A.E., Alshurideh M., AlHamad A., Al Barween K. (2020). The impact of innovation on firm performance: A systematic review. *International Journal of Innovation, Creativity and Change,* 14(5), 31–58.

Natalicchio A., Messeni Petruzzelli A., Cardinali S., Savino T. (2018) Open innovation and the human resource dimension: An investigation into the Italian manufacturing sector. *Management Decision,* 56(6), 1271–1284. https://doi.org/10.1108/MD-03-2017-0268

Niesten E., Stefan I. (2019) Embracing the paradox of interorganizational value co-creation – value capture: A literature review towards paradox resolution. *International Journal of Management Reviews,* 21(2), 231–255. https://doi.org/10.1111/ijmr.12196

Obradović T., Vlačić B., Dabić M. (2021) Open innovation in the manufacturing industry: A review and research agenda. *Technovation,* 102, 102221. https://doi.org/10.1016/j.technovation.2021.102221

Ovuakporie O.D., Pillai K.G., Wang C., Wei Y. (2021) Differential moderating effects of strategic and operational reconfiguration on the relationship between open innovation practices and innovation performance. *Research Policy*, 50(1), 104146. https://doi.org/10.1016/j.respol.2020.104146

Perkmann M., West J. (2015) Open science and open innovation: Sourcing knowledge from universities. In: *The Chicago Handbook of University Technology Transfer and Academic Entrepreneurship* (eds. A.N. Link, D.S. Siegel, M. Wright), Chicago: University of Chicago Press, pp. 41–74.

Pfeffer J., Salancik G. (2003) *External control of organizations — Resource dependence perspective,* Stanford, CA: Stanford University Press.

Psomas E., Kafetzopoulos D., Gotzamani K. (2018) Determinants of company innovation and market performance. *The TQM Journal*, 30(1), 54–73. https://doi.org/10.1108/TQM-07-2017-0074

Rai A., Tang X. (2010) Leveraging IT capabilities and competitive process capabilities for the management of interorganizational relationship portfolios. *Information Systems Research,* 21(3), 516–542. https://doi.org/10.1287/ISRE.1100.0299

Ramirez-Portilla A., Cagno E., Brown T.E. (2017) Open innovation in specialized SMEs: The case of supercars. *Business Process Management Journal,* 23(6), 1167–1195. https://doi.org/10.1108/BPMJ-10-2016-0211/FULL/HTML

Rohrbeck R., Hölzle K., Gemünden H.G. (2009) Opening up for competitive advantage — How Deutsche Telekom creates an open innovation ecosystem. *R&D Management,* 39, 420–430. https://doi.org/10.1111/j.1467-9310.2009.00568.x

Saura J.R., Palacios-Marqués D., Ribeiro-Soriano D. (2022) Exploring the Boundaries of Open Innovation: Evidence from Social Media Mining. *Technovation,* 119, 102447. https://doi.org/10.1016/J.TECHNOVATION.2021.102447

Schillo R.S., Kinder J.S. (2017) Delivering on societal impacts through open innovation: A framework for government laboratories. *Journal of Technology Transfer,* 42(4), 977–996. https://doi.org/10.1007/S10961-016-9521-4

Schroll A., Mild A. (2011) Open innovation modes and the role of internal R&D: An empirical study on open innovation adoption in Europe. *European Journal of Innovation Management,* 14(4), 475–495. https://doi.org/10.1108/14601061111174925/FULL/HTML

Stefan I., Hurmelinna-Laukkanen P., Vanhaverbeke W., Oikarinen E.L. (2022) The dark side of open innovation: Individual affective responses as hidden tolls of the paradox of openness. *Journal of Business Research*, 138, 360–373. https://doi.org/10.1016/j.jbusres.2021.09.028

Strazdas R., Cerneviciute J., Jancoras Z. (2014) Dynamics of the understanding of innovation in the context of the development of traditional and creative industries. *Transformations in Business and Economics*, 13(2), 377–395.

Tether B.S., Tajar A. (2008) Beyond industry university links: Sourcing knowledge for innovation from consultants, private research organisations and the public science-base. *Research Policy*, 37, 1079–1095. https://doi.org/10.1016/j.respol.2008.04.003

Tobiassen A.E., Pettersen I.B. (2018) Exploring open innovation collaboration between SMEs and larger customers: The case of high-technology firms. *Baltic Journal of Management,* 13(1), 65–83. https://doi.org/10.1108/BJM-01-2017-0018/FULL/HTML

Torkkeli M., Kock C., Salmi P. (2009) The "open innovation" paradigm: A contingency perspective. *Journal of Industrial Engineering and Management,* 2, 176–207. http://dx.doi.org/10.3926/jiem..v2n1.p176-207

Torres de Oliveira R., Gentile-Lüdecke S., Figueira S. (2021) Barriers to innovation and innovation performance: The mediating role of external knowledge search in emerging economies. *Small Business Economics*, 58, 1953–1974. https://doi.org/10.1007/s11187-021-00491-8

Urbinati A., Chiaroni D., Chiesa V., Frattini F. (2020) The role of digital technologies in open innovation processes: An exploratory multiple case study analysis. *R&D Management,* 50(1), 136–160. https://doi.org/10.1111/radm.12313

Van De Vrande V., De Jong J.P.J., Vanhaverbeke W., De Rochemont M. (2009) Open innovation in SMEs: Trends, motives and management challenges. *Technovation,* 29, 423–437. https://doi.org/10.1016/j.technovation.2008.10.001

Viglia G., Pera R., Bigné E. (2018) The determinants of stakeholder engagement in digital platforms. *Journal of Business Research*, 89, 404–410. https://doi.org/10.1016/J.JBUSRES.2017.12.029

Von Hippel E. (1988) *The Sources of Innovation,* New York: Oxford University Press.

Wagner S. (2010) Supplier traits for better customer firm innovation performance. *Industrial Marketing Management*, 39: 1139–1149. https://doi.org/10.1016/j.indmarman.2009.12.001

West J., Salter A., Vanhaverbeke W., Chesbrough H. (2014) Open innovation: The next decade. *Research Policy*, 43, 805–811. http://dx.doi.org/10.1016/j.respol.2014.03.001

West J.C. (2015) The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies. *Psychiatry,* 78(4), 380–383. https://doi.org/10.1080/00332747.2015.1105632

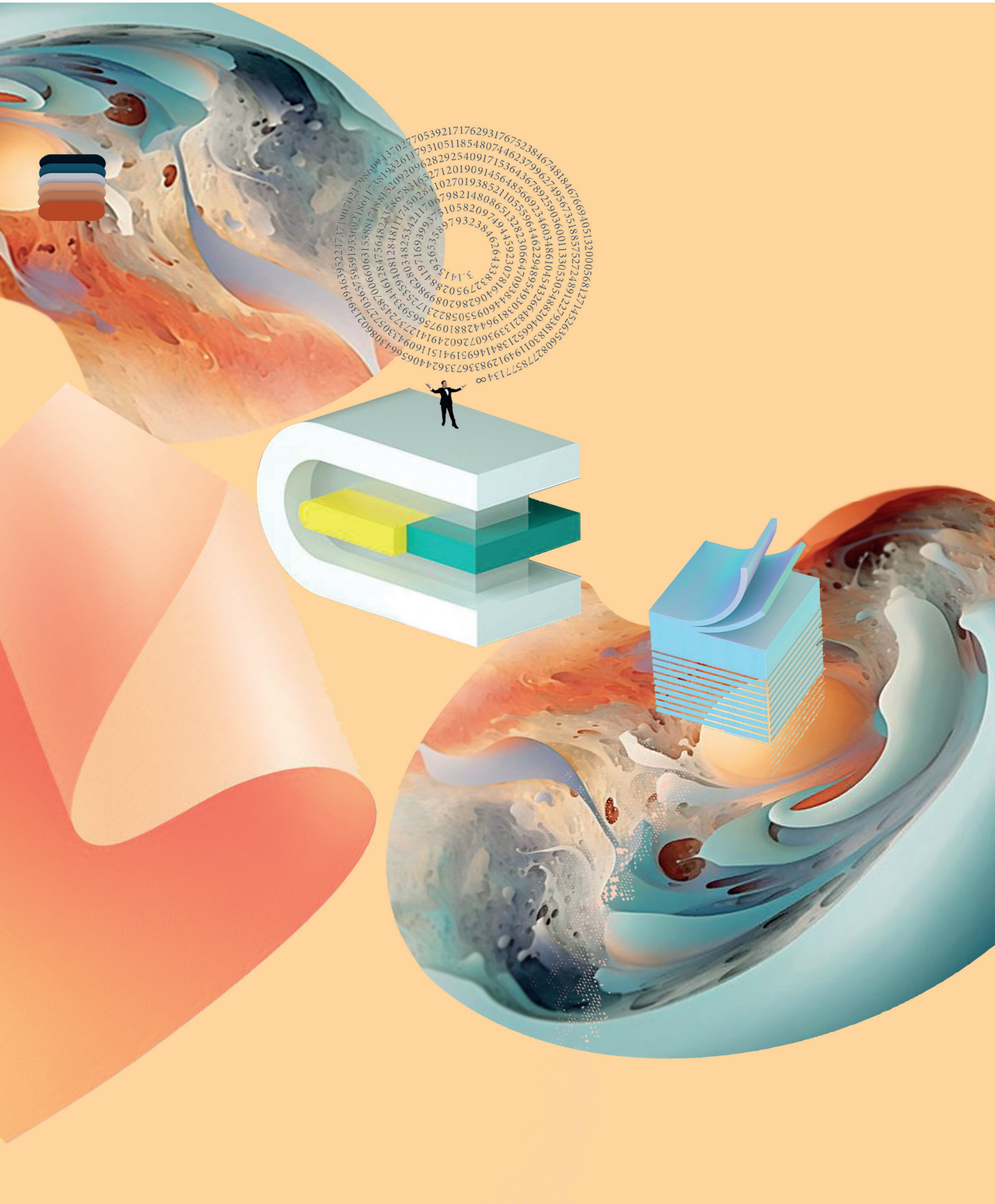
Wu S., Ding X., Liu R., Gao H. (2021) How does IT capability affect open innovation performance? The mediating effect of absorptive capacity. *European Journal of Innovation Managament*, 24(1), 43–65, https://doi.org/10.1108/EJIM-02-2019-0043

Wynarczyk P. (2013) Open innovation in SMEs: A dynamic approach to modern entrepreneurship in the twenty-first century. *Journal of Small Business and Enterprise Development*, 20(2), 258–278. https://doi.org/10.1108/14626001311326725/FULL/HTML

Wynarczyk P., Panagiotis Piperopoulos P., McAdam M. (2013) Open innovation in small and medium-sized enterprises: An overview. *International Small Business Journal: Researching Entrepreneurship,* 31(3), 240–255. https://doi.org/10.1177/0266242612472214

Zhong Q., Sun Y. (2020) The more the better? Relational governance in platforms and the role of appropriability mechanisms. *Journal of Business Research,* 108, 62–73. https://doi.org/10.1016/j.jbusres.2019.10.021

Zobel A.K. (2017) Benefiting from open innovation: A multidimensional model of absorptive capacity. *Journal of Product Innovation Management*, 34(3), 269–288. https://doi.org/10.1111/jpim.12361



The Landscape of Foresight Theory and Practice: Between Strategic and Transformational Orientation

Marcus Anthony
Associate Professor, marcus.anthony@cgt.bitzh.edu.cn

Beijing Institute of Technology in Zhuhai, Xiangzhou, Zhuhai 519087, China

Abstract

Foresight researchers, like other professional communities, are evolving to more sophisticated theories and practices that address complex problems at new levels, requiring a holistic view of complex social, economic, technological and environmental systems. There is an emerging need to understand the nature of complex systems in order to develop appropriate thinking beyond established notions of the nature of capabilities. The heterogeneous ability to absorb new knowledge has led to the emergence in Foresight research circles of a philosophical division between a relatively narrow (in the logic of corporate strategies) and a more holistic, transformative view of the future. The article assesses the extent of this division and the dynamics of its change through a sample analysis of the practices of the world's leading Foresight centers. An overview of their philosophies, concepts and practices is presented, and the degree of readiness for a systemic approach through the prism of the five dimensions of Foresight is assessed.

The study reveals a not so obvious trend - many centers understand the value and effectiveness of systems theory for solving contemporary problems in an increasingly complex context and are introducing "systemic" into their philosophy. However, there are difficulties in synthesizing the rational and irrational aspects in strategic thinking that are embedded in historical and cognitive dimensions. Overcoming this cognitive dichotomy allows Foresight practitioners to "see the future far, deep and inclusive in its wholeness", and gain a more accurate picture of what is coming and how to prepare for it proactively.

Keywords: history of strategic planning science; transformation; Foresight; futures studies; methods; ways of knowing; strategic management; scenario planning; future visioning

Citation: Anthony M. (2024) The Landscape of Foresight Theory and Practice: Between Strategic and Transformational Orientation. *Foresight and STI Governance*, 18(3), pp. 41–53.
DOI: 10.17323/2500-2597.2024.3.41.53

Introduction

In the rapidly evolving landscape of the twenty-first century, the related disciplines of Foresight and Futures Studies have emerged as vital arenas for strategic thinking. This paper offers an overview of contemporary practices and philosophies in these fields, emphasizing how their methodologies potentially shape our understanding of organisations, society and the future. Through an analysis of 10 influential Foresight organizations across Europe, Asia and the USA, this study aims to identify the common approaches and practices that characterize the current state of Foresight practice. This paper will also identify novel approaches, as well as suggest any notable absences and potential shortcomings in the employment of Foresight tools. Finally, in a broader civilizational sweep, this paper will summarize the typical ways of knowing and being that are either explicit or implicit within the cultures of these ten Foresight organizations. To this end, five domains of Foresight practice will be elucidated within each organisation: the empirical, interpretive, critical, creative, and mindful.

To contextualize this exploration, the study begins with a brief historical mapping of the recent history of both Foresight and systems theory. This historical context serves as a backdrop for an examination of the evolution of Foresight practices, especially in the current era.

Deep Futures vs Money and Machines Futures

Mintzberg (2022) has pointed to an unbridged chasm in "strategic management:" the divide between analytical and synthesizing management schools. He argues that the former is aligned with the thinking of Herbert Simon (focusing on the programming of work, and emphasizing "analysis" as a prime cognitive process); while the latter features consistencies with the thinking of Ludwig von Bertalanffy (arguing from General Systems Theory, and emphasizing "synthesis" as prime cognitive process). Mintzberg argues that there has been no successful bridge between these two kinds of strategic management.

This study recognizes a related significant philosophical divide within the Foresight community: that between "strategic foresight" and the more philosophical perspectives of «transformative foresight» (Anthony, 2022; Inayatullah, 2018; Markley, 2015; Marx Hubbard, 2015; Slaughter, 2020; Sweeney, 2024). In a related critique, I have previously highlighted limitations within some Foresight work, using a juxtaposition of "Deep Futures" and "Money and Machines" Futures (Anthony, 2010). Money and Machines Futures feature an imbalanced focus on technology and capitalism, shifting values away from deeper, more embodied, and mindful experiences. These futures involve estrangement from nature, with excessive time spent in artificial environments. These techno-centric futures also typically involve a disconnection from the body and its emotional intelligence, as well as from the psyche, leading to diminished self-awareness and an over-reliance on abstract rationality ("left-brained" logic, analysis, and empiricism). Alternatively, Deep Futures feature a greater balance between reason and other ways of knowing, including the introspective, intuitive, mindful, and spiritual approaches, with more emphasis on embodiment and mindful presence. There is also a greater valuing of sustainability, deep connection with nature, and recognition of the importance of human relationships, communities, and well-being (Anthony, 2022, 2023).

Strategic foresight organizations typically seek to assist the survival of organizations; focussing upon measurable outcomes, and analytical methods. In contrast, transformative foresight often has a broader focus, such as the longer-term, sustainable futures of human civilization and the planet. The argument put forward in this paper is that transformative foresight holds the greater potential of the two fields for genuine systemic changes.[1]

By offering an overview of important distinctions between strategic and transformative Foresight, and examining the philosophy and practices of ten leading foresight organisations today, this paper seeks to enhance understanding of the broader discourse on Foresight. The aim is to potentially contribute to the creation of a more balanced discourse, as we engage increasingly complex futures.

This research project begins with the hypothesis that transformative foresight organizations will tend to more commonly practice and embody systems thinking – including honouring relationships and connectivity with people and the planet. Conversely, it is hypothesised that those found to be practicing strategic foresight will tend to be more analytical and feature more of the techno-centric foci of Money and Machines Futures.[2]

Finally, this study invites exploration into how greater balance and depth might be brought to strategic foresight and strategic management in general. However, first we shall briefly explore the relatively brief histories of contemporary systems theories and Foresight itself.

A Brief History of Systems Thinking

Systems theory began in the early 20th century, emerging from biology, engineering, and social sciences. Bi-

[1] Yet this is not to dismiss the important contributions of strategic foresight. Alex Fergnani (2022), for example, has defended the more narrowly-focused corporate approach of many Foresight and Futures organizations. Corporate foresight drives strategic innovation, maintains competitive edge, anticipates future trends, navigates uncertainty, and improves decision-making, Fergnani argues. Fergnani thus emphasizes the practical advantages of corporate-based foresight over the idealized goals of more visionary futures work.

[2] Of course, the dichotomy between transformative and strategic foresight is not always precise; and foresight organisations may practice either at any given time, or in regard to any particular project. Nor is it suggested that the two fields operate in complete isolation from each other, nor that they cannot co-exist. Indeed, one framing of the dynamic is that one might naturally emerge from the other. Using the terminology of integral philosophy (Slaughter, 2020), transformative foresight might be seen include and transcend strategic foresight, given that the former typically includes strategic foresight's preferred empirical and analytical ways of knowing and being, but supplements them with the creative and mindful.

ologist Ludwig von Bertalanffy was a key figure, introducing «organismic biology» in the 1930s. He argued that biological systems should be understood as wholes rather than as isolated components (Bertalanffy, 1932). A decade later, Norbert Wiener's (1948) development of cybernetics, including his ideas on feedback loops and self-regulation, had a significant cross-disciplinary impact. In the social sciences, Talcott Parsons' structural functionalism was significant. He argued that society is a complex system where all parts contribute to the stability and function of the whole. These early systems approaches influenced sociological thought, encouraging further interdisciplinary thinking about how different social structures interconnect. During World War Two, operations research also contributed to systems thinking, when scientific methods were used to optimize resource allocation and planning in complex military operations (Churchman, 1968).

After 1950, systems theory expanded significantly. In 1954, the Society for General Systems Research was founded to promote interdisciplinary study of systems (Rudy, 1980). This facilitated the exchange of ideas across diverse fields.

In the 1960s and 1970s, Peter Senge popularized systems thinking within management and organizational theory. In the 1990s, *The Fifth Discipline* introduced the concept of learning organizations, stressing the value of seeing organizations as interconnected systems to improve adaptability and responsiveness (Senge, 1990).

The 1980s featured Peter Checkland's (1981) soft systems methodology, emphasizing the complexity of real-world problems and promoting flexible, participatory problem-solving approaches. This method highlighted the importance of understanding the social and stakeholder dynamics via systems analysis. Around the same time, complexity theory emerged, with scholars like Ilya Prigogine demonstrating that systems can exhibit behaviors not predictable from their individual components. The theory of self-organization and emergent properties was influential in fields like ecology, economics, and sociology (Prigogine, Stengers, 1997).

In recent decades, systems thinking has been widely applied to global challenges, including climate change and public health crises. The work of Donella Meadows (1999) in systems dynamics reinforced the need for systems-based approaches in policy-making, to address complex societal issues. After the year 2000, in Foresight work, systems thinking and the idea of complexity became notable amongst many futurists, including Richard Slaughter (2020) and Sohail Inayatullah (2018).

It can be seen that systems theory thinking has evolved from its early theoretical foundations to be applied more widely as practical tool for addressing multifaceted problems. Key figures like Senge and Prigogine expanded its scope, making systems thinking an essential framework for understanding complex global challenges.

One component of this study is to ascertain whether systems thinking is truly influential in Foresight theory and practice today – and whether it is helping to transcend Mintzberg's idea of delimited strategic management culture. The latter outcome would be suggestive of a contemporary expansion from strategic foresight into transformative foresight.

A Brief History of Foresight and Futures Studies

Foresight and futures studies developed rapidly after World War II, as technological advances and geopolitical changes spurred interest in long-term strategic planning. Therefore it trailed the development of systems thinking by just a few decades. Herman Kahn, a co-founder of the Hudson Institute, pioneered Scenario Planning in the 1960s, helping organizations explore multiple future scenarios to make better decisions (Kahn, 1960). The RAND Corporation also contributed significantly to futures studies during this period, conducting research on technological forecasting and policy analysis. RAND developed the Delphi method, a systematic process for gathering expert opinions to generate forecasts (Dalkey & Helmer, 1963). During the 1970s and 1980s, there was a period of Foresight institutionalization, and this featured further methodological developments. The Institute for the Future (IFTF), established in 1968, focused on long-range forecasting and Scenario Planning. The first International Conference on Futures Studies in 1970 helped legitimize the field globally. Further, Edward Cornish introduced the concept of «futures literacy,» advocating critical thinking about the future (Cornish, 1977). Notably, this is when systems thinking began influencing futures studies, especially through Peter Senge's work in the 1980s, which promoted a holistic view of organizational and societal futures (Senge, 1990).

The 1990s ushered in technological advances that transformed Foresight practices. The emergence of the internet and digital tools made it easier to gather data and conduct sophisticated scenario analyses using computer modelling. The World Future Society played a key role in disseminating futures research, publishing journals, and organizing conferences. During the 2000s, Foresight increasingly became part of government strategic planning. The European Union initiated Foresight projects to inform policies and foster innovation (Georghiou et al., 2008). These projects emphasized the growing role of Foresight in addressing social, technological, and economic change.

In recent years, Foresight has begun to play a more important role in tackling global issues like climate change, public health crises, and technological disruptions. The COVID-19 pandemic highlighted the importance of strategic foresight in navigating uncertainties. Participatory approaches have gained traction, with tools like Backcasting and design thinking allowing communities to engage in Futures planning. Organizations such as the Millennium Project, established in 1996, continue to drive global Foresight efforts, integrating artificial intelligence and big data into their methodologies (Glenn et al., 2014).

In general, in recent years there has been an increasing prevalence of systems thinking and criticality in Foresight, as evidenced in the progressive ideas of numerous practitioners like Richard Slaughter (2020), Andy Hines and Peter Bishop (2013) and Sohail Inayatullah (2018). As the world faces increasing complexity, the role of Foresight in shaping resilient, sustainable futures has become more crucial.

Foresight and futures studies have thus evolved significantly since 1950, transitioning from early Scenario Planning techniques to contemporary methods that involve technological integration, global collaboration and deep questioning about the future and humanity's place in nature.

In the following section, we shall begin our examination of the cultures and practices of ten prominent contemporary Foresight organisations, by first identifying five common domains of Foresight practice.

The Five Domains of Foresight

The core of this paper centres on the cultures and practices of the ten selected organizations and thinkers, examining their methodologies and the depth of their analyses. Sohail Inayatullah's (2018) taxonomy of Foresight approaches has been modified and adopted for this purpose, given its straightforward framework and potential in elucidating distinctions amongst the ten focus organizations. Inayatullah's first three domains of Foresight – "the empirical", "interpretive", and "critical" – have been retained here, with a modified fourth domain. A fifth domain has then been added.

Inayatullah's fourth domain is «anticipatory action learning,» which has been changed to simply the «creative» domain, as this term covers more ground. Finally, a fifth category – "mindful" – has been included because historically there has often been a transcendent or even spiritual dimension to much futures thinking. This domain is largely absent in mainstream institutions in the current digital age, including amongst strategic foresight practitioners, arguably because of the long historical exclusion of the religious and spiritual from western science and education since the scientific enlightenment of the 1700s (Anthony, 2008). This exclusion could also be interpreted as evidence that this domain has outlived its historical usefulness amidst today's "greater" scientific understandings. However, taking a more historically distanced perspective, and given the vast scope of "the future," the contemporary absence of "the mindful" may merely be a temporary hiatus. It is notable that there is currently a resurgence of the topic of mindfulness in many scientific and academic fields, especially in medicine, cognitive sciences, and business and innovation management (Carole et al., 2024; Gómez-Olmedo et al., 2024; Morin, Grondin, 2024; Ping, Long, 2024; Remscar et al., 2023;). This trend is also strong in educational settings, where mindfulness is typically discussed in the context of increasing concerns about the negative impacts of modern technology and devices on student focus, engagement and mental well-being (Anthony, 2022; Dunning et al., 2019). A growing number of authors are thus addressing this topic in and beyond the Foresight and management communities, giving it special importance.

These historical and contermporary contexts compel the inclusion of a fifth domain of Foresight.:

- ***The Empirical*** – data collection and processing. Predominantly forecasting and Horizon Scanning.
- ***The Interpretive*** – analysing situations, and examining the meanings we apply to people and events, and to change across time, space, and civilization.
- ***The Critical*** – elucidating and questioning the worldviews and assumptions behind futures thinking.
- ***The Creative*** – the practice of living, learning, teaching, imagining, planning and creating the future.
- ***The Mindful*** – questioning and practicing different ways of knowing and being; including the meditative, self-reflective, metacognitive, imaginative, and transcendent (spiritual).

This categorization format permits the drawing of important distinctions amongst the ten focus organizations. It also potentially helps highlight the strengths and weaknesses inherent in Foresight work in general, including revealing possible gaps in thinking and practice. The core of this paper thus centres on the practices of the selected organizations and thinkers, analyzing their methodologies and the depth of their cognitive approaches.

Situating the Foresight Organizations and Their Methods

Identifying the overt philosophies, tools and thinking processes of foresight organizations may help us to consider which domains of foresight they tend to operate from. For each of the ten organisations examined in this study, five domains of their Foresight practice cultures will be briefly outlined via an identification of their preferred foresight methods and preferred ways of knowing and being. Further, a brief qualitative evaluation of their systems thinking will be posited as a supplementary consideration. It is hypothesised that strategic and transformative foresight, respectively, will tend to express divergent expressions of these three characteristics. Those organisations with a tendency towards the practice of strategic foresight will tend to favour the empirical and interpretive domains of foresight. Conversely, transformative foresight organisations will tend to include more of the creative and mindful domains (and therefore their respective ways of knowing and being); while possibly using the critical domain to justify that expansion. Finally, it is postulated that transformative foresight organisations will tend to feature more systems thinking than strategic foresight organisations.

It is important to note that Foresight tools are rarely used in isolation; there are numerous possible combina-

tions of tools that could be employed in any given Foresight project or application. Table 1, below, lists the most common Foresight tools and processes found to be employed across the ten organisations within this study. The grouping process offered in Table 1 is somewhat subjective, and other practitioners within Foresight fields and beyond may categorize the tools differently. However, for the purposes of this study, the following general categorizations have been applied (Table 1).

The scope of this paper does not permit an in-depth discussion of my rationale for each of these categorizations, but a brief overview is posited, below.

The empirical tools are the simplest to situate. Horizon Scanning and Trends Analysis are clearly empirical tools. Delphi analyses are also empirical in that they seek to plot probable futures via data points—collating the perspectives of experts within a given focus area. Of course, each contributor may have employed any imaginable rational, analytical, or intuitive means to reach their conclusions, so interpretation plays a significant role.

The Futures Wheel is a visual brainstorming tool that explores the potential consequences of events or trends, and potentially spans the interpretive, critical and creative domains. It helps users visualize and analyze future impacts in a structured way. Starting with a central idea, first-order consequences are drawn around it, followed by second-order consequences, creating a branching structure that illustrates relationships between outcomes. This method encourages deeper thinking about impacts and aligns with systems thinking by emphasizing interconnections within a system.

Inayatullah's (2018) Causal Layered Analysis is arguably the most flexible and inclusive of all the methods and theoretically permits data and input from all five domains. However, at its core, it is predominantly interpretive and critical. It is also clearly compatible with systems thinking, with one of its four layers specifically devoted to considering society and its systems.

The aim of Inayatullah*'s Futures Triangle is to po*sit the most probable future of a focus issue. Practitioners do this by listing the inherent pushes (trends), pulls (common narratives and images), and weights (historical baggage and general roadblocks). The *Futures Triangle* thus values the empirical, the interpretive, and the creative.

Similarly, Backcasting begins with an imaginative Visioning of the future and then works backwards to the present to identify the possible steps to build that desirable future. Visioning aligns well with this tool. Visioning, in turn, encourages imaginative exploration of the future, with mindfulness and intuition possibly playing central roles. For example, Oliver Markley's (2015) innovative future Visioning methods emphasize creating future scenarios to support planning and decision-making. These methods incorporate creative and intuitive processes such as guided imagery and scenario building. Markley's innovative depth intuition includes techniques like Mental Time Travel and Experiencing the Needs of Future Generations (Markley, 2015). The primary goal is to enhance participants' perceptions and understanding of potential future developments, thereby improving their ability to anticipate and prepare for change. Markley argues that his methods are particularly beneficial for organizations and individuals in complex and uncertain environments (Markley, 2015).

Overview of the 10 Foresight Organisations

The ten organisations have largely been chosen at random. However, the selection predominantly European and Asian, with the exception of two American organisations. No attempt has been made to examine organisations and Foresight practice beyond these spaces. Most notably, there is no examination of individual practitioners.

Table 2, below offers an overview of the ten Foresight organisations which are the focus of this study.

What follows next is a brief overview of the ten selected Foresight organisations. Specifically, there is a discussion of their methods, ways of knowing and being, and engagement with systems thinking.

The Oxford Scenarios Planning School (OSPS), affiliated with the University of Oxford, features innova-

Table 1. **Foresight Tools Arranged According to the Five Domains of Foresight Practice**

Method	Practical dimension				
	Empirical	Interpretive	Critical	Creative	Mindful
Horizon Scanning	✓				
Trends Analysis	✓				
Delphi Method	✓	✓			
CLA		✓	✓		
Futures Wheel		✓	✓	✓	
Futures Triangle	✓	✓		✓	
Backcasting		✓		✓	
Visioning				✓	✓
Macrohistory		✓	✓		

Source: author.

Table 2. **Ten Selected Organizations Involved in Foresight Practice**

Name	Country of origin / headquarter location	Size	Year of foundation	Status (ownership)	Main target audience coverage	Partner networks
Oxford Scenario Planning School	Great Britain	Small	2005	University Division	Global	Global
Kishita Lab	Japan	Small	2016	University Division	National	National
WFSF	USA	Middle	1973	Independent	Global	Global
Insight-Foresight Institute	Spain	Small	2015	Independent research center	Regional (mainly Europe)	Regional (mainly Europe)
Tamkang Graduate Institute of Futures Studies	Taiwan	Small	2004	State	Global	Global
Shaping Tomorrow	Great Britain	Middle	2003	Private	Global	Global
Science & Technology Policy Institute (STEPI)	Korea	Middle	1987	State	National	Global
UN Futures Lab	France	Middle	2023	International network structure	Global	Global
Singapore Center Strategic Futures	Singapore	Unknown (network structure)	1969	State	National	Global
Houston Foresight	USA	Small	2005	University Division	National	Global

Source: author.

tive foresight methodologies, with a focus on Scenario Planning. The school assists organizations, including multinational corporations and governments, in navigating complex uncertainties like climate change and geopolitical disruptions. Their work helps entities develop long-term strategies through Scenario Planning, with notable clients such as Shell and the UK government (Ramirez, Wilkinson, 2016). The OSPS employs a systems theory approach, recognizing the complexity and interconnectedness of modern challenges. Their foresight philosophy moves beyond linear thinking to embrace systems science principles. By emphasizing stakeholder engagement and the inclusion of diverse knowledge systems, they aim to provide a more holistic understanding of future scenarios. This systems theory approach advocates for cross-sector collaboration and interdisciplinary thinking in Foresight processes (Wilkinson, Ramirez, 2015). The core method at OSPS is Scenario Planning, specifically identifying key drivers of change, developing multiple future scenarios, and engaging in strategic conversations with stakeholders. These scenarios function as narratives to explore different futures rather than predict them, fostering collaborative discussions aimed at generating insights for actionable strategies. Techniques such as quantitative Trends Analysis complement qualitative approaches, enhancing creativity, critical thinking, and collaboration in strategic planning (Ramirez, Wilkinson, 2016).

OSPS's focus on Scenario Planning suggests a preference for the interpretive and creative domains of Foresight practice. Their approach involves comprehensive analysis of stakeholder views and environmental factors, often utilizing tools like PESTLE (Political, Economic, Social, Technological, Legal, Environmental) and SWOT (Strengths, Weaknesses, Opportunities, Threats) analyses. This possibly positions the empirical domain as a secondary feature in their sensemaking structures, although Trends Analysis remains central to their scenario work. While their methods are predominantly analytical, they also engage in participatory workshops that include storytelling and role-playing. These techniques encourage emotional engagement, potentially fostering a deeper understanding of possible futures and enabling more mindful engagement with foresight[3]. Nonetheless, there is an absence of direct evidence that the mindful domain features significantly in their work.

Summary: The Oxford Scenario Planning School blends interpretive, empirical, and creative approaches in its foresight work, with a strong emphasis on Scenario Planning. Their methods highlight systemic interconnections and encourage collaborative, multi-stakeholder engagement to navigate uncertainty and explore future possibilities.

The Kishita Lab, based at the University of Tokyo, focuses on sustainable design and urban planning. The lab employs foresight methodologies rooted in systems science and theory. Collaborating with stakeholders like local governments, NGOs, and academic institutions, the lab contributes to sustainable urban development and climate change mitigation. Their research informs policy-making and urban planning through co-creation with communities, aligning with sustainability goals[4].

[3] https://www.sbs.ox.ac.uk/programmes/executive-education/person-programmes/oxford-scenarios-programme, accessed 09.08.2024.

[4] https://www.susdesign.t.u-tokyo.ac.jp/kishitalab/index_en.html, accessed 12.08.2024.

The Kishita Lab's philosophy is openly grounded in systems theory, acknowledging the interdependence of social, economic, and environmental systems. They emphasize integrating temporal dynamics into the design process, recognizing that sustainable solutions must consider long-term impacts. The lab explores how technology and society can interact to promote sustainability. Their participatory approach encourages collaboration across disciplines, ensuring holistic, adaptable strategies for urban and environmental challenges.

The Kishita Lab's work spans the empirical, interpretive and creative domains of Foresight. Empirically, they use tools like Geographic Information Systems (GIS) and life cycle assessments to understand urban systems and environmental impacts. Their analytical framework involves scenario simulations and modelling to evaluate future urban developments. As with most of the other organisations in this study, creative processes are emphasized through participatory design workshops, engaging stakeholders in co-creating solutions and incorporating creative methods like storytelling. However, it remains unclear from their online self-descriptions whether they encourage deeper, mindful ways of knowing and being. Nonetheless, their multidimensional approach encourages informed decision-making that integrates diverse perspectives and reflective insights.

Summary: The Kishita Lab employs a comprehensive approach to foresight that integrates empirical, analytical, and creative methods. Their systems theory-based philosophy supports sustainable urban development through collaboration with diverse stakeholders. By leveraging a variety of foresight techniques, the lab potentially contributes significantly to the practice of Foresight, promoting innovative, inclusive solutions for urban and environmental sustainability.

The World Futures Studies Federation (WFSF) is a leading organization advancing futures studies globally. It focuses on education, research, and the development of Foresight methodologies. Collaborating with educational institutions, governments, NGOs, and businesses, the WFSF aims to enhance futures thinking and capacity-building. Their work encompasses a wide range of global issues, including sustainability, technology, and social change, promoting a broad and inclusive approach to understanding and shaping future possibilities[5].

The WFSF embraces a progressive systems theory perspective, emphasizing the interconnectedness and complexity of global systems. It advocates for holistic and inclusive Futures thinking, recognizing the need to integrate diverse perspectives and address global issues such as sustainable development and social justice. The WFSF promotes understanding of systemic interactions and feedback loops, highlighting the importance of addressing macro trends and emerging uncertainties. Their approach includes collaborative efforts with governments, NGOs, and academic institutions to strategize for desirable futures.

The WFSF promotes various Foresight tools, including Scenario Planning, Backcasting, Trends Analysis, and Delphi surveys. These methods help identify emerging trends, risks, and opportunities, enabling individuals and organizations to prepare for diverse future outcomes. Scenario Planning and Backcasting are used to envision multiple future possibilities and shape strategies. The Delphi method facilitates expert consensus on future trends, while Trends Analysis helps track and interpret evolving patterns. The arts and story-telling are part of their Foresight toolkit. All these methods support a comprehensive understanding of potential futures and strategic decision-making.

The WFSF thus employs a systematic, multidisciplinary approach, drawing from economics, sociology, political science, and technology. It also uses empirical methods, such as data collection and Trends Analysis, to inform its Foresight work. The organization values critical thinking and philosophical frameworks to analyze complex issues. Nonetheless, the WFSF also incorporates elements of the creative and mindful domains of Foresight practice. Beyond their advocation of the arts and storytelling, they promote creativity and holistic thinking. Further, their integral/transdisciplinary approach aims for multi-perspectival and planetary inclusion. The WFSF's online self-description thus suggests that it embraces all five domains of Foresight practice.

Summary: The WFSF integrates analytical, empirical, and intuitive approaches in Futures work, emphasizing the interconnectedness of global systems. Its commitment to holistic and inclusive thinking supports diverse and innovative strategies for addressing global challenges, and is strongly indicative of transformative foresight practice.

The Insight-Foresight Institute (IFI), based in Spain, engages in Foresight consulting to help organizations craft long-term strategies[6]. The IFI's philosophy implicitly aligns with systems theory, emphasizing the interconnectedness and complexity of global systems. Driving "structural change" is a primary aim. By focusing on the interplay of various drivers of change and advocating for adaptability and resilience, the IFI adheres to systems thinking principles, integrating diverse perspectives to address complex future challenges (Börjeson et al., 2006).

The IFI utilizes a range of Foresight methods, including more quantitative processes like the Delphi Method and trends identification. Their self-description suggests a primary focus on the empirical and interpretive domains of Foresight. In the empirical domain, IFI uses statistical tools to measure social, economic, and technological indicators. Scenario Planning and SWOT are

[5] https://wfsf.org/about, accessed 27.07.2024.

[6] https://if-institute.org, accessed 18.08.2024.

also utilised in the interpretive domain. The creative domain is less represented[7].

While some of their language is suggestive of deeper introspection, the focus of the Insight-Foresight Institute is not in the mindful domain of Foresight. Their references to "insight" are in regard to analysing the present and past, not personal reflection. Further, their common reference to "transformative governance" focusses upon social and technical change, promoting greater balance in terms of diversity, connectivity, polycentricity and so on. Overall, these methods support the identification of emerging trends, risks, and opportunities, enabling stakeholders to develop informed and adaptable strategies for future challenges; yet with no obvious focus on the mindful domain of Foresight.

Summary: The Insight-Foresight Institute integrates empirical, interpretive, and creative methods in its foresight practices, reflecting a commitment to holistic and systems-oriented thinking. Their focus on strategic consulting, policy development, and education is aimed at enhancing organizational and societal preparedness for future uncertainties. Their employment of these methods, while emphasizing holistic interconnectedness, suggests the IFI is transformative futures organisation.

The Tamkang University Graduate Institute of Futures Studies (GIFS) has a comprehensive approach to futures research and education. GIFS offers graduate-level education in futures studies, focusing on diverse methodologies and analytical tools. Their work includes Foresight consulting, policy development, and research on societal challenges, technology, and environmental issues. GIFS collaborate with governments, businesses, and NGOs, providing expertise in strategic planning, policy-making, and impact assessment[8]. GIFS adopts a progressive systems theory philosophy, emphasizing systemic thinking and holistic approaches. The use of Inayatullah's (2018) Causal Layered Analysis features heavily in their programming, a method which is inherently inclusive of systems thinking. Methods like CLA enable deep exploration of futures by combining empirical, analytical, and intuitive approaches. GIFS also utilizes empirical methods, including data collection, Trends Analysis and the Delphi Method to guide their Foresight work. Their approach potentially merges the quantitative, philosophical, critical, creative and visionary. More mindful cognitive processes are also encouraged, with creative workshops and arts-based methods fostering holistic and emotional engagement.

Summary: The Tamkang University Graduate Institute of Futures Studies integrates empirical, analytical, and intuitive methods in its foresight practices. Their focus on systemic thinking and progressive philosophy, alongside a diverse range of methods, positions GIFS as a significant contributor to the field of Futures Studies.

Shaping Tomorrow is a private Foresight, software-based organization that aids businesses, governments, and other entities in navigating future challenges. Shaping Tomorrow offers customized services, including access to an AI-driven platform "Athena" thus helping clients anticipate change and develop adaptive strategies. Shaping Tomorrow's collaborative approach aims to empower organizations with the insights and tools needed to manage complexity and uncertainty[9]. Their methods are designed to help deepen understandings of relationships and dynamics across various domains, reflecting a system thinking approach. By engaging diverse stakeholders and fostering collaborative discussions, Shaping Tomorrow acknowledges the complexity and interrelation of social, economic, and environmental systems. Their commitment to a holistic perspective supports addressing multifaceted global challenges and crafting comprehensive strategies.

The organization utilizes all of empirical, interpretive, critical and creative methods in its foresight practices. Empirical methods, such as Trends Analysis and quantitative, AI-driven research, offer a structured approach to understanding emerging patterns. Their software supports rigorous analytical techniques, allowing data synthesis from diverse sources. Creative approaches are integrated through workshops that potentially promote emotional and holistic engagement. These processes also feature creative activities and collaborative exercises that explore varied perspectives. This blend potentially enhances the Foresight process by combining rational analysis with emotional and embodied insights. However, a probable limitation of the Shaping Tomorrow process is its predominantly online nature, potentially creating a less personal and mindful experience.

Summary: Shaping Tomorrow's work spans the empirical, interpretive, critical, and creative domains of Foresight. Their AI-driven software and participatory workshops highlight their commitment to understanding complex systems and engaging diverse perspectives. This approach potentially enables organizations to develop resilient strategies and navigate future challenges effectively, aligning with progressive systems theory principles.

The Korea Science and Technology Policy Institute (STEPI) is a leading organization in South Korea dedicated to Foresight and strategic planning in science and technology. Established to assist the government and other stakeholders, STEPI supports policy development through robust Foresight analysis. The institute conducts research on emerging technologies, provides advisory services to government bodies, and offers training programs to enhance foresight capabilities. STEPI also collaborates with universities, research institutions, and industries to integrate diverse perspectives into their foresight studies and policy recommenda-

[7] https://if-institute.org/transformative-governance-of-innovation-ecosystems, accessed 18.08.2024.

[8] http://future.tku.edu.tw/intro/super_pages.php?ID=intro1, accessed 24.06.2024.

[9] https://www.shapingtomorrow.com/about/our-system, accessed 17.06.2024.

tions[10]. STEPI's approach incorporates elements of systems theory (Kim, 2010). The organization recognizes the interconnectedness of technological, economic, and social factors, reflecting systems thinking principles. By using methods that include diverse stakeholder input and acknowledging the complexity of the systems they analyse, STEPI demonstrates a commitment to understanding the broader context of science and technology. Their participatory workshops further reveal an openness to diverse insights, aligning with systems theory's emphasis on inclusivity and holistic analysis. STEPI utilizes Foresight methods specifically designed for science and technology policy development. In the empirical domain, their technology-oriented Foresight research incorporates expert interviews, surveys, and literature reviews to identify emerging technologies and their societal impacts. Participatory workshops engage stakeholders in collaborative Foresight exercises, fostering collective intelligence and dialogue. STEPI primarily focuses on empirical and analytical methods. Their approach emphasizes rational measurement through technology foresight, Trends Analysis, and data-driven techniques. However, there is little evidence of exploration of the mindful domain, and the terms "mindful," "intuition," "meditation," and "spiritual" return no results when entered into STEPI's web site. Yet while the organization's core methods are predominantly empirical and analytical, participatory workshops introduce creative and potentially intuitive elements by encouraging personal contributions from diverse stakeholders.

Summary: The work of the Korea Science and Technology Policy Institute (STEPI) predominantly spans the empirical and interpretive domains of Foresight practice. Yet the common references to systems thinking and creativity suggest that they are not a purely strategic foresight organisation.

The United Nations Futures Lab is a strategic initiative under the United Nations designed to bolster Foresight and Futures thinking capabilities within organizations. The Lab aims to enhance the UN's ability to address complex global challenges through advanced Foresight practices. The Lab promotes a global multistakeholder network, engaging diverse sectors to address 21st-century challenges. The UN Futures Lab emphasizes participatory foresight, engaging stakeholders from various sectors such as governments, academia, civil society, the private sector, and philanthropic organizations. By fostering collaboration and inclusivity, the Lab aims to build Foresight capacity and advance future-oriented policies[11]. The UN Futures Lab demonstrates elements of systems theory through its emphasis on interconnectedness and complexity. The Lab's methodologies reflect an understanding of the relationships between different domains and the dynamics of change. Their commitment to participatory approaches aligns with systems theory principles by engaging diverse stakeholders and acknowledging the interconnectedness of global systems. However, the Lab's focus is more on pragmatic and strategic foresight, rather than deep critical reflections.

The UN Futures Lab employs Foresight methods to enhance understanding and planning for future challenges. These methods include Scenario Planning, Horizon Scanning and Trends Analysis. Participatory workshops engage diverse stakeholders to co-create insights and shared visions, while Futures tools such as the Futures Wheel, Backcasting, and Causal Layered Analysis help explore alternative futures and identify necessary transformations. The Lab's web site openly describes its process as "strategic foresight," as well as "participatory foresight," yet its stated methods suggest that it does not fit exclusively within the realm of strategic foresight, as earlier defined in this study.

It can be seen that the Lab's preferred ways of knowing and being span a diverse range of cognitive processes. The Lab utilizes structured approaches like Scenario Planning and Horizon Scanning to analyze complex data and trends, supporting evidence-based policy decisions. More personal and potentially mindful elements are fostered through participatory workshops, and allowing for innovative ideas and exploration of alternative futures. Although the Lab has an overt valorisation of observable trends and research, it synthesizes diverse insights rather than focusing solely on measurement. Guiding principles emphasize considering alternative futures, making decisions adaptable to various scenarios, preparing for opportunities and transformations, and using diverse data sources to anticipate significant changes early. Finally, its support for Causal Layered Analysis and alternative futures suggests an openness to criticality and deep thinking

Summary: The UN Futures Lab's wide range of foresight methods are used to address global challenges and guide future policy-making. The Lab's approach valorises the interpretive and empirical domains of Foresight, but with a strong emphasis on inclusivity and stakeholder engagement, while critically challenging dominant futures thinking. Its alignment with systems thinking highlights a commitment to understanding the complexity and interconnectedness of global issues. Yet as with most of the ten focus organisations in this study, the Lab's commitment is to practical Foresight and strategic planning, and so does not openly engage with the mindful domains of Foresight.

The Singapore Centre for Strategic Futures (CSF), operating under the Prime Minister's Office, plays a significant role in advancing Foresight and strategic planning within the Singapore government. By enhancing the government's ability to address future challenges and identify emerging opportunities, the CSF focuses on developing Foresight skills, understanding trends, and informing policy decisions. Collaborating with various stakeholders, including private sector organi-

[10] https://www.stepi.re.kr/site/stepien/main.do, accessed 19.06.2024.

[11] https://un-futureslab.org, accessed 12.07.2024.

zations and educational institutions, the CSF aims to build resilience and adaptability across multiple domains, including public policy development and capacity building[12].

CSF's work demonstrates systems thinking with its holistic approach, recognizing the interconnectedness of various elements within the systems they analyse. They have an emphasis on acknowledging complexity, interdependence, and inclusivity in Foresight practices. These are often implicit rather than explicit in their work.[13]

The Centre for Strategic Futures tends to be centred in the empirical and interpretive domains of Foresight practice. It engages Trends Analysis, Environmental Scanning through Emerging Issues Analysis, SWOT analysis, Backcasting, war-gaming techniques, and monitoring of emerging threats and opportunities with early warning systems. In the creative domain, participatory workshops entitled "FutureCraft" are integral to their process. These are designed to introduce key skills and tools relevant to government foresight work, and to engage stakeholders in generating innovative solutions and fostering collective sense-making. Their commitment to participatory futures ensures that diverse perspectives inform their processes, potentially enriching the understanding of complex changes. Moreover, through transition management, they seek to navigate change, while speculative design allows for the creation of tangible representations of possible.

Conclusion: The Singapore Centre for Strategic Futures utilizes a combination of empirical and analytical methods, with some creative elements present in their collaborative engagements. Their work spans public policy development, strategic planning, research, and capacity building, with a strong focus on engaging complexity. However, there is little evidence that the CSF spans the mindful domain of Foresight practice.

Houston Foresight is based at the University of Houston, USA, and it has developed a comprehensive approach to the teaching of Foresight as both theory and practice. The organization's students are drawn from across a wide spectrum of society, and they work with governmental agencies, non-profits and the private sector in navigating complex and uncertain futures. Houston Foresight's mission is to help students and clients enhance their strategic planning and decision-making capabilities, utilize foresight methodologies to anticipate and prepare for possible futures, and to foster a deeper understanding of emerging trends and disruptions.

Houston Foresight's methods are comprehensive, and span all five domains of Foresight practice: embracing all of empirical, interpretive, critical, creative and mindful approaches to futures thinking. These tools include Environmental Scanning, Trends Analysis, Scenario Planning, and participatory workshops. In the empirical domain, they utilise Environmental Scanning and Trends Analysis, gathering and evaluating quantitative data, which they see as essential for sectors like public policy and business. They also valorise the interpretive domain, where they dissect complex issues through Scenario Planning and policy analysis[14]. Additionally, in the creative domain they espouse a desire to help their students "envision, plan for, and work toward their preferred future." They also encourage creative engagement via workshops that incorporate storytelling, arts and crafts. Further, certain curricula feature a variety of concepts and tools which show a strong acceptance of the mindful domain. For example, the course "Alternative perspectives on the future" includes readings and discussions on spiral dynamics and integral theory, Causal Layered Analysis, intuition, Visioning, "presencing" and "big questions." This holistic approach is designed to enrich participants' understanding and emotional connection to the futures they explore, ensuring a comprehensive examination of potential outcomes[15]. There is also strong evidence that Houston Foresight embrace criticality, perhaps most notably in their open aim of challenging "prevailing assumptions about change".

Houston Foresight subscribes to a progressive systems theory philosophy, emphasizing the interconnectedness of various components within complex systems. Their approach considers the dynamic interactions between social, technological, economic, and environmental factors. By fostering a holistic view of these interrelationships, they seek to address complex challenges more effectively The organization integrates systems thinking in its Foresight work, encouraging clients to consider multiple perspectives and the broader context of any issue. Their coursework and collaborative efforts reflect this commitment, helping clients understand how various factors interact within broader systems, shaping future outcomes.

Summary: Houston Foresight's approach to futures spans all five domains of Foresight practice. By employing methods like Scenario Planning, trends analysis, participatory workshops, and Environmental Scanning, they help clients from diverse sectors prepare for complex futures. Their progressive systems theory philosophy underscores a holistic understanding of interdependencies, allowing for more profound insight into future challenges. This comprehensive approach potentially empowers students and organizations to make informed and strategic decisions, and to navigate the uncertainties of the future.

[12] https://www.csf.gov.sg/, accessed 15.08.2024.

[13] But there is some evidence of systems thinking in the public sphere, such as a 2019 special lecture on governance and complexity delivered at the Conference on Complex Systems, by the CSF's senior advisor Peter Ho (Ho, 2019).

[14] https://www.houstonforesight.org/#foresight-definition, accessed 12.08.2024.

[15] https://www.houstonforesight.org/wp-content/uploads/2022/12/Alternative-Perspectives-Syllabus-2023-1.docx, accessed 18.04.2024.

Table 3. **Relative Strengths of the Five Domains and Systems Thinking**

Organization	Practical Dimension					Systems
	Empirical	Interpretive	Critical	Creative	Mindful	
Oxford Scenario Planning School	moderate	strong	weak	strong	weak	strong
Kishita Lab	strong	strong	weak	strong	weak	strong
WFSF	moderate	strong	strong	strong	moderate	strong
Insight-Foresight Institute	strong	strong	weak	moderate	weak	moderate
Tamkang Graduate Institute of Futures Studies	moderaate	strong	strong	strong	moderate	strong
Shaping Tomorrow	strong	strong	moderate	strong	weak	moderate
Science & Technology Policy Institute (STEPI)	strong	strong	weak	moderate	weak	strong
UN Futures Lab	strong	strong	moderate	strong	weak	moderate
Singapore Center Strategic Futures	strong	strong	weak	strong	weak	moderate
Houston Foresight	moderate	strong	strong	strong	strong	strong

Source: authors.

Findings of this study

This research project has attempted to assess whether there is evidence that Mintzberg's (2008) analytical/synthesis divide is as prevalent in today's Foresight organisations as Mintzberg claimed it was in strategic management in 2022. A distinction has been made between strategic foresight and transformative foresight, with the hypothesis that transformative foresight organizations will tend to better balance the empirical and interpretive domains of Foresight practice with the creative and mindful domains - and their associated ways of knowing and being. There was also a tentative suggestion that transformative foresight practitioners might employ the critical domain to justify that expansion into the more mindful or "softer" ways of knowing. Finally, it was also hypothesised that transformative foresight organisations would feature a greater valorisation of systems thinking. In other words, a portion of this study has attempted to determine whether these two divergent practices of Foresight currently face each other across the great divide between Deep Futures and Money and Machines Futures.

Finally, this study invited an exploration of how greater balance and depth might be brought to strategic foresight and strategic management in general.

Yet, as evidenced by Table 3, above, this study has found that no great strategic chasm currently exists amongst the ten Foresight organisations. There are differences in the balancing of left and right-brained thinking amongst the organisations, but the distinctions are not vast. All organisations strongly or moderately feature the empirical and interpretive domains; and their common tools like Horizon Scanning, the Delphi method, and scenario work. Yet the creative domain was similarly well represented, with participatory workshops, Backcasting and Scenarios being used by most organisations to strong or moderate degree. Likewise, it is clear that systems and complexity theory is highly influential amongst these ten Foresight organisations, with no organisation showing weak expression of this area of knowledge.

The most obvious omission from most of the organisations was clear espousal of the mindful domain: explorations of the deep human psyche, mythologies, dreams and spiritual perceptions. Visioning as a precise method, was barely mentioned in any of literature or online texts (though it is implicit in tools like Scenarios, Backcasting, the Futures Triangle and so on). Only Houston Foresight received a "strong" rating here, with Tamkang University's GIFS and the WFSF showing "moderate" expression of the mindful domain. The other institutions received a "weak" rating. It might be that this reluctance to embrace the mindful reflects a twenty-first century civilisation that has not quite freed itself from the Newtonian, mechanistic paradigm that has arguably constrained our potential for embodying a wider range of ways of knowing and being, since the seventeenth century (Anthony, 2008; Kuhn, 2012).

Of all the domains of Foresight practice, the critical domain is the most surprising absence in these organisations' public self-descriptions. This study found few of the organisations speaking the language of genuine criticality, as found in Critical Futures Studies - which in turn is inspired by the poststructuralists like Foucault and Derrida (Inayatullah, 2018). Again, Houston Foresight featured most strongly here, with Shaping Tomorrow and the UN Futures lab receiving a "moderate" rating – the rest were "weak" in this domain. Yet this may not be entirely reflective of the genuine aims and beliefs of these organisations and their members. Instead, it may simply be a metaphorical case of not wishing to bite the hand that feeds – and where more diplomatic language is required in public relations.

Yet ultimately, none of these organisations can be said to be purely practicing "strategic foresight." All feature enough balance across the left-right-brain divide to be called practitioners of transformative foresight. This study suggests that the current practice of Foresight has (internally) bridged Mintzberg's strategic divide, including an embracing of systems thinking. These ten organisations appear to be propelling us towards Deep

Futures (as opposed to Money and Machines Futures). Yet this is a tentative conclusion, given the limitations of the study posited in the following section.

Still, these findings suggest that the practice of Foresight may have progressed to bridge only *part* of the strategic divide, and is yet to truly embrace a wider range of right-brained thinking, feeling and perception. This conclusion is drawn from the lack of representation of the mindful domain amongst most of our ten Foresight organisations. Of course, this point can itself be challenged from a position somewhat closer to the centre of the continuum; with the argument that the mindful realm is too esoteric and "unscientific" for most Foresight practice, especially in the corporate sector and amongst governments and large public, academic and scientific institutions. Nonetheless, there is a possible yet unrealised future where Foresight organisations might more readily incorporate processes like mindfulness, intuition, visioning etc. into their practice of Foresight.

Limitations of this Study

The findings of this study are based on the author's interpretation of texts, predominantly the public descriptions of the organisations themselves. The classification of the Foresight tools (Table 1), and the final "ratings" (Table 3) are subjective, and based on a perusal of the documentation. These cannot be deemed definitive conclusions. Instead, the author's hope is that they might generate further research and discussion, given the application of more time and the energy of other enthusiastic explorers of Foresight.

Another limitation of this study is that it has examined only ten Foresight organizations, and as such, they cannot fully represent the entirety of Foresight practice today. Furthermore, all but two of the organizations selected are based in Europe and Asia (with two American). There is no representation from other regions across the globe, where a significant number of Foresight practitioners and organizations are located. A larger and more diverse sample might have yielded somewhat different findings.

It must also be acknowledged that Foresight organizations, by their very nature, tend to be progressive (in the academic sense), typically challenging dominant ideas and narratives of contemporary society and business. Generally speaking, people do not become futurists and Foresight practitioners to uphold the status quo. As a result, while these findings indicate that Foresight organisations generally espouse Deep Futures (as opposed to techno-centric Money and Machines Futures), this study cannot definitively conclude that Mintzberg's strategy split has been bridged in spaces beyond the discipline of Foresight. To extend these conclusions to strategic management in general, for example, the study would need to include a comparison with other organisations that do not practice Foresight, as well as assess the contemporary literature on strategic management—an endeavour that is beyond the scope of this paper.

A further potentially impactful aspect of this research topic that is not addressed in this paper regards the more cognitive science that Foresight organisations may be covertly researching (and possibly applying) in their businesses, but not wishing to publically acknowledge. It is theoretically within the best interests of these organisations to apply this knowledge in order to enhance the well-being and productivity of their staff and clients. The elucidation of these opaque components of organisations, including Foresight organisations, would require a different methodology than that applied to this study, as the knowledge is implicit. Nonetheless, because this theoretical shadow domain may add further evidence for a shift towards transformational foresight in general, this is a realm of investigation that is potentially fruitful for future research.

Finally, this paper has not focused on detailed case studies—specific instances of Foresight organizations working with corporations, businesses, NGOs, governments and so on. It is possible that, at this level, the day-to-day business of Foresight may prove to be more practical, more analytical, and more aligned towards strategic foresight than the transformative. Alternatively, we may find that there is more of the critical and mindful domain. In regard to the latter, as noted earlier in this paper, there is a comtemporary shift towards the mindful in medicine, cognitive sciences, business and innovation management, and education (Anthony, 2022; Dunning et al., 2019; Carole et al., 2024; Gómez-Olmedo et al., 2024; Morin, Grondin, 2024; Ping, Long, 2024; Remscar et al., 2023;). These strong signals are a potentially rich and important focus of further research.

Conclusion

The study has found tentative evidence that, within the ten Foresight organizations examined, Mintzberg's concerns about the analytical-synthesizing management divide may be overly pessimistic. The institutional cultures present amongst these organisations can be said to be representative of transformative foresight. Further, it appears that systems thinking is now common in the practice of Foresight today, although sometimes merely implicitly. However, there is less evidence of the more transcendent, potentially paradigm-breaking features of «Deep Futures,» as found in embodied practice of the mindful domain.

Corporate and civilisational sustainability is not just about profit, nor merely about the "environment." Sustainability is about fostering ways of knowing and being that allow human beings to thrive in conscious relationship with nature and with each other. And with themselves – with their own psyches. Therefore, a process of self-correction and self-reflection is necessary to enable the personal and civilizational shifts that our futures require of us.

Civilisational paradigm shifts tend to be slow, as Thomas Kuhn noted in the 1960s. But they are more frequent than we often realize. At the beginning of the 20th century, Western civilization was still caught in the tension between Neo-Darwinism and the Romantic movement—a left-brained-right-brained struggle that has roots going back to the scientific enlightenment of the 17th century, and to ancient Greece itself (Anthony, 2008). Foresight work has the potential to help shape a civilizational shift towards a more balanced expression of human consciousness. This study suggests that we might be at the edge of such a shift in paradigm, in consciousness. But that is a matter of interpretation. The signals are not quite "strong," but they are strengthening.

References

Anthony M.T. (2008) *Integrated intelligence*, Rotterdam: Sense Publishers.

Anthony M.T. (2010) *Deep Futures: Beyond Money & Machines,* Singapore: Nanyang Technological University.

Anthony M.T. (2022) A Critical Futures Studies Perspective on Embodiment and the Crisis in Sensemaking. In: *Crisis Management – Principles, Roles and Application* (ed. C. Yi), London: InTechOpen. https://doi.org/10.5772/intechopen.107776

Anthony M.T. (2023) *Power and Presence: Reclaiming Your Authentic Self in a Weaponized World*, MindFutures.

Börjeson L., Höjer M., Pettersson K., Stjernberg T. (2006) Scenario types and methods: A framework for scenario analysis. *Futures*, 38(7), 720–739. https://doi.org/10.1016/j.futures.2005.10.003

Carole D., Rafi M.M., Chowdhury E.G. (2024) Mindfulness, spiritual well-being, and sustainable consumer behavior. *Journal of Cleaner Production,* 455, 142293. https://doi.org/10.1016/j.jclepro.2024.142293

Checkland P. (1981) *Systems thinking, systems practice*, New York: John Wiley & Sons.

Churchman C.W. (1968) *The systems approach,* New York: Delacorte Press.

Cornish E. (1977) *The Study of the Future: A Guide to the Literature,* Bethesda, MD: World Future Society.

Dalkey N.C., Helmer O. (1963) An Experimental Application of the Delphi Method to the Use of Experts. *Management Science,* 9(3), 458–467. https://www.jstor.org/stable/2627117

Fergnani A. (2022) Corporate foresight: Real or ideal? *Academy of Management Perspectives,* 36(2), 851–856. https://doi.org/10.5465/AMP.2021.0049

Georghiou L., Cassingena Harper J., Keenan M., Ralston K. (2008) *The Handbook of Technology Foresight*, Cheltenham: Edward Elgar Publishing.

Glenn J.C., Gordon T.J., Florescu E. (2014) *Futures Research Methodology V3.0*, The Millennium Project.

Gómez-Olmedo A.M., Diéguez M.A., Vicente-Pascual J.A. (2024) Redefining success in innovative crowdfunding projects: Empirical evidence of effective mindful consumption promotion in Kickstarter. *Journal of Innovation & Knowledge*, 9(4), 100558. https://doi.org/10.1016/j.jik.2024.100558

Hines A., Bishop P.C. (2013) Framework foresight: Exploring futures the Houston way. *Futures,* 51, 31–49. https://doi.org/10.1016/j.futures.2013.05.002

Ho P. (2019) *Governance in Complexity: A Singapore Perpective*. Special lecture by Mr Peter Ho, senior advisor, Centre for Strategic Futures, at the Conference on Complex Systems, 30th September 2019. https://www.csf.gov.sg/files/media-centre/speeches/2019-09-30-governance-in-complexity.pdf, accessed 17.08.2024.

Hubbard M. (2015) Learning to Use Intuition in Futures Studies: A Bibliographic Essay on Personal Sources, Processes and Concerns. *Journal of Futures Studies*. 20(1), 111–114. https://jfsdigital.org/wp-content/uploads/2015/09/S6-new-10-13.pdf

Inayatullah S. (2018) *What Works: Case Studies in the Practice of Foresight*, New Taipei City (Taiwan): Tamkang University Press.

Kahn H. (1960) *On Thermonuclear War,* Princeton, NJ: Princeton University Press.

Kim W. (2010) Factors and Implications for Creative Scientists: A Systems View of Creativity. *STI Policy Review*, 1(2), 32–50.

Kuhn T. (2012) The structure of scientific revolutions (4th ed), Chicago, IL: The University of Chicago Press.

Markley O. (2015) Learning to Use Intuition in Futures Studies: A Bibliographic Essay on Personal Sources, Processes and Concerns. *Journal of Futures Studies*, 20(1), 119–129.

Meadows D.H. (1999) *Leverage Points: Places to Intervene in a System*, Hartland (UK): The Sustainability Institute.

Mintzberg H. (2008) *Tracking Strategies – Toward a General Theory,* Oxford: Oxford University Press

Mintzberg H. (2022) An underlying theory for strategy, organization, and management: Bridging the gap between analysis and synthesis. *Strategic Management Review,* 3(1), 125–144. http://dx.doi.org/10.1561/111.00000039

Morin A., Grondin S. (2024) Mindfulness and time perception: A systematic integrative review. *Neuroscience & Biobehavioral Reviews,* 162, 105657. https://doi.org/10.1016/j.neubiorev.2024.105657

Parsons T. (1968) *The structure of social action,* New York: Free Press.

Ping X.F., Long H.T. (2024) Teams' stressors and flow experience: An energy-based perspective and the role of team mindfulness. *Journal of Business Research,* 183, 114860. https://doi.org/10.1016/j.jbusres.2024.114860

Prigogine I., Stengers I. (1997) *The end of certainty: Time, chaos, and the new laws of nature,* New York: Free Press.

Ramirez R., Wilkinson A. (2016) *Scenario planning for organizations: How to create, use, and assess scenarios*, Oxford: Oxford University Press.

Remskar M., Western M.J., Osborne E.L., Maynard O.M., Ainsworth B. (2023) Effects of combining physical activity with mindfulness on mental health and wellbeing: Systematic review of complex interventions. *Mental Health and Physical Activity,* 26, 100575. https://doi.org/10.1016/j.mhpa.2023.100575

Rudy A. (1980) The Society for General Systems Research: Past, Present, and Future. *Systems Research and Behavioral Science*, 1(1), 1–7.

Senge P.M. (1990) *The Fifth Discipline: The Art and Practice of the Learning Organization,* New York: Doubleday.

Simon H.A. (1956) Rational choice and the structure of the environment. *Psychological Review*, 63, 129–138. https://doi.org/10.1037/h0042769

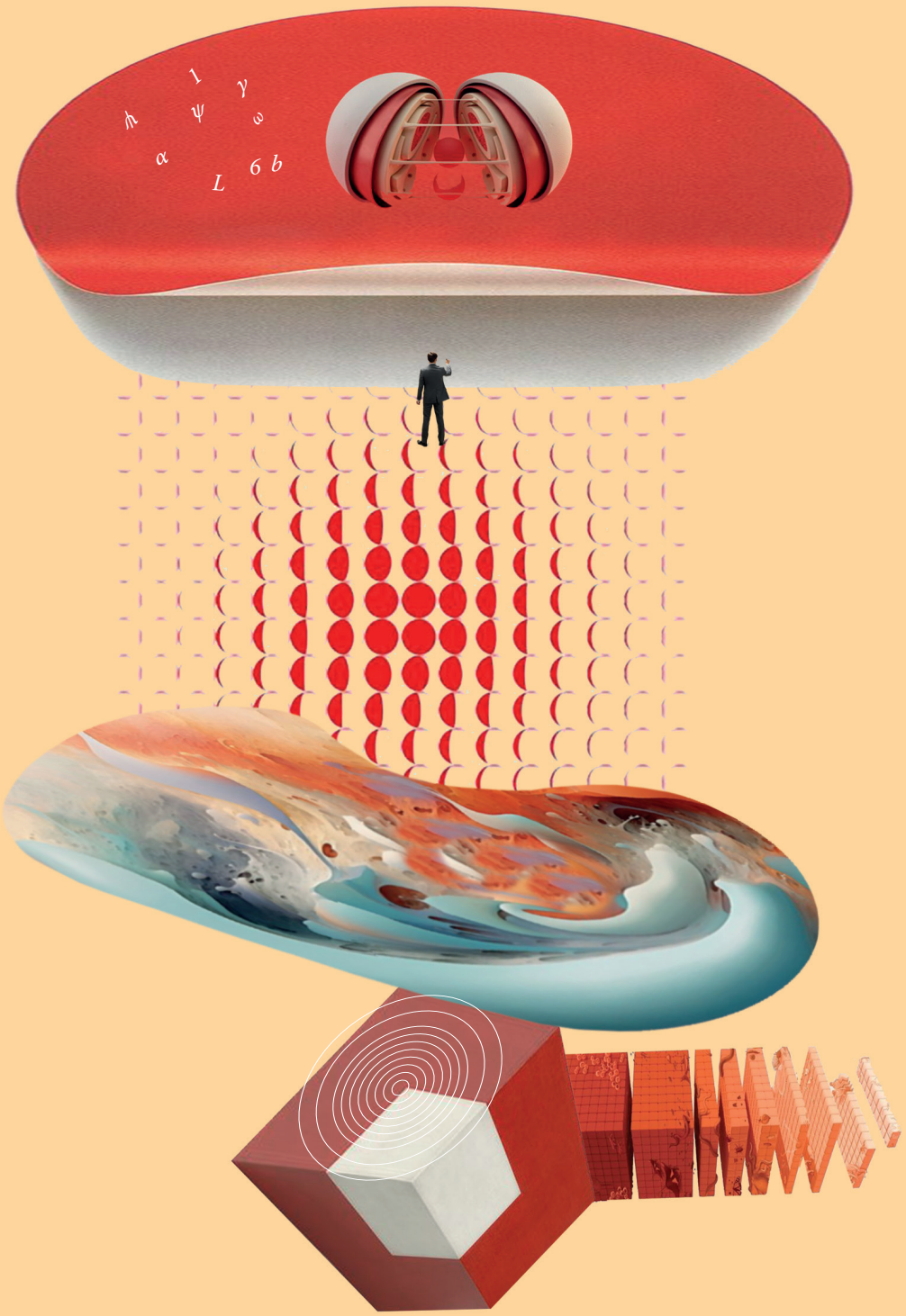
Slaughter R. (2020) Farewell alternative futures? *Futures,* 121, 102496. https://doi.org/10.1016/j.futures.2019.102496

Sweeney J.A. (2024) *Authentic Futures.* Paper presented at the 2024 Asia Professional Futurists Network Meeting, Bangkok, September 4.

Von Bertalanffy L. (1932) Die Theorie der offenen Systeme in der Biologie. *Die Naturwissenschaften*, 20(18), 18–22.

Wiener N. (1948) *Cybernetics: Or Control and Communication in the Animal and the Machine,* Cambridge, MA: MIT Press.

Wilkinson A., Ramirez R. (2015) The future of scenario planning: From strategy to social change. In: *The Handbook of Business Strategy,* Bingley (UK): Emerald Group Publishing Limited, pp. 1–16.



Building Human Capabilities for an Increasingly Complex Entrepreneurial Ecosystem

Deny John Samuvel
Associate Professor [a] and Post-doctoral Fellow[b], j.deny@klu.ac.in

Jerzy R. Szymański
Professor[b], j.szymanski@uthrad.pl

Marta Żurek-Mortka
Expert[c], marta.zurek-mortka@itee.lukasiewicz.gov.pl

Mithileysh Sathiyanarayanan
Founder and CEO[d], s.mithileysh@gmail.com

[a] Department of Electronics and Communication Engineering, Kalasalingam Academy of Research and Education), Anand Nagar, Krishnankoil-626126, Tamil Nadu, India
[b] Kazimierz Pulaski University of Technology and Humanities in Radom, Malczewskiego 29 PL26-600, Radom, Masovian Voivodeship, Poland
[c] Lukasiewicz Research Network, Institute for Sustainable Technologies, Kazimierza Pułaskiego 6/10, 26-600 Radom, Poland
[d] MIT SQUARE, 128 Kemp House, City Road, London, Great Britain, UK — EC1V 2NX, UK

Abstract

The topic of nurturing specific entrepreneurial human capital acquires new relevance as the prospects for economic development in a changing context are associated with it. Relying on a solid base of knowledge, competencies, and progressive tools would allow young professionals to produce decent results in complex entrepreneurial ecosystems. Consequently, close attention is paid to the content of entrepreneurial education.

This article analyzes the dynamics of the emerging research landscape regarding entrepreneurial education. The new context calls for a revision and adjustment of training programs based on many factors. The most common topics of discussion are the following: the transition from formal to creative, hybrid learning that combines different formats and learning styles, the holistic study of the contradictory nature of innovation processes, and the development of entrepreneurial thinking and behavior through previously untouched deep cognitive dimensions. The case of the Kalasalingam Academy of Research and Education (KARE) in India on training entrepreneurs and their adaptation to entrepreneurial ecosystems of different levels and complexity is presented.

Keywords: entrepreneurial education; innovation training; entrepreneurial thinking; meta skills; innovation activity; entrepreneurial ecosystem; creation of venture enterprises; risks; identifying opportunities

Citation: John-Samuvel D., Szymański J.R., Żurek-Mortka M., Sathiyanarayanan M. (2024) Building Human Capabilities for an Increasingly Complex Entrepreneurial Ecosystem. *Foresight and STI Governance*, 18(3), pp. 41–53. DOI: 10.17323/2500-2597.2024.3.41.53

Introduction

Entrepreneurship, its nature, opportunities for and barriers to development continue to be a relevant topic, which in new conditions is being rethought through the prism of different dimensions. Its strategic part is entrepreneurial education and training (EET), the potential of which has been perceived differently at different times, depending on the emerging context and other aspects.

Today, EET takes on new meanings due to the wide range of new challenges, and its role and demand at universities and colleges around the world is growing (Sreenivasan, Suresh, 2023). In the traditional model, universities guide graduates toward a predetermined career path, which will subsequently be influenced by a variety of forces. Entrepreneurial education is aimed at developing a different set of skills, more universal, which, in combination with professional ones, can enrich the content of any specialty and equip it with a more powerful arsenal for action in a complex and changing reality. Many governments directly or indirectly support EET, creating the conditions for the development of adequate human potential upon which economic growth and employment depend (Kuratko, 2005; Pittaway et al., 2007). Dynamic technological development and the emergence of new management concepts have a transformative impact on business, and as a result, entrepreneurial education programs are also subject to adjustments and changes (Fellnhofer, 2019). First of all, this is manifested in the interdisciplinary richness of the programs, the focus on the holistic coverage of reality, with all its ambiguity and complexity (Neumeyer, Santos, 2020). The impact and need for entrepreneurial education at universities continues to be an important part of academic discussions. The relationship between entrepreneurial education, entrepreneurial competencies, and entrepreneurial intentions represents one of the key issues. Numerous studies on the results of EET in different countries indicate its positive effects on the development of entrepreneurial thinking, appropriate behavior, and overall career choice in the business world (Nabi et al., 2017; Boubker et al., 2021). This created a new narrative: entrepreneurs are not necessarily born - they are made (Gorman et al., 1997; Ernst&Young, 2011). It has been found that students who have studied entrepreneurship demonstrate higher motivation for business activity compared to those who have not undergone such training (Westhead, Solesvik, 2016).

Along with this, many works raise the question of the weaknesses of EET - its formalism, inconsistency with new realities, the unbalanced content of programs, and other important omissions. The diversity of business forms and its complex, ambiguous nature are often ignored, and the speed and depth of contextual change is underestimated. As a result, the potential of EET remains insufficiently revealed, while strengthening its practical orientation and introducing a synthesis approach would lead to qualitatively different results.

The research presented in this article contributes to the search for answers to the identified problems. Its goal is to find out how researchers see the picture of the changing entrepreneurial landscape, and how educational programs can be adapted to the requirements of the modern agenda from the business sector and society as a whole, taking into account the emerging new knowledge and tools in this direction.

This article reveals the limitations of established EET paradigms. The case of the Indian Academy of Scientific Research and Education is presented. The Kalasalingam Academy of Research and Education, KARE) for training entrepreneurs who can integrate into ecosystems of different levels and complexity.

Literature Review

EET has been one of the three most popular topics in entrepreneurship research (Landström, Harirchi, 2019; Fayolle et al., 2020). Its positive contribution to enhancing entrepreneurial activity and decision-making about choosing entrepreneurship as a career path has been confirmed in many research papers (Martin et al., 2013). This segment of education is currently being replenished with new disciplines, such as entrepreneurship in engineering (Da Silva et al., 2015), digital entrepreneurship, social entrepreneurship, and work with generative artificial intelligence (AI). The author's many years of teaching experience also indicate an increase in demand for social entrepreneurship programs (Deny, 2020). Thus, recent data from the Global Entrepreneurship Monitor, found an increase in the number of teachers with professorial status specializing in entrepreneurship, reflecting growing demand for entrepreneurial education and training (EET) in Germany. Here, the majority of students in educational programs still consider their preparation for starting a business and the abilities they need to be at a relatively low level (Sternberg et al., 2021). This fact indicates that training programs require constant improvement.

EET at universities and business schools has a history of more than 60 years (Solomon, 2007). Over time, its evolution accelerated (Neck, Corbett, 2018; Fayolle, 2013; Frese, Gielnik, 2014), and it was enriched with new concepts, knowledge and practices (Loi et al., 2021). A recent publication (Sreenivasan, Suresh, 2023) analyzed over 2,185 scientific articles published between 2002 and 2022. A particularly sharp increase in research on this topic began in 2017 and continues to maintain momentum. China makes the largest contribution to the increase in knowledge (443 publications), followed by the USA (288). The second tier includes Great Britain, Germany, Australia, Spain, Finland, India, and the Netherlands.

Progress in entrepreneurial education has moved from simply teaching the basics of creating new companies, to developing an entrepreneurial mindset (EM), developing business scenarios, launching digital enterprises (Ferreira et al., 2018), taking into account subtle cognitive and psychological aspects (in terms of "attitudes", "actions", "beliefs" and "behaviour") (Liñán, Fayolle, 2015). The work (Fayolle, Gailly, 2015) analyzed the critical role of universities in the formation of an entrepreneurial mentality.

The way entrepreneurship is taught varies greatly across countries and universities (Fayolle, Klandt, 2006). Despite the fact that the practice-oriented one has proven to be more effective (Gorman et al., 1997; Edelman et al., 2008), classical lectures are still the most common method. Project-Based Learning (PBL) has many facets, however, the overall purpose of its programs is not only to teach management tools, but also to form an individual with systemic, strategic thinking and appropriate behavior (Fretschner, Weber, 2013).

From the array of these and other EET studies, several thematic clusters can be traced, the description of which we provide.

A shift from formal to informal learning

The impact of EET on entrepreneurial behavior is more complex than previously thought. The nature of partnerships between universities and real businesses varies greatly across countries and cultural contexts. In most cases, it remains formal, superficial and situational, despite the active incentives of government policy (Gao, Zhang, 2024). Meanwhile, research results show that an informal approach to organizing classes develops entrepreneurial thinking (EM), increases curiosity in discovering hidden opportunities in ambiguous environments, and increases openness to acceptable risks.

Many authors offer enriched concepts for PBL that draw on recent advances in behavioral psychology and other sciences. The relevant approach seems to be flexible, adaptive programs with elements of experimentation. The overly theoretical nature of training does not allow entrepreneurial skills to emerge (Sharp et al., 2018). The most effective is considered to be a balanced approach, in which sufficient attention is paid to affective options that trigger deep cognitive processes that stimulate increased interest in solving complex, complicated quests in a complex reality (Loon, Bell, 2017). In the work (Nabi et al., 2017) the proliferation of a hybrid type of learning is demonstrated, synthesizing "passive" elements of education with active ones, which actively use developments from educational psychology and other areas. It has been found that the effectiveness of training increases if its content is adapted to a personal situation (Leitner, 2005; Kneppers et al., 2007).

The same effect is achieved by creating a unique a learning space with elements of art, architecture, and industrial design, flexibly customized to solve different problems (Barry, Meisiek, 2015), which is often described by the concept of a "complex learning environment". It sets bold and provocative tasks that encourage you to think outside the box, explore the "unfamiliar," and apply approaches and solutions that have not been used before (Fast et al., 2010; Mayhew et al., 2016). Working with quests that require attention, certain volitional efforts, and the connection of deep cognitive resources puts learning into a mode of "competition with oneself" (Csikszentmihalyi, 1990; Bronfenbrenner, 1979), which creates extraordinary results. Although the difficulties of strong internal mobilization are initially perceived as an undesirable experience, attitudes toward this state change over time. Young people tend to choose non-trivial tasks that challenge them. The concept of design thinking is also consistent with the concept of a complex learning environment, which also requires significant cognitive effort using framing, the method of analogies, abductive reasoning, mental modeling, and so on (Visser, 2006, 2009). These developments allow you to act quickly in changing conditions by reformulating tasks and skillfully improvising in situations that have not been experienced before (Dong et al., 2016; Garbuio et al., 2018).

Discussions around "innovative ideas"

The topic of generating innovative ideas within EET is increasingly being critically discussed in publications. A number of experts draw attention to a peculiar "fashion" - pushing insufficiently prepared and immature students toward ambitious, innovative projects (Bandera et al., 2021). Often the bet is on the popular narrative about the hero-entrepreneur and his rapid ascent to the business Olympus, thanks to the successful innovation *x*. Many works are devoted to the results of such "overheating," which manifests itself in financial losses, frustration, and refusal to further engage in entrepreneurship. A holistic approach avoids such distortions. Programs should objectively present the process of creating innovations as a difficult, sometimes dangerous, transformative journey, the passage of which requires a wide range of specific skills, often lengthy preparation, and readiness to make certain sacrifices (Byrne, Shepherd, 2015).

Closely related to this topic is another large cluster of research— ***the study of the "dark sides" of entrepreneurship.*** Entrepreneurship, despite its great creative power, can also have negative social, psychological, and financial consequences (Scott, 2024). This issue has been studied for more than 30 years (Wright, Zahra, 2011; Shepherd, 2019; Byrne, Shepherd, 2015; Lundmark, Westelius, 2019; Armstrong, 2005). In a new context, this topic is being rethought, a more accu-

rate understanding of the causes and consequences of losses, crises, and preventive work with them has been sought (Bandera et al., 2021; Ziemianski, Golik, 2020).

The dark side of entrepreneurship refers to negative psychological states and emotional reactions (Shepherd, 2019). Any discussion about the dark side of EET benefits from the clarification of key terms, including risk, danger, and denial of resource support. In entrepreneurship, a special role is played by the aspect of risk and taking into account the phenomenal nature of the innovations themselves, which have destructive potential if treated superficially. For a long time, the world of business was dominated by the mindset of "growth and profit first" (Slater, Dixon-Fowler, 2010). Entrepreneurs were seen as the main "economic engines" pushing the economy forward (Wickham, 2006). At the same time, important blocks of complex reality were ignored, which in such a one-sided process created blocking forces and destructive effects. The modern view takes a different view of the various facets of the entrepreneurial process, calling for critical thinking, an objective assessment of one's potential, personal cognitive biases, an assessment of the characteristics of the context, and consideration of other important factors.

(Bandera et al., 2021) presents the results of a Foresight project based on a Delphi survey, in which the dark sides of entrepreneurship were carefully studied from different points of view. An analysis was carried out of the underestimated aspects that subsequently led to failures and losses.

Among the conclusions: embedded training programs currently look like short instructions for going into "unexplored places", characterized by an overly narrow disciplinary focus (Morris, Liguori, 2016). There is no detailed analysis of risk factors, acceptable losses, methods for increasing self-efficacy, and emotional self-regulation (how to quickly rise after falls, learning creative lessons and valuable experience, etc.). Forming the skills of recalibrating one's negative emotions, overcoming frustration, and objectively assessing one's own entrepreneurial intentions require a lot of time (Vanevenhoven, Liguori, 2013). The work (Khelil, 2016) provides a classification of the main groups of factors of entrepreneurial failure, indicating the corresponding "culprits": "deterministic" (market context), "voluntaristic" (improper asset management), and "emotional" (lack of determination and motivation). The competencies promoted within EET require significant practice (Neck, Corbett, 2018) and new approaches (Bandera et al., 2018; Kassean et al., 2015). For example, recognizing opportunities requires tacit knowledge that can only be gained through experience (Neck, Corbett, 2018; Smith et al., 2009). Delphi survey respondents recommended that EET programs teach "acceptable losses" and "help one understand personal risk tolerance."

During the discussion, the issue of assessing the effectiveness of EET programs was also raised. This is difficult because entrepreneurship, unlike other disciplines such as management, engineering, and medicine, does not have any "objective", unambiguous criteria and assessment tools such as minimum indicators, performance measures, certification, and standardized exams (Pittaway, Edwards, 2012). In addition to the factors noted, the dark side can arise from the entrepreneurial process itself, even when participants enter into it with the best of intentions (Shepherd, 2019).

Formation of entrepreneurial thinking from the perspective of a new understanding of cognitive aspects

The work in this area is quite extensive, so we will pay more attention to it, since the influence of EET on EM is revealed in a variety of non-obvious relationships. Many researchers focus on the task of developing a mindset based on the understanding that the entrepreneurial path requires caution, vigilance, constant revision of both one's own and collective decisions, overly optimistic ideas, familiarity with the paradoxes of ambidexterity - being different from others and being part of a community (Shepherd, Haynie, 2009); combine career with relationships (family, friends) (Kirkwood, Tootell, 2008); while maintaining motivation, at the same time keeping compulsive behavior under control (Spivack, McKelvie, 2018); correctly experience crises, losses, failures (Jenkins et al., 2014).

A sufficient number of publications are devoted to the concept *of entrepreneurial alertness,* which explains the mechanism for developing the ability to recognize emerging business opportunities (Roundy et al., 2018; Liu, 2023). Previous studies have examined the positive and significant relationship between EET and this type of vigilance in university programs (Saadat et al., 2022). However, the focus has not been on the possible implications that different types of courses (whether theoretically or practically oriented) may have (Yang et al., 2021). For some time, vigilance has occupied a central place in opportunity research. There are several dimensions of entrepreneurial alertness: scanning (searching for data), synthesis (summarizing and structuring disparate information), and analyzing potentially valuable opportunities (Tang et al., 2012). In another study, entrepreneurial vigilance, as a part of EM, is presented in other aspects: recognizing hidden opportunities, extracting them, and creating opportunities from scratch (Sarasvathy et al., 2010). According to the concept of entrepreneurial vigilance, its carriers are able to recognize subtle "cues" in a confusing, ambiguous environment (Kirzner, 1979). Rapid *opportunity recognition* involves scanning and searching for weak signals through association, evaluation, and judgment about the nature of the opportunity (Tang et al., 2012). The higher the level of entrepreneurial alertness (a common element of EM), the more likely it is

that opportunities will not take significant time to be discovered (George et al., 2016).

The central argument is that vigilance is not truly entrepreneurial unless it involves judgment and action, constantly filtering and accumulating relevant information (McMullen, Shepherd, 2006). Only in such a process are deep cognitive structures formed - cumulative experience and knowledge that form an understanding of a specific area, market landscape, etc. While scanning and searching can be passive or active, skillfully synthesizing information and compiling it into potentially viable business projects creates the prerequisites for success (Alvarez, Barney, 2017). The work of (Cui et al., 2021) makes a significant contribution to highlighting the implicit effects of EET on the development of entrepreneurial knowledge, skills, behavior, and intentions that arise from the presence of EM. It is about the hidden phenomenon of working with malleable cognitive structures (Krueger, 2015) to create entrepreneurial uniqueness (Cui et al., 2021). The underlying nature of such thinking is cognitive adaptability (Haynie et al., 2010) and the ability to discover opportunities that determine economic success. Various researchers characterize EM as: the ability and willingness to become emotionally involved in the process, act quickly, and mobilize under conditions of uncertainty to achieve a goal (Shepherd et al., 2010); the ability to identify and exploit opportunities without relying on current resources (McMullen et al., 2016); and metacognition, which develops through learning and then becomes ingrained as a habit (Schmidt, Ford, 2003). Among the cognitive components of EM, researchers especially highlight: risk taking, tolerance of uncertainty, dispositional optimism, and vigilance to opportunities and consider them the key driving forces for improving the effectiveness of EET (Kaish, Gilad, 1991; Shane, Venkataraman, 2000; Baron, 2006).

Many experts proceed from the theories of *entrepreneurial intentions, planned behavior* (Ajzen, 1991), and *entrepreneurial events*[1] (Shapero, Sokol, 1982).

Risk taking is not a stable and unchanging trait, but can vary and be shaped depending on different scenarios (Wang et al., 2016), in particular, this trait will increase under the influence of EET (Neneh, 2012).

Tolerance of ambiguity is associated with the ability to respond to uncertain situations, where there is a lot of contradictory, confusing, and unfamiliar information, "clues" are fragmented and vague and can be understood only by interpreting and processing incoming signals (Furnham, Ribchester, 1995). This is an integral part of EM, which perceives ambiguity as a complex variety of potential possibilities.

Dispositional optimism is defined as the basic tendency to believe in the best (Crane et al., 2012), which supports a long-lasting will to overcome difficulties. This parameter is closely related to self-efficacy (Crane, 2014), which, however, can be said about all of the listed components.

Another important driving force, which is also the subject of many works on the topic of EET, is inspiration (Souitaris et al., 2007). A study on a sample of students at a British university demonstrated a close connection between this factor and entrepreneurial intention. Because deep learning engages affective aspects, inspiration can be cultivated as a mediating driver of successful entrepreneurial outcomes. This type of inspiration is likely to be a central construct both as an indicator of the impact of EET and as a predictor of other interventions in the learning process (Nabi et al., 2017).

Entrepreneurial education in the digital world

This theme is also reflected in many works. Digitalization provides entrepreneurs with new tools to achieve their goals. They increasingly rely on data analytics, artificial intelligence, and automation to optimize processes. In the digital context, entrepreneurship is transforming its business models, hence this influences the content of EET (Lamine et al., 2021). The emergence of digital entrepreneurship is a game changer in the modern business landscape, requiring players to be more flexible and adaptable.

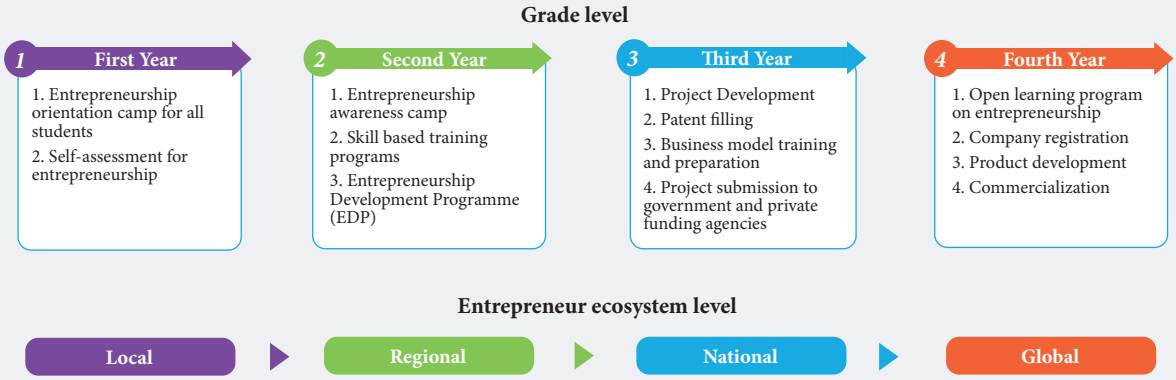
Digital literacy (skills for learning and communicating in a digital environment) must continually evolve as technology becomes more complex. The concept of digital ethics emerges — a critical analysis of personal digital activity (Baierl, Thamm, 2023). A special topic is the rules of security and data protection in the digital world, which offers a wide variety of tools and online platforms for education (through business simulation, gamification elements, agent-based modeling, etc.) (Isabelle, 2020).

Software has emerged that combines the classical modeling approach with entrepreneurial and creative aspects. Training can take place in real or virtual environments. Workshops are being created to create virtual business models, where the management of all stages of the process is practiced. Here, it is easier to master such a complex paradoxical phenomenon as organizational ambidexterity (one of its variants is the ability to simultaneously explore new opportunities and exploit existing resources) (O'Reilly, Tushman, 2013).

Research on digital entrepreneurship education identifies five theories: planned behavior, social cognition,

[1] According to the "entrepreneurial event" model, readiness to create your own business is determined by three groups of factors. The first of them is disruptive events in life, both positive and negative, forcing a change in the usual pattern of behavior. The second is an assessment of the social environment (general cultural context, moods of loved ones, acquaintances, colleagues, presence of mentors, etc.). The third is an assessment of the available resource potential (availability of sources of financing, partner networks, proven prospects of a business ideas, etc.).

Figure 1. **The process of implementing the educational program and the transition of students to new levels of the entrepreneurial ecosystem**



Source: authors.

self-determination, task-technology fit, and interactive engagement (Hayati, Caniago, 2023). In addition, the effectiveness of gamification in online entrepreneurship education has been comprehensively studied from various perspectives. The relationship of this process with digital policy evaluation, self-efficacy, and intention to become a digital entrepreneur has been studied (Xin, Ma, 2023). Incorporating gamification into online entrepreneurial education significantly increases students' intention to engage in digital entrepreneurship. Digital policy and self-efficacy play a mediating role in this regard.

The presented literature review highlights theoretical and practical gaps in EET that hinder its effectiveness.

Universities rarely manage to raise EET to the required level; therefore, the competency potential of graduates is insufficient to fully take advantage of the opportunities in opening career tracks.

The pedagogical approach upon which most programs are based often turns out to be insufficiently comprehensive and does not fully reveal the different facets of entrepreneurial activity, including its dark sides. Finally, due to the narrow orientation of EET programs, students lack awareness of the specifics of broader contexts (industrial, national, international) and their requirements, as a result of which the opportunities for professional self-realization are narrowed.

Formation of Multi-Level Entrepreneurial Competencies: the Case of an Indian University

The case of the Kalasalingam Academy of Research and Education (KARE), founded in 1984, clearly exemplifies a holistic, hybrid approach to entrepreneurial education. Entrepreneurship training itself has been conducted since 2014, for which a special unit was created - the Entrepreneurship Development Center in collaboration with an international network of teachers, methodologists, and consultants, including the authors of this article. Its activities are based on a comprehensive educational program to develop competencies that allow graduates and their business projects to join the global entrepreneurial ecosystem.

The program is designed for technical specialties and covers the entire four-year period of undergraduate study. As they accumulate competencies within existing companies, as well as creating their own startups, students consistently move up the hierarchy of entrepreneurial ecosystems - from local, entry-level to global. At all stages, all kinds of systemic support mechanisms are in place - advisory, financial, infrastructural, and so on (Table 1). The program is designed to ensure that as students move up, they appropriately embrace the growing diversity of contacts and networks, interacting skillfully in complex systems and expanded contexts. In this sequence, entrepreneurial thinking intensively develops, gradual adaptation to larger markets and an intense competitive environment occurs. Familiarity with and the ability to work with different levels and types of entrepreneurial ecosystems helps build the human potential of innovative entrepreneurs with diverse backgrounds. The general scheme of program implementation by year of study is shown in Figure 1.

At the first level of the ecosystem (first year of study) students can dive into the world of entrepreneurship, its different dimensions, and potential tracks. Classes combine different formats - from lectures, master classes, seminars, to meetings with successful entrepreneurs who have realized themselves in business. The level of personal readiness to do business over a long distance and, in fact, internal potential is carefully studied. Students choose priority areas for developing competencies within the program and prepare to open a business at the level of the local entrepreneurial ecosystem, which is formed by the university and local communities. The program includes comprehensive resource support (infrastructure, mentoring, network-

Table 1. **Financing schemes and infrastructure support for the Entrepreneurship Development Center at the KARE Academy**

Initiative	Content	Grant (Thousand USD)	Total no of Beneficiaries	Infrastructural support
Innovation and Entrepreneurship Development Center, IEDC Science Technology and Innovation Hub	Department of Science and Technology (DST)	398	477	Shared working office space with workstations University department / research labs / equipment International Research Centre A Fab-lab & Maker Lab Facility to ideate and test the concepts and product developments made
National Implementing and Monitoring Agency, NIMAT National Initiative for Developing and Harnessing Innovations, STARTUP NIDHI	Entrepreneurship Development and Innovation Institute Tamil Nadu (EDII-TN)	180	1420	
Innovation voucher programme	EDII-TN	66	3	
Atal Innovation Mission (AIM)	ACIC-Kalasalingam Innovation Foundation (ACIC-KIF)	250	62	
MSME Championship	KARE	250	3	
Startup India Seed Fund Scheme, SISFS	Startup India	500	unknown	

Source: authors.

ing opportunities, internships at regional companies). The application of acquired knowledge in practice begins in the format of hackathons and competitions, where, in a collaborative atmosphere, students offer their solutions to real problems faced by local enterprises.

The second level represents the field for action in the context of only one's own region. Entrepreneurial skills are transferred to such dimensions as leadership, communications, marketing, and financial management. Now the knowledge is superimposed on the business context of its region, and there is an immersion in the intricacies of industry trends and sources of financing. Finally, methods of emotional "survival" in the process of failure of starting strategies are mastered. Integration into the regional entrepreneurial ecosystem requires the transformation of one's previous ideas and adaptation to complex combinations of factors and processes. The main training formats at this stage are mentoring, seminars, practical projects, modeling of real business scenarios, and participation in meetings with successful businessmen with a solid background. Step by step, the required level of competencies is being increased to create companies at a higher level.

The third level provides access to the country's entrepreneurial ecosystem. The acquired competencies allow you to create viable prototypes, strategies, and business models, which are submitted for evaluation by investors. The best projects receive support and the opportunity to patent. At this stage, you can join in the implementation of government priorities.

The fourth level is the time to enter the global entrepreneurial ecosystem, starting with joining a professional association and mastering new rules and opportunities. Thinking is developing in the logic of international opportunities. Projects are still in business incubators, with the goal of commercialization being set. A mentality is being formed - "lifelong education", in addition to constantly increasing knowledge, which allows one to improve in identifying weak signals, tracking changes in legislation, and so on. Here, students master strategies for bringing their materialized "products" to the market and their scalability. Familiarity with global trends and approaches helps adapt ideas to international standards and market requirements.

Interactions with foreign experts and graduates opens endless benefits. Here the complex of skills and abilities that were painstakingly laid down at each passing level will be manifested.

Analysis of achievements and constraints to increase program effectiveness

Table 2 describes the evolution of projects to develop entrepreneurial thinking and behavior in KARE since its inception in 2014. Table 3 shows the dynamics and trends of the results obtained over the last five years. It can be seen that after a significant drop in activity associated with the onset of the pandemic, the ecosystem managed to adapt, return to dynamic growth, and exceed pre-crisis indicators, which indicates the continued interest of students in the entrepreneurship track. Graduates of the Center have developed 24 successful products and files 58 patents. Two biomedical companies stand out in particular: LivVolta Healthcare Innovations (founded 2019) and PSM Enterprise (2021). The first develops production technologies, the second uses them to manufacture health and fitness products.[2] Both enterprises have gained stable positions on the national market.

[2] For example, a portable electric muscle stimulation belt.

Table 2. **Creation of entrepreneurship support centers**

Initiatives	Starting year of study	Contents
Innovation and Entrepreneurship Development Center (IEDC)	2014–2015	Pre-Incubation, Prototype Development, Training
Kalasalingam Technology Business Incubator (KTBI)	2017–2018	Incubation Space, Seed Fund, Company Formation
Institution Innovation Council (KARE-IIC)	2018–2019	IPR and I&E Training, NISP, ARIIA
Science Technology and Innovation Hub	2019–2020	Improve the socio-economic status of SC population through Technology and Products
ACIC-Kalasalingam Innovation Foundation (ACIC-KIF)	2020–2021	Promote economy and employment, and enable community-oriented innovations
MSME Championship	2021–2022	MSME Champion Scheme – Recognised Incubator
Startup India Seed Fund Scheme (SISFS)	2022–2023	Financial assistance to startups for proof of concept, prototype development, product trials, market-entry, and commercialization

Source: authors.

Table 3. **Chronology of activities implemented in the last five academic years**

Time Period	Number of Activities	Description
2019–2020	70	The year started strong, marking a vibrant and active ecosystem.
2020–2021	53	There was a notable decrease in activities, likely due to the COVID-19 pandemic, which affected in-person events and engagements.
2021–2022	55	A slight rebound occurred as the ecosystem adapted to the changing circumstances.
2022–2023	69	A significant rise in activities demonstrated the resilience and recovery of the ecosystem.
2023–2024	72	The highest recorded activities, indicating a thriving environment and successful implementation of innovative strategies.

Source: authors.

If we talk about the factors that hinder the increase in the effectiveness of the program, then one of the main problems is attracting funding from the state and other sources. This can become a demotivating factor for both students and their environment (primarily parents). Often, they are not even aware of these opportunities, or are hesitant to take advantage of them, or when faced with difficulties when applying for grants, they retreat. Therefore, the program pays close attention to informing students about existing funding options and assisting them in completing and submitting applications for funds.

Teachers play a key motivating and mentoring role, but at the initial stage it can be difficult to implement due to lack of time and varying degrees of initial motivation among students.

Furthermore, a significant deterrent is the influence of many parents who tend to encourage their children to pursue traditional careers. Entrepreneurship in their eyes is too risky an activity with unstable income. Naturally, this imposes certain barriers. However, this factor can also be eliminated with the help of special consultations for both students and parents.

In solving the identified problems and significantly increasing the effectiveness of training programs, a key role is played by resource support strategies and the formation of a favorable environment of cooperation between teachers, students, and their immediate social environment, which is relevant not only for the case under consideration, but also in other contexts.

Conclusion

The topic of the formation of a specific aspect of human potential shaped by entrepreneurship is acquiring new significance on a global scale. It is with it that the prospects for the dynamic development of the economy and national welfare in a changing environment are linked. Relying on an appropriate arsenal of knowledge, competencies, progressive tools, approaches, and practices will allow graduates of university EET programs to produce worthy results in complex entrepreneurial ecosystems (at the national and global levels).

This article attempts to analyze the emerging landscape of research on entrepreneurial education, its dynamics, and nascent processes that require the revision and adjustment of educational programs taking into account many factors. Among them are the transformation of traditional business models of companies and their adaptation to the complex rules of the game in the global entrepreneurial ecosystem.

The scanning of publications on the topic under consideration has revealed a number of directions that have been voiced earlier, but in recent years have gained increased relevance. The most extensive cluster of publications is built around the thesis that univer-

sities should move from formal education (rooted in tradition, in place for a long period of time, but poorly suited to modern realities) to a creative, hybrid approach combining different formats and learning styles.

A significant number of works cover the problems of limited training in innovation creation processes. Due to the formalism dominating most cultural contexts in the contacts between universities and real businesses, EET programs ignore the full nature of this activity. It overlooks its discrete and "dark" sides, dealing with which requires special training and many non-obvious aspects.

Another vast field of research is devoted to unlocking students' inner potential, developing entrepreneurial thinking and behavior through previously untouched underlying cognitive dimensions. The subtle connections and mechanisms of the formation of such drivers of success as motivation to overcome difficulties, the will to achieve in particularly challenging contexts, the phenomena of entrepreneurial intention and entrepreneurial vigilance (thanks to which hidden opportunities are discovered) are being studied. Their discovery in practice is made possible by the application of the concept of "complex learning environments" in EET. Through the lens of new interdisciplinary knowledge, the entrepreneurial mindset looks like an asset that can be mastered and developed. This corrects the previous notion that entrepreneurs are inherently endowed with a specific talent. The new narrative suggests the opposite - "entrepreneurs are not only born, but also become entrepreneurs". This thesis is well illustrated by the case of KARE Academy in India, which trains entrepreneurs and adapts them to entrepreneurial ecosystems of different levels and complexity. The design of the four-year entrepreneurship education here is centered on the key objective of creating and strengthening in students' thinking a holistic view of reality, an understanding of the value of "lifelong learning", the courage to act globally, to build upon existing networks and create new ones. A sequential process of ascending through a hierarchy of external and internal complexity to an expanding diversity of possibilities is presented. KARE offers a new type of EET program that enables students to progressively ascend to increasingly complex levels of entrepreneurial ecosystems and, using the competencies acquired, to operate effectively at any of them.

In conclusion, there are a number of promising areas of work to ensure that EET programs realize their full potential and remain relevant in changing contexts.

Longitudinal studies are needed to assess the long-term effects of such programs on the career trajectories of graduates and their contribution to societal development. A deeper study of cultural specificity in EET will provide a better understanding of its impact on attitudes toward entrepreneurship, entrepreneurial behavior, and the performance of graduates from different backgrounds. The integration of emerging technologies, such as generative AI, into training programs is to be evaluated.

Policy concepts and regulatory frameworks governing EET should be further analyzed to identify ways to improve them. Relevant criteria are needed to assess the effects of EET programs, including economic, social, and environmental indicators.

The implementation of the above-mentioned set of measures should contribute to building a critical mass of human potential in the new conditions and maximizing opportunities for socioeconomic development.

References

Ajzen I. (1991) The theory of planned behavior. *Organizational Behavior and Human Decision Processes,* 50(2), 179-211. https://doi.org/10.1016/0749-5978(91)90020-T

Alvarez S.A., Barney J.B. (2017) Resource-based theory and the entrepreneurial firm. In: *Strategic Entrepreneurship: Creating a New Mindset* (eds. M.A. Hitt, R.D. Ireland, S.M. Camp, D.L. Sexton), New York: Wiley, pp. 87–105. https://doi.org/10.1002/9781405164085.ch5

Armstrong P. (2005) *Critique of entrepreneurship: People and policy,* London: Palgrave Macmillan.

Baierl R., Thamm R. (2023) Entrepreneurship Education in Digital Environments: Developing a Didactic Framework for a New Era. In: Progress in Entrepreneurship Education and Training. FGF Studies in Small Business and Entrepreneurship (eds. J.H. Block, J. Halberstadt, N. Högsdal, A. Kuckertz, H. Neergaard), Cham: Springer, pp. 1–13. https://doi.org/10.1007/978-3-031-28559-2_18

Bandera C., Eminet A., Passerini K., Pon K. (2018) Using mind maps to distinguish cultural norms between French and United States entrepreneurship students. *Journal of Small Business Management*, 56(S1), 177–196. http://dx.doi.org/10.1111/jsbm.12398

Bandera C., Santos S.C., Liguori E.W. (2021) The Dark Side of Entrepreneurship Education: A Delphi Study on Dangers and Unintended Consequences. *Entrepreneurship Education and Pedagogy*, 4(4), 609–636. https://doi.org/10.1177/2515127420944592

Barnard A., Pittz T., Vanevenhoven J. (2019). Entrepreneurship education in U.S. community colleges: A review and analysis. *Journal of Small Business and Enterprise Development*, 26(2), 190–208. https://doi.org/10.1108/JSBED-06-2018-017

Baron R.A. (2006) Opportunity recognition as pattern recognition: How entrepreneurs "connect the dots" to identify new business opportunities. *Academy of Management Perspectives,* 20(1), 104–119. https://doi.org/10.5465/amp.2006.19873412

Barry D., Meisiek S. (2015) Discovering the business studio. *Journal of Management Education,* 39(1), 153–175. https://doi.org/10.1177/1052562914532801

Boubker O., Arroud M., Ouajdouni A. (2021) Entrepreneurship education versus management students' entrepreneurial intentions. A PLS-SEM approach. *The International Journal of Management Education,* 19(1), 100450. https://doi.org/10.1016/j.ijme.2020.100450

Bronfenbrenner U. (1979) *The ecology of human development: Experiments by nature and design,* Cambridge, MA: Harvard University Press.

Byrne O., Shepherd D. (2015) Different strokes for different folks: Entrepreneurial narrative of emotion, cognition, and making sense of business failure. *Entrepreneurship Theory and Practice*, 39(2), 375–405. https://doi.org/10.1111/etap.12046

Csikszentmihalyi M. (1990) *Flow. The psychology of optimal experience,* New York: Harper Perennial.

Cui J., Sun J., Bell R. (2021) The Impact of Entrepreneurship Education on the Entrepreneurial Mindset of College Students in China: The mediating role of inspiration and the role of educational attributes. *International Journal of Management Education,* 19(1), 100296. https://doi.org/10.1016/j.ijme.2019.04.001

Da Silva G.B., Costa H.G., De Barros M.D. (2015) Entrepreneurship in engineering education: A literature review. *International Journal of Engineering Education,* 31(6), 1701–1710.

Deny J.S. (2020) JD Paradigm for Student Innovation, Start-ups, and Entrepreneurial Ecosystem. *TEST Journal of Engineering and Management* (May-June), 12310–12312.

Dong A., Garbuio M., Lovallo D. (2016) Generative sensing: A design perspective on the microfoundations of sensing capabilities. *California Management Review,* 58(4), 97–117. https://doi.org/10.1525/cmr.2016.58.4.97

Dorst K. (2011) The core of 'design thinking' and its application. *Design Studies,* 32(6), 521–532. https://doi.org/10.1016/j.destud.2011.07.006

Edelman L.F., Manolova T.S., Brush C.G. (2008) Entrepreneurship education: Correspondence between practices of nascent entrepreneurs and textbook prescriptions for success. *Academy of Management Learning and Education*, 7(1), 56–70. https://www.jstor.org/stable/40214497

Ernst & Young (2011) *Nature or nurture? Decoding the DNA of the entrepreneur,* Kansas City, MO: Ewing Marion Kauffman Foundation.

Fast L.A., Lewis J.L., Bryant M.J., Bocian K.A., Cardullo R.A., Rettig M., Hammond K.A. (2010) Does math self-efficacy mediate the effect of the perceived classroom environment on standardized math test performance? *Journal of Educational Psychology,* 102(3), 729–740. https://doi.org/10.1037/a0018863

Fayolle A. (2013) Personal views on the future of entrepreneurship education. *Entrepreneurship & Regional Development*, 25(7–8), 692–701. https://doi.org/10.1080/08985626.2013.821318

Fayolle A., Klandt H. (2006) Issues and Newness in the Field of Entrepreneurship Education: New Lenses for New Practical and Academic Questions. In: *International Entrepreneurship Education* (ed. A. Fayolle), Cheltenham: Edward Elgar Publishing, pp. 1–17.

Fayolle A., Lamine W., Mian S., Phan P. (2021) Effective models of science, technology and engineering entrepreneurship education: Current and future research. *Journal of Technology Transfer,* 46, 277–287. https://doi.org/10.1007/s10961-020-09789-3

Fellnhofer K. (2019) Toward a taxonomy of entrepreneurship education research literature: A bibliometric mapping and visualization. *Educational Research Review,* 27, 28–55. https://doi.org/10.1016/J.EDUREV.2018.10.002

Ferreira J., Fayolle A., Ratten V., Raposo M. (2018) *Entrepreneurial Universities,* Cheltenham: Edward Elgar Publishing.

Frese M., Gielnik M.M. (2014) The psychology of entrepreneurship. *Annual Review of Organizational Psychology and Organizational Behavior*, 1(1), 413–438. https://doi.org/10.1146/annurev-orgpsych-031413-091326

Fretschner M., Weber S. (2013) Measuring and Understanding the Effects of Entrepreneurial Awareness Education. *Journal of Small Business Management,* 51, 410–428. https://doi.org/10.1111/jsbm.12019

Furnham A., Ribchester T. (1995) Tolerance of Ambiguity: A Review of the Concept, Its Measurement and Applications. *Current Psychology,* 14, 179–199. https://doi.org/10.1007/BF02686907

Gao W., Zhang L. (2024) Entrepreneurs-in-residence programmes: The SUIBE approach. *Entrepreneurship Education,* 7, 87–103. https://doi.org/10.1007/s41959-024-00113-w

Garbuio M., Dong A., Lin N., Tschang T., Lovallo D. (2018) Demystifying the genius of entrepreneurship: How design cognition can help create the next generation of entrepreneurs. *The Academy of Management Learning and Education,* 17(1), 41–61. https://doi.org/10.5465/amle.2016.0040

George N.M., Parida V., Lahti T., Wincent J. (2016) A systematic literature review of entrepreneurial opportunity recognition: Insights on influencing factors. *International Entrepreneurship and Management Journal*, 12(2), 309–350. https://doi.org/10.1007/s11365-014-0347-y

Gorman G., Hanlon D., King W. (1997) Some research perspectives on entrepreneurship education, enterprise education and education for small business management: A ten-year literature review. *International Small Business Journal*, 15, 56–77. https://doi.org/10.1177/0266242697153004

Hayati K., Caniago I. (2023) *Digital Entrepeneurship Education: Review of Literature*. Paper presented at the 6th International Conference of Economics, Business, and Entrepreneurship, ICEBE 2023, 13-14 September 2023, Bandar Lampung, Indonesia. http://dx.doi.org/10.4108/eai.13-9-2023.2341223

Haynie J.M., Shepherd D., Mosakowski E., Earley P.C. (2010) A situated metacognitive model of the entrepreneurial mindset. *Journal of Business Venturing,* 25(2), 217–229. https://doi.org/10.1016/j.jbusvent.2008.10.001

Hayward M.L.A., Shepherd D.A., Griffin D. (2006) A hubris theory of entrepreneurship. *Management Science*, 52(2), 160–172. https://doi.org/10.1287/mnsc.1050.0483

Hietala P., Kaplan S.N., Robinson D.T. (2003) What is the price of hubris? Using takeover battles to infer overpayments and synergies. *Financial Management*, 32(3), 5–31.

Hmieleski K.M., Baron R.A. (2009) Entrepreneurs' optimism and new venture performance: A social cognitive perspective. *The Academy of Management Journal,* 52(3), 473–488. http://dx.doi.org/10.5465/AMJ.2009.41330755

Hmieleski K.M., Lerner D.A. (2016) The dark triad and nascent entrepreneurship: An examination of unproductive versus productive entrepreneurial motives. *Journal of Small Business Management,* 54(1), 7–32. https://doi.org/10.1111/jsbm.12296

Isabelle D.A. (2020) Gamification of Entrepreneurship Education. *Decision Sciences,* 18(2), 203–223 https://doi.org/10.1111/dsji.12203

Jenkins A.S., Wiklund J., Brundin E. (2014) Individual responses to firm failure: Appraisals, grief, and the influence of prior failure experience. *Journal of Business Venturing,* 29, 17–33. https://doi.org/10.1016/j.jbusvent.2012.10.006

Kaish S., Gilad B. (1991) Characteristics of opportunities search of entrepreneurs versus executives: Sources, interests, general alertness. *Journal of Business Venturing*, 6, 45–61. https://doi.org/10.1016/0883-9026(91)90005-x

Kassean H., Vanevenhoven J., Liguori E., Winkel D.E. (2015) Entrepreneurship education: A need for reflection, real-world experience and action. *International Journal of Entrepreneurial Behavior & Research,* 21(5), 690–708. https://doi.org/10.1108/IJEBR-07-2014-0123

Katz J.A. (2007) Education and Training in Entrepreneurship. In: *The Psychology of Entrepreneurship* (eds. J.R. Baum, M. Frese, R.A. Baron), Mahwah, NJ: Lawrence Erlbaum Associates Publishers, pp. 209–235.

Khelil N. (2016) The many faces of entrepreneurial failure: Insights from an empirical taxonomy. J*ournal of Business Venturing*, 31(1), 72–94. https://doi.org/10.1016/j.jbusvent.2015.08.001

Kirchherr J., Klier J., Lehmann-Brauns C., Winde M. (2019) *Future Skills: Welche Kompetenzen in Deutschland fehlen*, Berlin: Stiftverband.

Kirkwood J., Tootell B. (2008) Is entrepreneurship the answer to achieving work-family balance? *Journal of Management Organization*, 14, 285–302. https://doi.org/10.5172/jmo.837.14.3.285

Kirzner I.M. (1979) *Perception, opportunity, and profit,* Chicago, IL: University of Chicago Press.

Kneppers L., Elshout-Mohr M., Boxtel C., van Hout-Wolters B. (2007) Conceptual learning in relation to near and far transfer in the secondary school subject of economics. *European Journal of Psychology of Education,* 22(5), 115–129. https://doi.org/10.1007/BF03173517

Koudstaal M., Sloof R., van Praag M. (2016) Risk, uncertainty, and entrepreneurship: Evidence from a lab-in-the-field experiment. *Management Science*, 62(10), 2897–2915. https://www.jstor.org/stable/44012222

Krueger N. (2015) *OECD thematic paper on entrepreneurial education in practice. Part 1: The entrepreneurial mindset*, Paris: OECD.

Lamine W., Mian S., Fayolle A., Linton J.D. (2021) Educating scientists and engineers for technology entrepreneurship in the emerging digital era. *Technological Forecasting and Social Change,* 164, 120552. https://doi.org/10.1016/j.techfore.2020.120552

Landström H. , Harirchi G. (2019) "That's Interesting!" in Entrepreneurship Research. *Journal of Small Business Management*, 57(S2), 507–529. https://doi.org/10.1111/jsbm.12500

Lehrer J. (2008) The eureka hunt. *The New Yorker,* 28, 40–45.

Liguori E., Corbin R., Lackeus M., Solomon S. J. (2019) Under-researched domains in entrepreneurship and enterprise education: Primary school, community colleges and vocational education and training programs. *Journal of Small Business and Enterprise Development*, 26(2), 182–189. https://doi.org/10.1108/JSBED-04-2019-402

Linán F., Fayolle A. (2015) A Systematic Literature Review on Entrepreneurial Intentions: Citation, Thematic Analyses, and Research Agenda. *Entrepreneurship and Management Journal*, 11, 907–933. https://doi.org/10.1007/s11365-015-0356-5

Liñán F., Fayolle A. (2015) A systematic literature review on entrepreneurial intentions: Citation, thematic analyses, and research agenda. *International Entrepreneurship and Management Journal,* 11(4), 907–933. https://doi.org/10.1007/s11365-015-0356-5

Liu M. (2023) How to promote students' entrepreneurial alertness within theoretical and practical entrepreneurship courses: The role challenging learning environment. *Entrepreneurship Education,* 6, 425–444. https://doi.org/10.1007/s41959-023-00107-0

Loi M., Fayolle A., van Gelderen M., Riot E., Refai D., Higgins D., Haloub R., Salusse M.A.Y., Lamy E., Verzat C., Cavarretta F. (2022) Entrepreneurship Education at the Crossroads: Challenging Taken-for-Granted Assumptions and Opening New Perspectives. *Journal of Management Inquiry*, 31(2), 123–134. https://doi.org/10.1177/10564926211042222

Loon M., Bell R. (2017) The moderating effects of emotions on cognitive skills. *Journal of Further and Higher Education*, 42(5), 694–707. https://doi.org/10.1080/0309877X.2017.1311992

Lundmark E., Westelius A. (2019) Antisocial entrepreneurship: Conceptual foundations and a research agenda. *Journal of Business Venturing Insights,* 11, e00104. https://doi.org/10.1016/j.jbvi.2018.e00104

Martin B.C., McNally J.J., Kay M.J. (2013) Examining the formation of human capital in entrepreneurship: A meta-analysis of entrepreneurship education outcomes. *Journal of Business Venturing,* 28(2), 211–224. https://doi.org/10.1016/j.jbusvent.2012.03.002

Mayhew M.J., Simonoff J.S., Baumol, W.J., Selznick B.S., Vassallo S.J. (2016) Cultivating innovative entrepreneurs for the twenty-first century: A study of US and German students. *The Journal of Higher Education*, 87(3), 420–455. https://doi.org/10.1080/00221546.2016.11777408

McMullen J.S., Shepherd D.A. (2006) Entrepreneurial action and the role of uncertainty in the theory of the entrepreneur. *Academy of Management Review*, 31(1), 132–152. https://doi.org/10.5465/amr.2006.19379628

Morris M.H., Liguori E. (2016) Preface: Teaching reason and the unreasonable. In: *Annals of entrepreneurship education and pedagogy–2016* (eds. M.H. Morris, E. Liguori), Cheltenham: Edward Elgar Publishing, pp. 14–22.

Nabi G., Liñán F., Fayolle A., Krueger N., Walmsley A. (2017) The impact of entrepreneurship education in higher education: A systematic review and research agenda. *Academy of Management Learning & Education*, 16(2), 277–299. https://doi.org/10.5465/amle.2015.0026

Neck H.M., Corbett A.C. (2018) The scholarship of teaching and learning entrepreneurship. *Entrepreneurship Education and Pedagogy*, 1(1), 8–41. https://doi.org/10.1177/2515127417737286

Neneh B. (2012) An Exploratory Study on Entrepreneurial Mindset in the Small and Medium Enterprise (SME) Sector: A South African Perspective on Fostering Small and Medium Enterprise (SME) Success. *African Journal of Business Management*, 6(9), 3364–3372. https://doi.org/10.5897/AJBM10.1631

Neumeyer X., Santos S.C. (2020) A lot of different flowers make a bouquet: The effect of gender composition on technology-based entrepreneurship teams. *International Entrepreneurship and Management Journal,* 16(1), 93–114. https://doi.org/10.1007/s11365-019-00603-7

Olaison L., Sørensen B. (2014) The abject of entrepreneurship: Failure, fiasco, fraud. *International Journal of Entrepreneurial Behavior & Research*, 20(2), 193–211. https://doi.org/10.1108/IJEBR-09-2013-0143

O'Reilly C.A., Tushman M.L. (2013) Organizational ambidexterity: Past, present, and future. *The Academy of Management Perspectives*, 27(4), 324–338. https://doi.org/10.5465/amp.2013.0025

Pittaway L., Cope J. (2007) Simulating entrepreneurial learning. *Management Learning,* 38(2), 211–233. https://doi.org/10.1177/1350507607075776

Pittaway L., Edwards C. (2012) Assessment: Examining practice in entrepreneurship education. *Education + Training,* 54(8/9), 778–800. https://doi.org/10.1108/00400911211274882

Roundy P.T., Harrison D.A., Khavul S., Pérez-Nordtvedt L., McGee J.E. (2018) Entrepreneurial alertness as a pathway to strategic decisions and organizational performance. *Strategic Organization,* 16(2), 192–226. https://doi.org/10.1177/1476127017693970

Saadat S., Aliakbari A., Majd A., Bell R. (2022) The effect of entrepreneurship education on graduate students' entrepreneurial alertness and the mediating role of entrepreneurial mindset. *Education + Training*, 64(7), 892–909. https://doi.org/10.1108/ET-06-2021-0231

Sarasvathy S.D., Dew N., Velamuri S.R., Venkataraman S. (2003) Three Views of Entrepreneurial Opportunity. In: *Handbook of Entrepreneurship Research* (eds. Z.J. Acs, D.B. Audretsch), International Handbook Series on Entrepreneurship (vol. 1), Boston, MA. Springer. https://doi.org/10.1007/0-387-24519-7_7

Schmidt A.M., Ford J.K. (2003) Learning within a learner control training environment: The interactive effects of goal orientation and metacognitive instruction on learning outcomes. *Personnel Psychology,* 56(2, 405–429. https://doi.org/10.1111/j.1744-6570.2003.tb00156.x

Scott K. (2024) Humility and reverence: Mitigating the dark side of entrepreneurship education. *Entrepreneurship Education,* 7, 1–19. https://doi.org/10.1007/s41959-024-00110-z

Shane S., Venkataraman S. (2000) The Promise of Entrepreneurship as a Field of Research. *The Academy of Management Review*, 25(1), 217–226. https://doi.org/10.2307/259271

Shapero A., Sokol L. (1982) The Social Dimensions of Entrepreneurship. In: *Encyclopedia of Entrepreneurship* (eds. C.A. Kent, D.L. Sexton, K.H. Vesper), Englewood Cliffs, NJ: Prentice-Hall, pp. 72–90.

Sharp J.G., Sharp J.C., Young E. (2018) Academic boredom, engagement and the achievement of undergraduate students at university: A review and synthesis of relevant literature. *Research Papers in Education,* 35(2), 144–184. https://doi.org/10.1080/02671522.2018.1536891

Shepherd D. (2019). Researching the dark side, downside, and destructive side of entrepreneurial action: It's the compassionate thing to do. *Academy of Management Discoveries,* 5(3), 217–220. https://doi.org/10.5465/amd.2018.0194

Shepherd D., Haynie J.M. (2009) Birds of a feather don't always flock together: Identity management in entrepreneurship. *Journal of Business Venturing,* 24, 316–337. https://doi.org/10.1016/j.jbusvent.2007.10.005

Shepherd D.A., Patzelt H., Haynie J.M. (2010) Entrepreneurial Spirals: Deviation-amplifying Loops of an Entrepreneurial Mindset and Organizational Culture. *Entrepreneurship Theory and Practice,* 34(1), 59–82. https://doi.org/10.1111/j.1540-6520.2009.00313.x

Shi Y., Wang C. (2023) The entrepreneur-in-residence system in American universities: Origin, model and implication. *Journal of Higher Education Management*, 17(1), 59–68. https://doi.org/10.13316/j.cnki.jhem.20230103.003

Short J.C., Ketchen D.J., Shook C.L., Ireland R.D. (2010) The concept of "opportunity" in entrepreneurship research: Past accomplishments and future challenges. *Journal of Management,* 36(1), 40–65. https://doi.org/10.1177/0149206309342746

Slater D.J., Dixon-Fowler H.R. (2010) The future of the planet in the hands of the MBAs: An examination of CEO MBA education and corporate environmental performance. *Academy of Management Learning and Education*, 9(3), 429–441. https://doi.org/10.5465/amle.9.3.zqr429

Smith B.R., Matthews C.H., Schenkel M.T. (2009) Differences in entrepreneurial opportunities: The role of tacitiness and codification in opportunity identification. *Journal of Small Business Management,* 47(1), 38–57. https://doi.org/10.1111/j.1540-627X.2008.00261.x

Solomon G. (2007) An examination of entrepreneurship education in the United States. *Journal of Small Business and Enterprise Development*, 14(2), 168–182. https://doi.org/10.1108/14626000710746637

Souitaris V., Zerbinati S., Al-Laham A. (2007) Do entrepreneurship programmes raise entrepreneurial intention of science and engineering students? The effect of learning, inspiration and resources. *Journal of Business Venturing*, 22(4), 566–591. https://doi.org/10.1016/j.jbusvent.2006.05.002

Spicer A., Alvesson M., Karreman D. (2009) Critical performativity: The unfinished business of critical management studies. *Human Relations*, 62(4), 537. https://doi.org/10.1177/0018726708101984

Spivack A.J., McKelvie A. (2018) Entrepreneurship addiction: Shedding light on the manifestation of the 'Dark Side' in work-behavior patterns. *Academy Management Organization,* 17, 358–378. https://doi.org/10.5465/amp.2016.0185

Sreenivasan A., Suresh M. (2023) Twenty years of entrepreneurship education: A bibliometric analysis. *Entrepreneurship Education,* 6, 45–68. https://doi.org/10.1007/s41959-023-00089-z

Vesper K.H., Gartner W.B. (1997) Measuring progress in entrepreneurship education. *Journal of Business Venturing*, 12(5), 403–421. https://doi.org/10.1016/S0883-9026(97)00009-8

Visser W. (2006) *The cognitive artifacts of designing*, Mahwah, NJ: Lawrence Erlbaum Associates

Visser W. (2009) Design: One, but in different forms. *Design Studies,* 30(3), 187–223. https://doi.org/10.1016/j.destud.2008.11.004

Wang C.M., Xu S.J., Zhang B.B. (2016) Influence of Personality and Risk Propensity on Risk Perception of Chinese Construction Project Managers. *International Journal of Project Management,* 34, 1294–1304. https://doi.org/10.1016/j.ijproman.2016.07.004

Westhead P., Solesvik M.Z. (2016) Entrepreneurship education and entrepreneurial intention: Do female students benefit? *International Small Business Journal,* 34(8), 979–1003. https://doi.org/10.1177/0266242615612534

Wibowo A., Narmaditya B.S. (2022) Predicting Students' Digital Entrepreneurial Intention: The Mediating Role of Knowledge and Inspiration. *Dinamika Pendidikan,* 17(1), 25–36.

Wickham P. (2006) *Strategic entrepreneurship* (4th ed.), New York: Pearson Education Limited.

Wright M., Zahra S.A. (2011) Entrepreneurship's next act. *Academy of Management Perspectives,* 25(4), 67–83. https://doi.org/110.5465/amp.2010.0149

Xin B., Ma X. (2023) Gamifying online entrepreneurship education and digital entrepreneurial intentions: An empirical study. *Entertainment Computing,* 46, 6–8. https://doi.org/10.1016/j.entcom.2023.100552

Yang Q., Chen J., Yang L., Liu Z. (2021) How to develop entrepreneurial talent more effectively? A comparison of different entrepreneurship educational methods. *Frontiers in Psychology,* 12, 1090. https://doi.org/10.3389/fpsyg.2021.644113

Zahorik J.A. (1996) Elementary and secondary teachers' reports of how they make learning interesting. *Elementary School Journal,* 96(5), 562–564. https://doi.org/10.1086/461844

Zeng L., Zhang Z., Liu Y. (2017) The strategy of 'double creation' in the service of innovation and entrepreneur education in colleges and universities needs collaborative development. *Educational Research*, 38(1), 70–76.

Ziemianski P., Golik J. (2020) Including the dark side of entrepreneurship in the entrepreneurship education. *Entrepreneurship Education*, 10(8), 1–26. https://doi.org/10.3390/educsci10080211

Foresight Scenarios for the Iran's Petrochemical Industry

Mohammad Amin Ghalambor
Lecturer, Faculty of Management, Ghalambor@ut.ac.ir

University of Tehran, Shanzdah-e-Azar (Engelab Avenue), Tehran, Iran

Abstract

Iran's vast oil and gas reserves and strategic location present a unique opportunity for its petrochemical industry. However, the industry faces a dynamic future influenced by rapid and complex economic, political, technological, and regulatory changes. This study presents the findings of a foresight research project on the Iranian petrochemical industry in collaboration with Tehran's industry chambers (TCCIM and APEC), utilizes scenario planning — a methodology grounded in the established Global Business Network (GBN) model — to explore various potential futures. Extensive data collection forms the foundation of this study. Primary and secondary data are gathered through a rigorous multi-method approach encompassing in-depth library research, benchmark analyses of similar industries around the world, and insightful interviews with industry experts. By employing this approach, the research identifies the key factors that will determine the future trajectory of Iran's petrochemical industry. Following the data collection phase, a comprehensive analysis categorizes these factors based on their importance and degree of uncertainty. This analysis allows researchers to prioritize the most critical drivers that will ultimately define the industry's future.

Drawing upon this understanding, the research then constructs four distinct scenarios, each depicting a unique narrative for the industry's potential trajectory. These scenarios — "Phoenix" (potential resurgence), "Glimmer" (moderate growth), "Swamp" (stagnation), and "Amphibian" (struggle for survival) — offer a comprehensive spectrum of possibilities. Additionally, the research establishes leading indicators to anticipate the specific conditions that might trigger each scenario. The research does not stop at simply outlining these potential futures. It transcends this by engaging a select group of industry executives in scenario simulations. Through these simulations, the research identifies the key opportunities and threats inherent in each potential future. This comprehensive approach empowers stakeholders with a deeper understanding of the various paths the industry might take, allowing them to formulate informed policies and strategies for a successful future in the ever-changing global landscape.

Keywords: petrochemical industry; scenario planning; futur; Foresight; Iran; oil and gas; scenario simulation

Citation: Ghalambor M.A. (2024) Foresight Scenarios for the Iran's Petrochemical Industry. *Foresight and STI Governance*, 18(3), pp. 54–68. DOI: 10.17323/2500-2597.2024.3.54.68

Introduction

Understanding the future trajectory of the Iranian petrochemical industry is crucial not only for industry participants but also for broader economic and political stakeholders. This study was conducted by ARA Consulting Company in collaboration with the Tehran Chamber of Commerce, Industries, Mines and Agriculture (TCCIM) and the Association of Engineering and Contracting Companies in Oil, Gas and Petrochemical Industries (APEC) in 2023. The TCCIM, with over 33,000 members, is the largest chamber of commerce, industries, mines and agriculture in Iran. APEC, currently with 268 members, is one of the TCCIM's important petrochemical industry associations, comprising private sector companies active in engineering and project implementation in the oil, gas, and petrochemical industries. The industry's influence extends far beyond its own operations, significantly impacting the supply chains and the value of numerous sectors such as automotive, construction, and pharmaceuticals.

However, the industry faces significant challenges, including currency fluctuations, environmental regulations, attracting foreign investment, and knowledge transfer restrictions. These challenges hinder strategic decision-making. Iran boasts a prominent position in the global petrochemical landscape (Figure 1). It holds 24% of the Middle East's oil reserves and 12% of the world's total.[1] Additionally, it was the fifth-largest producer in OPEC in 2021. Iran's position is further bolstered by holding the second-largest natural gas reserves globally by the end of 2021 and ranking as the third-largest producer in 2020. Despite its vast energy reserves, Iran's petrochemical production has declined noticeably since 2017. This decline is primarily attributed to reduced investments and increased international sanctions.[2]

Investment is a recognized driver of economic growth, and attracting both domestic and foreign capital is vital for the Iranian petrochemical industry's growth and development (Sternberg, Lubart, 1991; Sazvar, Sepehri, 2020). Successfully securing the necessary investments and allocating them effectively across various sectors will pave the way for sustainable development (Farashah et al., 2021). Foreign direct investment (FDI) plays a particularly crucial role by influencing financing, access to technology, and export opportunities (Blomstrom et al., 2000; Anwar, Nguyen, 2010). Due to privatization, the industry cannot rely solely on government funding. Consequently, attracting private and foreign investors is crucial for its future.

However, sanctions and unfavorable economic indicators present significant challenges in this area. To gain a deeper understanding of the industry's future, it is essential to examine relevant Iranian policies and high-level documents. This analysis will help define the research scope, objectives, and the approach to identifying future trends and uncertainties. An analysis of high-level documents in the oil, gas, and petrochemical sector reveals the ambitious goals set for the industry. These include reducing energy intensity, maintaining a leading position in OPEC oil production, and achieving regional dominance in gas production and refining capacity. While these goals highlight the industry's importance, their achievement will be challenging due to the complex and volatile economic environment. This research aims to identify the factors impacting the future of the Iranian petrochemical industry. By developing and simulating future scenarios, we will explore potential opportunities and threats in each scenario, providing a comprehensive understanding of the industry's future trajectory.

Literature Review

In today's rapidly changing world, characterized by ambiguity, uncertainty, and resource scarcity (Richter et al., 2018), futures research emerges as a crucial discipline for navigating complexity (Brem, Utikal, 2019; Walsh, Winsor, 2019; Van de Ven, 2017). The intricate nature of the environment underscores the need for innovative perspectives and tools to formulate strategic responses and uncover opportunities for success (Renwick et al., 2019; Goldsby, Zinn, 2016; Kieser et al., 2015).

A growing number of researchers and forward-thinking businesses are embracing the power of futures research and foresight, employing this knowledge systematically (Sarin et al., 2018). Futures studies, a systematic approach to exploring possible, probable, and preferable futures (Nagy et al., 2016; Murayama et al., 2015), offer valuable insights.

Given the inherent uncertainties and complexities within the Iranian petrochemical industry, a foresight approach is employed to map and explore its potential future trajectory. As the first step in examining the industry's future, we must identify and analyze the critical factors shaping its direction and potential transformation. To achieve this, Porter's PESTEL framework, which investigates political, economic, social, environmental, technological, and legal factors, will be utilized. The following section will delve into the most significant factors identified through a combination of literature reviews, benchmarking, and expert interviews. Political changes and developments, both domestically and internationally, have always exerted a significant influence on Iran's economy and industries. These developments can manifest as political and economic sanctions, regional conflicts and wars, international agreements, and new domestic policies.

[1] https://www.ogj.com/ogj-survey-downloads/worldwide-production/document/14302750/worldwide-reserves-and-production, accessed 11.06.2024.

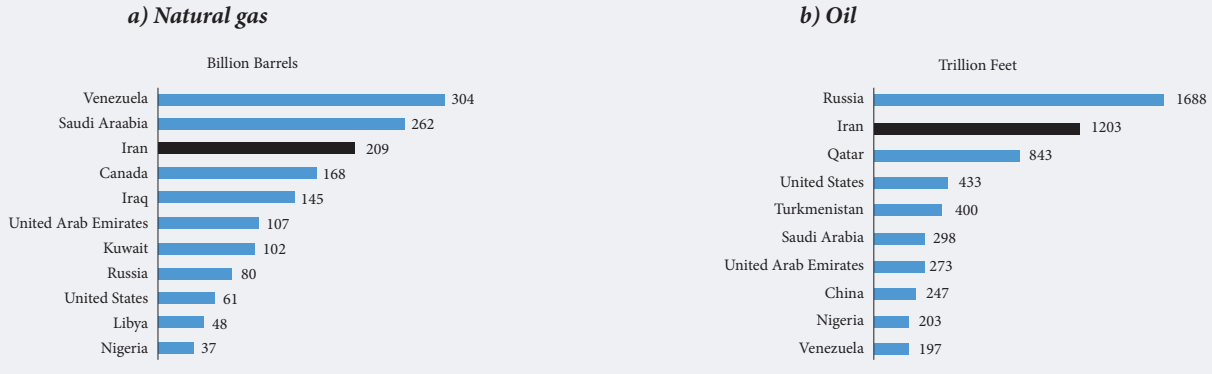
[2] www.eia.gov/international/analysis/country/IRN, accessed 11.06.2024.

Sun (2023) examined the consequences of war and military conflicts (specifically, the conflict between Russia and Ukraine) on the oil, petrochemical, and renewable energy industries. The study revealed a positive impact of rising oil prices on stock returns for renewable energy companies, while the effect on petroleum product stock returns was negligible. In another relevant study, Farashah et al. (2021) explored the factors influencing the development of the petrochemical industry. They modeled the mechanism for creating a capacity increase budget, a proposed policy, using a system dynamics approach. This model was used to simulate variables related to each product, such as production capacity value, production rate, domestic sales revenue, and exports. Based on the simulation results, Iran's petrochemical product capacity could reach approximately 104 million tons by 2025, a scenario deemed undesirable. This research suggests program improvement and budget allocation as the most effective solutions for achieving development in the petrochemical industry. By implementing this policy, the model predicts a 4% and 13% improvement in production capacity and total income, respectively, in 2025 compared to the baseline scenario. Financial risks and a complex regulatory environment pose significant challenges for the continued development of Iran's petrochemical industry.

Shafiei Nataghi et al. (2023) employed a research model to identify and categorize these financial strategic risks. Their study, utilizing expert interviews, literature reviews, and thematic analysis, revealed a network of interconnected risks. These include sanctions risk, government financial decision-making risk, credit risk, liquidity risk, production area financial risks, macroeconomic risk, product and market risk, insurance sector risk, and strategic management risks (Shafiei Nataghi et al., 2023). Beyond financial considerations, effective regulations are crucial for the sustainable growth of any industry. Mirjalili's (2003) report for the Majlis Research Center highlights the critical role of regulations in fostering a balanced and sustainable development trajectory for the petrochemical value chain. The report identifies the lack of a coherent industrial and sectoral development strategy as a key challenge. This ambiguity in policymaking and targeting hinders progress within the industry (Mirjalili, 2003).

Economic developments also significantly influence the performance of the petrochemical industry. Golshen et al. (2022) investigated the impact of exchange rate fluctuations on Iran's petrochemical and oil product industries. Their analysis of Tehran Stock Exchange data revealed a positive correlation between exchange rate changes and the price index of companies in these sectors (Golshen et al., 2022). Furthermore, Mamarzadeh et al. (2019) examined the effects of global crude oil market shocks on the Iranian petrochemical stock index. Their findings suggest that market demand increases have a positive impact on the index, while supply-side increases have a negligible effect. Additionally, the dollar exchange rate and inflation positively affect the index, whereas increased liquidity exerts a negative impact (Mamarzadeh et al., 2019). Similarly, Zarei (2020) explored the influence of inflation and exchange rates on the Iranian petrochemical stock index. The study concluded that exchange rate fluctuations have a greater long- and short-term impact on the industry compared to inflation. This can be attributed to the industry's reliance on international trade for product exports and raw material/technology imports. Additionally, essential inputs like subsidized natural gas are less susceptible to general price level changes (Zarei, 2020). The potential economic impact of foreign direct investment (FDI) on Iran's oil and gas sector

Figure 1. **Largest Proven Reserves of Oil and Natural Gas in World and Iran Position**



Source: author.

was explored by Nejati and Bahmani (2020). Their research suggests that FDI can have negative consequences if it does not lead to increased productivity. This could result in a significant rise in raw material consumption (oil and gas) within the Iranian economy, potentially leading to decreased production and employment in tradable sectors, with a corresponding increase in non-tradable sectors (Nejati, Bahmani, 2020). The text also acknowledges the growing global trend toward renewable energy sources.

Studies by Hwangbo et al. (2022) and Heo et al. (2024) examine the potential of artificial intelligence (AI) in decarbonization efforts and minimizing the environmental impact of the petrochemical industry. Additionally, Wu et al. (2023) explored the impact of environmental laws and regulations on China's petrochemical industry. Their research suggests that three types of environmental laws positively affect the financial performance of petrochemical companies: fines for environmental protection violations, pollution discharge costs, and environmental protection taxes. Public environmental concerns in areas with petrochemical companies were also found to have a positive influence (Wu et al., 2023). Environmental sustainability and energy conservation have become paramount concerns in the petrochemical industry, driven by growing environmental awareness, regulatory pressures, and economic incentives. Minimizing waste and reducing pollutant emissions are crucial measures for achieving these goals (Kiet, 2023; Rao, 2002; Zhu et al., 2005; Lee et al., 2012).

Iran's current electricity generation capacity stands at 90,900 megawatts (MW), with over 80% derived from thermal sources reliant on natural gas. This heavy dependence on natural gas has rendered the power sector vulnerable to supply disruptions, posing a significant challenge to meeting the country's growing energy demands. The lack of diversity in Iran's electricity generation portfolio, coupled with its excessive dependence on natural gas and limited fuel supply constraints, necessitates a strategic shift toward renewable energy sources to ensure a sustainable and secure energy supply for economic growth. Iran boasts an estimated renewable energy potential of 124 GW, with solar energy accounting for 71 GW and wind energy contributing 49 GW. Despite the recognition of renewable energy's importance in national laws, regulations, and policies, their share in the country's total electricity generation remains below 0.5%. This stands in stark contrast to the global average, where renewable energy sources account for approximately 12.8% of electricity production. International projections indicate that global electricity demand will increase by about 60% by 2050, with renewable energy sources poised to play a dominant role, contributing 43% of the total electricity generation. Iran's transition to a renewable energy-driven future is not merely an option but a necessity. The Seventh Development Plan provides a roadmap for this transformation, emphasizing the need for a concerted effort from all stakeholders to harness the immense renewable energy potential of Iran (Saberi et al., 2023).

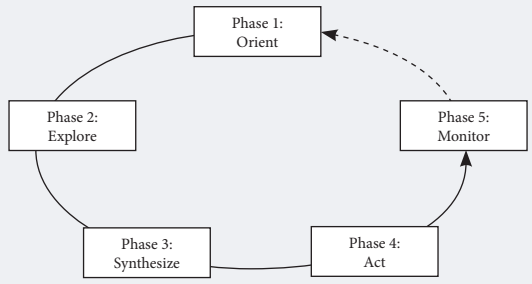
Technology and knowledge are recognized as the driving forces behind industrial growth and productivity enhancement. Allahi and Shavalpour (2019) examined the significance of local knowledge networks in the oil, gas, and petrochemical industry of Iran's Khuzestan Province. Ghaithan et al. (2021) investigated the impact of Industry 4.0 technologies and lean manufacturing on the sustainable performance of petrochemical companies in Saudi Arabia. Their findings revealed a positive and coherent relationship between Industry 4.0 technologies and sustainable development performance, confirming a causal link between lean manufacturing and Industry 4.0 technologies. Min et al. (2019) explored the application of machine learning-based digital twins for production optimization in the petrochemical industry. Their study proposed a framework and approaches for constructing an industrial Internet of Things (IIoT)-based digital twin in the petrochemical sector, incorporating machine learning and a feedback loop to exchange information between the physical plant and a virtual digital twin model for achieving production control optimization. Fayez et al. (2021) studied public-private partnerships (PPPs) in the downstream industries of Iran's oil sector. Their findings revealed that political and legal factors have the most significant influence on PPPs. Additionally, the study emphasized the importance of strengthening transparency in PPPs. Malik et al. (2020) examined the impact of disruptive events, with a focus on the COVID-19 pandemic, on the petrochemical industry in a McKinsey & Company report. The report delineated the impact of pandemic-induced disruptions – namely, declining demand and oil prices – on the short-term, medium-term (second half of 2020 to 2023), and long-term (post-2023) outlook for the petrochemical industry. The study concluded that chemical industry leaders and financial investors alike need to update their perspectives and management plans to focus on recovery scenarios, regional supply chains, and capital efficiency.

As evident, numerous factors influence the petrochemical industry. Some of these have positive impacts, while others have negative consequences. Some can be considered threats, while others can be considered opportunities. Building upon the identified factors from the literature review and comparative studies, we proceed to code them and determine their impact intensity using an importance-uncertainty matrix. Subsequently, the positive and negative effects of the most significant factors in each scenario are narrated. Finally, the threats and opportunities arising from their interactions are identified and explained.

Methodology

Scenario planning is a widely recognized and valuable approach to futures studies. Due to the inherent ambiguity, complexity, and uncertainty associated with the petrochemical industry, numerous studies have employed this method (Rubio et al., 2023; Guivarch et al., 2017; Khosala et al., 2021; Parajuli, 2015; Matsumoto,Voudouris, 2015; Paltsev, 2014). This research employs a mixed-methods approach to develop scenarios for the future of Iran's petrochemical industry. To ensure coherence throughout the research process, the Global Business Network (GBN) model (Scearce, Fulton, 2004) is utilized. This model comprises five key phases: orient, explore, synthesize, act, and monitor (Figure 2).

Figure 2. **GBN Scenario Planning Process**



Source: author.

Scenario Planning Process Based on the GBN Method

Phase 1: Orient

The orientation phase establishes the objectives of scenario planning for the future of Iran's petrochemical industry. This stage aims to clearly define the problem under consideration to guide the subsequent four stages. The orientation stage commences by discussing the most significant challenges facing the industry and progress toward identifying assumptions regarding these challenges and their potential future roles. The most effective approach in this stage involves asking key questions of decision-makers, senior managers, and primary stakeholders through semi-structured interviews. Additionally, the time frame of the scenarios can be determined either prior to the interviews or based on their findings. The outcomes of this phase are elucidated through document reviews and expert interviews.

Phase 2: Explore

This phase identifies the key factors that shape the central issue. Key factors can be both internal and external, influencing the future of the petrochemical industry in predictable and unpredictable ways. Key factors can also be categorized as predictable factors and uncertainties. Predictable factors are change forces that effectively and relevantly impact the future timeframe, such as political changes, changes in people's and government income, and technological advancements. Uncertainties are unpredictable forces that can have significant impacts, such as changes in societal values, public opinion, or the role of government in the petrochemical industry. The literature comprehensively identifies and describes predictable factors in the petrochemical industry's macro-environment. Uncertainties are identified and determined based on previous studies, in-depth interviews, and questionnaires.

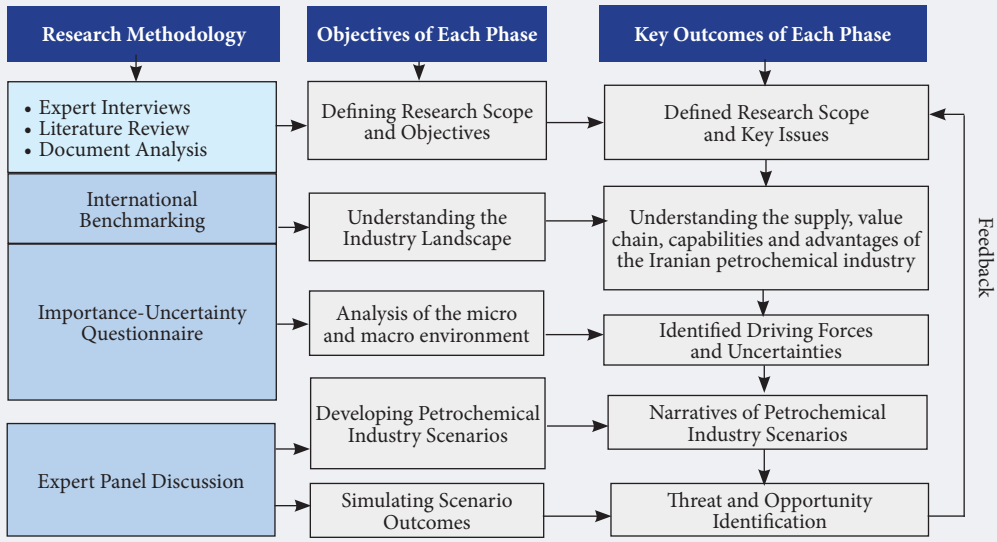
Phase 3: Synthesize

In phase three, the effective forces identified in the preceding phase are combined and integrated to construct scenarios. While numerous factors may have been identified in the previous phases, they may also differ meaningfully; although all factors may be important, their significance is not equal. This phase involves differentiating the identified factors and selecting the key drivers for scenario development. The goal of prioritization is to identify two or three forces that have the most significant impact and influence on the central question or issue. These factors represent critical uncertainties and form the foundation of the scenarios. Eliminating certain factors may create the perception that the value of the work is diminished; however, there are opportunities to revisit the factors identified in the preceding phases in subsequent processes.

Phase 4: Act

Scenarios are employed in phase four to inform and encourage activities. Experimenting with a group of scenarios does not imply reaching precise conclusions about the future but rather empowers petrochemical industry stakeholders to learn, adapt, and select more effective activities. After developing each scenario, one must deeply envision working with it and ask: What if this scenario unfolds in the future? What actions should be taken today to prepare? Responses to such questions constitute the reactions of key decision-makers and industry stakeholders to the scenarios. Subsequently, their reactions in each scenario must be analyzed: Were the reactions effective? Did the reactions in each scenario differ effectively? Can any of these differing reactions be adopted as a strategy? The patterns and insights gained from reactions to the scenarios serve as frameworks for building strategies. Predictable factors identified and determined in the preceding phases can also be utilized to inform strategic planning.

Figure 3. **Research Process and Methodology**



Source: author.

Phase 5: Monitor

The objective of this phase is to establish key indicators for evaluating the accuracy and validity of scenarios as real-world events unfold. Additionally, this phase establishes a mechanism for enabling industry stakeholders to navigate the environment and adapt strategies. Effective forces may exist that have the potential to exert greater influence over time and should be identified as guiding indicators.

The research process, including the methodology, goals, and achievements of each stage, is depicted in the Figure 3 below. Following the established process, the first step involved defining the research territory, limitations, and needs. Subsequently, macro-trends, trends, events, challenges, and opportunities were identified within this domain to construct a basket of factors influencing the future of the petrochemical industry. Next, an uncertainty and importance questionnaire was employed to investigate the factors impacting Iran's petrochemical industry specifically. The key drivers were then selected to serve as the foundation for scenario formulation. The research team, along with a panel of experts in the field, subsequently developed the logic, structure, and narrative of these scenarios. Finally, to enrich the scenarios and gain a deeper understanding of the implications for key players, a scenario simulation panel was conducted. This panel aimed to identify opportunities and threats associated with each scenario. Importantly, the experts prioritized the most critical opportunities and threats based on their insights. By employing this structured research methodology, the study provides a robust and insightful analysis of the Iranian petrochemical industry's future, enabling informed decision-making and strategic planning for industry stakeholders.

To gain a deeper understanding of the identified key factors and explore a broader range of potential influences, the research team consulted with subject matter experts during the exploring phase. Their perspectives further informed the completion of the importance-uncertainty questionnaires. Interviews were conducted with 43 experts associated with Iran's petrochemical industry. To ensure the development of well-crafted questions and the evaluation of high-quality responses, a semi-structured interview protocol was designed for the present study following the format of the RAND Corporation's semi-structured interview protocol (Harrell, Bradley, 2009). The respondents whose demographic characteristics are presented in the Table 1 were asked about:

- The most important challenges and issues facing the industry
- The most important economic, political, technological, legal, social, and environmental factors affecting the industry by 2030
- The most attractive markets for the industry in the future
- The main competitive advantages of the industry
- The biggest transformation that the industry will undergo in the future.

Results

As mentioned in previous sections, to explore the future trajectories of the petrochemical industry, we examined historical trends, key events, strategic documents, comparative studies, and conducted in-

Table 1. **Experts demographic characteristics**

Category	Share (%)
Education Level of Experts (total 100%, including)	
Bachelor's Degree	11.8
Master's Degree	47
Doctoral Degree	41.2
Work Experience (total 100%, including)	
Less than 5 years	17.6
More than 5 and less than 10 years	26.6
More than 10 and less than 20 years	35.3
More than 20 years	20.5
Organizational Position (total 100%, including)	
Engineer	23.6
Middle Manager	32.3
Senior Manager	44.1

Source: author.

terviews with experts to identify a basket of the most critical factors influencing the future of this sector. Table 2 presents a list of 36 key factors affecting the future of the petrochemical industry.

After identifying the factors influencing the industry's future, we analyzed these factors using an importance-uncertainty matrix, distributed through a questionnaire among the identified experts. This matrix serves as a tool for classifying the factors identified in the previous stages. The dispersion of factors in this matrix reflects their status and position in scenario design and development, as the interpretation of each quadrant of the matrix shapes the structure and narrative of each scenario (Figure 4).

Table 3 and Figure 5 below show the dispersion of key factors and average expert opinions affecting the future of Iran's petrochemical industry, based on the results of the importance-uncertainty matrix.

Scenarios for Iran's Petrochemical Industry by 2030

In this section, to develop scenarios for Iran's petrochemical industry, the identified key factors are classified into categories of drivers based on expert opinions. The drivers that shape the scenarios are selected based on the highest level of importance and uncertainty for scenario development. Figure 6 below illustrates the constellation of key factors affecting the future of this sector.

It is crucial to acknowledge that the impact of each factor mentioned below can vary depending on the specific scenario being analyzed. Not all variables will have a uniformly positive or negative influence. For instance, while sanctions may impose challenges and restrictions on Iran, they can also lead to more strategic domestic investments and the expansion of ties with countries outside the sanctions regime, fostering a focus on internal capabilities and alternative partnerships.

As determined by the importance-uncertainty matrix and analysis of the research team, the set of factors encompassing Iran's foreign policy (extensive relations with the world, limited relations with the world) and government economic policies (intelligent policies, unstable policies) represent the most important and uncertain drivers shaping the scenarios for the petrochemical industry. At this stage, based on the matrix logic, the upper limits of two drivers are determined in two directions, toward improvement and deterioration of the current situation, and four scenarios are drawn from their interaction (Figure 7).

Next, we present the narratives of the four scenarios: Phoenix, Glimmer, Swamp, and Amphibian, based on the identified drivers (Figure 8). It is important to note that the scenario narratives are based on the status of the identified key factors constellation, and in each scenario, in addition to depicting the overall future picture, the occurrence of these factors is explained.

The Phoenix Scenario: A Bright Future for Iran's Petrochemical Industry

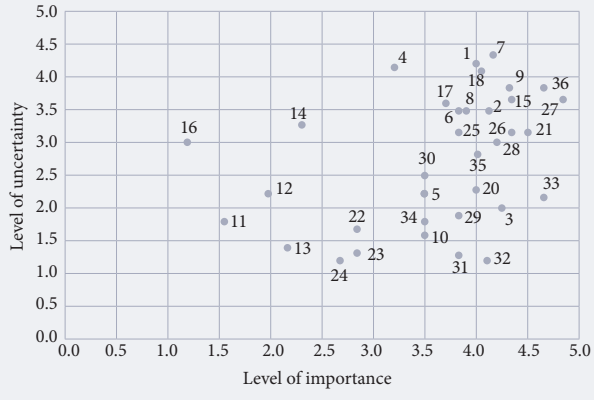
The Phoenix scenario depicts a future where improved foreign relations with other countries have opened

Figure 4. **Position of identified factors in Importance-Uncertainty Matrix**

High Uncertainty	Zone two **Surprise Potentials**	Zone one **Critical Uncertainties**
Low Uncertainty	Zone three **Context**	Zone four **Key Trends**
	Low Importance	High Importance

Source: author.

Figure 5. **Importance-Uncertainty Matrix of factors influencing Iran's Petrochemical Industry**



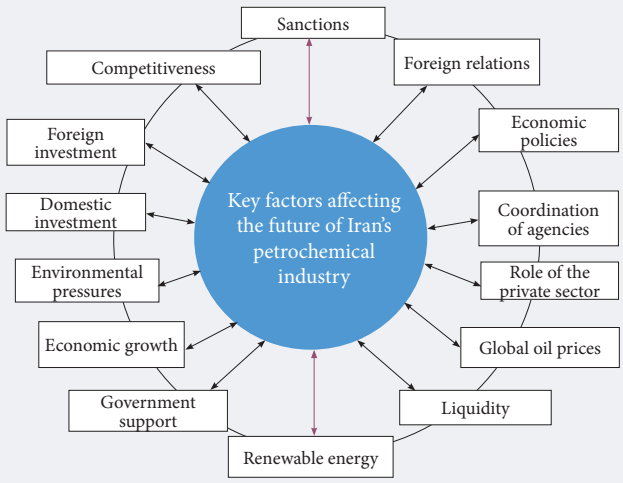
Note: Deciphering of Factor Numbers see in Table 2.
Source: author.

Table 2. **Prioritization of Factors Affecting Iran's Petrochemical Industry by Importance-Uncertainty**

Row	Key Factor	Degree of Importance	Degree of Uncertainty
1	Sanctions (banking, technology, etc.)	4.67	3.83
2	Technological advancements	4.11	3.50
3	Replacement of fossil fuels with renewable energy sources	3.50	2.22
4	Foreign relations with regional countries	3.20	4.17
5	Foreign relations with Russia and China	4.25	2.00
6	Foreign relations with European countries	3.83	3.50
7	Foreign relations with the United States	4.16	4.33
8	Domestic economic policies	3.98	4.00
9	Domestic laws and regulations	4.33	3.83
10	E-government	3.50	1.58
11	Incoherence and conflicts between domestic organizations and agencies	1.55	1.78
12	Limited involvement of the private sector in policymaking	1.96	2.23
13	Rentier factors (subsidized exchange rates, informal relationships, etc.)	2.15	1.40
14	COVID-19 and unforeseen events	2.30	3.30
15	International competitiveness	4.36	3.66
16	Global political and trade conflicts	1.20	3.00
17	Regional military conflicts	3.70	3.60
18	2021 presidential election	4.00	4.17
19	Exchange rate	4.05	4.11
20	Inflation rate	4.00	2.30
21	Global oil prices	3.89	3.50
22	Climate and environment	2.83	1.70
23	Global standards	2.83	1.30
24	Environmental pressures	2.67	1.20
25	Ability to export crude oil	3.83	3.17
26	Domestic investment	4.33	3.17
27	Foreign investment	4.83	3.67
28	Economic growth rate	4.21	3.00
29	Domestic infrastructure (roads, etc.)	3.83	1.90
30	Government support for the private sector	3.50	2.50
31	Skilled workforce	3.83	1.30
32	Companies' managerial capabilities	4.10	1.20
33	Companies' financing and liquidity	4.67	2.15
34	Indigenous technical know-how	3.50	1.78
35	Private sector claims on the government	4.00	2.83
36	Degree of government budget dependence on oil	4.50	3.17

Source: author.

Figure 6. **Constellation of Key Factors Affecting the Future of the Iranian Petrochemical Industry**



Source: author.

doors to enhanced economic ties. The government's adoption of intelligent economic policies has fostered a healthier and more competitive environment for players in the petrochemical industry. The short-term reduction of some financial sanctions, coupled with minimal fluctuations in others, has instilled optimism for improved economic indicators. These factors, combined with better relations between branches of government and the implementation of more informed laws and regulations that support industry participants, have created favorable conditions for increased domestic and foreign investment. In this scenario, chambers of commerce and economic associations play a more prominent role in decision-making. Government policies and strategies, informed by the collective wisdom and experience of the private sector, are geared toward strengthening national competitive advantages. However, improved relations with the West, while paving the way for faster economic growth, have also introduced new limitations and conditions imposed by international regulations. Compliance with global standards and environmen-

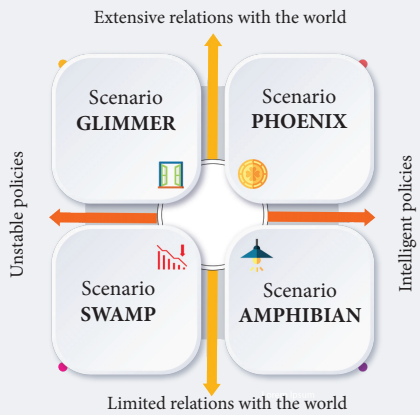
Figure 7. **Constellation of Key Factors Affecting the Future of the Iranian Petrochemical Industry**

Source: author.

tal pressures presents additional challenges. Additionally, the rise of renewable energies, a key global trend, poses a potential disruption, albeit not a significant one in the next decade. Companies that fail to monitor their environment and adapt to technological advancements risk being caught off guard. One of the significant opportunities in this scenario is the facilitation of large-scale oil sales. As the macro-trends suggest, the value of oil in the Phoenix scenario is no longer solely based on its direct sale, a strategy now employed by many energy source owners globally. The key here lies in the government's intelligent investment of the generated liquidity in infrastructure development and private-sector empowerment. Reduced demands from the private sector, coupled with improved financial resources and liquidity for oil, gas, and petrochemical contractors, has opened doors for wider investments in both upstream and downstream industries.

Companies have expanded their reach into larger regional and global markets by establishing bilateral and multilateral agreements with international counterparts. The diversification of their activity portfolios has mitigated the potential damage caused by reduced demand due to the adoption of renewable energies. Industry pioneers in research and development have also made significant contributions to global innovation. Improved government

Figure 8. **Scenarios for Iran's Petrochemical Industry by 2030**



Source: author.

structure has led to a more efficient supply chain in downstream industries, satisfying industry players by providing timely, adequate, and cost-effective raw materials, thus facilitating value creation. The establishment of stability and predictability in economic indicators has not only increased the attractiveness of the petrochemical industry but has also intensified competition. Enhanced relations with regional and global players have opened new markets for industry participants, creating opportunities for novel services and products. This has spurred the emergence of new knowledge-based companies and the development of established ones. The rising demand for energy in South and East Asia, coupled with the Middle East's energy needs and Iran's oil and gas export potential, presents a golden opportunity for regional and global development. By investing in and collaborating with international companies, domestic firms have rapidly increased their LNG and CNG exports, leveraging their geopolitical advantages to secure their position in this sector. The increasing global integration and development of advanced platforms require agility and adaptability from consulting and contracting companies in the oil, gas, and petrochemical industries. Companies that can quickly adapt to new standards and regulations will have a significant advantage on this evolving market. Overall, the Phoenix scenario paints a promising picture for the future of Iran's petrochemical industry, but success will hinge upon careful planning, strategic decision-making, and continuous adaptation to a changing global landscape.

The Glimmer Scenario: A Glimpse of Opportunity Amid Missed Chances

The Glimmer scenario portrays a future where improved foreign relations have compelled the world to ease sanctions. However, due to a lack of coherence and intelligence in domestic economic policies, a favorable environment for the growth of domestic economic actors has not materialized. International companies in the oil, gas, and petrochemical sectors show interest in investment and participation in contracting and consulting projects. However, the lack of coordination, conflict management, and a coherent policy among governing institutions leads to a situation where the benefits from relaxed sanctions disproportionately favor rent-seekers and intermediaries, with minimal value creation. In this scenario, the focus shifts toward purchasing existing technologies and equipment to keep the petrochemical industry operational, rather than acquiring and transferring essential technologies. The lifting of sanctions facilitates the sale of raw materials, but due to liquidity constraints and accumulated challenges, industry leaders prioritize this strategy to address financial issues and increase sales volume and liquidity. This short-term approach is further reinforced by the high turnover of managers. The global shift toward renew-

Table 3. **List of Key Factors Affecting the Future of the Iranian Petrochemical Industry and Their Positioning in the Four Quadrants of the Importance-Uncertainty Matrix**

Key Factors	Zone	References
1. Sanctions (banking, technology, etc.) ⬆	One	Shafiei Nataghi et al., 2023; Hoshdar, 2017; Bonyani, 2018; Bollino, 2019; Kaveh, 2021; Ziyae, 2020; Experts Panel
2. Technological advancements ⬆ & ⬇	One	Allahy, Shavalpour, 2019; Ghaithan et al., 2021; Min et al., 2019; Doulabi, 2022; Ziyae, 2020; Mottaghi, 2019
3. Replacement of fossil fuels with renewable energy sources ⬇	Four	Hwangbo et al., 2022; Heo et al., 2024; Shokouhi, 2024; Fartash, Ghorbani, 2023; Mottaghi, 2019
4. Foreign relations with regional countries ⬆	One	Bonyani, 2018; Bollino, 2019; Mottaghi, 2019; Experts Panel
5. Foreign relations with Russia and China ⬆	Four	Bonyani, 2018; Bollino, 2019; Mottaghi, 2019; Experts Panel
6. Foreign relations with European countries ⬆	One	Bonyani, 2018; Bollino, 2019; Mottaghi, 2019; Experts Panel
7. Foreign relations with the United States ⬆	One	Hoshdar, 2017; Bonyani, 2018; Bollino, 2019; Ziyae, 2020; Mottaghi, 2019; Experts Panel
8. Domestic economic policies ⬇	One	Farashah et al., 2021; Zarei, 2020; Mamarzadeh et al., 2020; Mottaghi, 2019
9. Domestic laws and regulations ⬇	One	Mirjalili, 2023; Mottaghi, 2019; Experts Panel
10. E-government ⬇	Four	Shafiei Nataghi et al., 2023; Experts Panel
11. Incoherence and conflicts between domestic organizations and agencies	Three	Fayez et al., 2021; Hoshdar, 2017; Experts Panel
12. Limited involvement of the private sector in policymaking ⬇	Three	Fayez et al., 2021; Shafiei Nataghi et al., 2023
13. Rentier factors (subsidized exchange rates, informal relationships, etc.) ⬇	Three	Shafiei Nataghi et al., 2023; Ziyae, 2020; Experts Panel
14. COVID-19 and unforeseen events ⬆	Two	Malik et al., 2020; Experts Panel
15. International competitiveness⬆	One	Bonyani, 2018; Bollino, 2019; Experts Panel
16. Global political and trade conflicts ⬆	Two	Shafiei Nataghi et al., 2023; Bollino, 2019
17. Regional military conflicts ⬇	One	Sun, 2023
18. 2023 presidential election ⬇	One	Experts Panel
19. Exchange rate ⬇	One	Mamarzadeh et al., 2020; Zarei, 2020; Ziyae, 2020; Mottaghi, 2019
20. Inflation rate ⬇	Four	Zarei, 2020; Mamarzadeh et al., 2020; Mottaghi, 2019
21. Global oil prices ⬆	One	Mamarzadeh et al., 2020; Shokouhi, 2024; Ghandi, 2017; Bollino, 2019; Ziyae, 2020; Mottaghi, 2019
22. Climate and environment ⬆	Four	Hwangbo et al., 2022; Heo et al., 2024; Mottaghi, 2019
23. Global standards ⬆	Four	Hwangbo et al., 2022; Heo et al., 2024; Shokouhi, 2024
24. Environmental pressures ⬆	Four	Wu et al., 2023; Hwangbo et al., 2022; Heo et al., 2024; Mottaghi, 2019
25. Ability to export crude oil ⬆ & ⬇	One	Nejati, Bahmani, 2020; Bollino, 2019; Mottaghi, 2019; Experts Panel
26. Domestic investment ⬇	One	Sternberg, Lubart, 1991; Sazvar, Sepehri, 2020; Shokouhi, 2024; Ziyae, 2020; Mottaghi, 2019
27. Foreign investment ⬆	One	Sternberg, Lubart, 1991; Sazvar, Sepehri, 2020; Nejati, Bahmani, 2020; Shokouhi, 2024; Ghandi, 2017; Mottaghi, 2019
28. Economic growth rate ⬇	One	Blomstrom et al., 2000; Anwar, Nguyen, 2010; Mottaghi, 2019
29. Domestic infrastructure (roads, etc.) ⬇	Four	Blomstrom et al., 2000; Anwar, Nguyen, 2010
30. Government support for the private sector ⬇	One	Fayez et al., 2021; Experts Panel
31. Skilled workforce ⬇	Four	Allahy, Shavalpour, 2019; Ghaithan et al., 2021; Min et al., 2019; Doulabi, 2022; Hoshdar, 2017; Bonyani, 2018
32. Companies' managerial capabilities ⬇	Four	Shafiei Nataghi et al., 2023; Hoshdar, 2017; Bonyani, 2018; Doulabi, 2022; Ziyae, 2020; Experts Panel
33. Companies' financing and liquidity ⬇	Four	Shafiei Nataghi et al., 2023; Shokouhi, 2024; Bonyani, 2018; Mottaghi, 2019; Experts Panel
34. Indigenous technical know-how ⬇	Four	Allahy, Shavalpour, 2019; Min et al., 2019; Bonyani, 2018; Doulabi, 2022
35. Private sector claims on the government ⬇	One	Farashah et al., 2021; Shafiei Nataghi et al., 2023
36. Degree of government budget dependence on oil ⬇	One	Farashah et al., 2021; Experts Panel

External factors: ⬆ Internal factors: ⬇

Source: author..

able energy presents an investment opportunity that is missed due to the absence of long-term policies and strategies. Iran not only fails to become a player in this sector, but also gradually loses its competitive edge derived from its oil and gas resources.

The lack of intelligent support for domestic companies, coupled with the entry of multinational and international firms, threatens the survival of many Iranian contracting and consulting companies. The burden of global regulations, environmental pressures, and the absence of government support significantly disadvantage domestic companies in a more competitive landscape. The presence of international companies, further bolstered by a lack of government support, creates an uneven playing field for Iranian engineering and contracting firms. The relatively cheaper Iranian workforce initially attracts international companies to projects. However, Iranian companies are gradually outcompeted due to technological deficiencies, outdated systems, and financial limitations, ultimately becoming mere shells of their former selves. To ensure their survival and growth on future markets, Iranian engineering and contracting companies should act swiftly upon recognizing the signs of this scenario. Forming memorandums and cooperation agreements with multinational and international companies can establish them as business partners, ensuring their place on future markets. Despite a less than ideal national business environment, improved political relations with regional countries offer opportunities to penetrate lucrative regional markets. Engineering and contracting companies in the petrochemical industry should prioritize actions such as establishing regional offices, monitoring tenders, forming cooperation agreements, attending exhibitions, and developing business relationships. Improved relations also present a golden opportunity for technology transfer and localization. Engineering and consulting companies that have already identified technological challenges and needs can quickly enter the market and generate sustainable income by providing solutions. The accumulated needs and infrastructure wear and tear within the industry will create a short-term demand for equipment, technical knowledge, and other resources. Companies that have already established relationships with suppliers will be well-positioned to capitalize on this demand and achieve high profit margins. The Glimmer scenario presents a future with mixed prospects. While improved foreign relations offer opportunities, the lack of a robust domestic economic policy could hinder long-term growth for Iran's petrochemical industry. Taking advantage of the opportunities requires proactive measures by industry players, particularly in terms of technology transfer and strategic partnerships.

The Swamp Scenario: Stagnation and Decline in a Tense Global Landscape

The Swamp scenario depicts a future characterized by peak tensions in foreign relations, particularly with the United States and European countries. This climate, coupled with a lack of coherence, tact, and intelligence in domestic economic policies, has led to widespread bankruptcies and a decline in petrochemical industry players. The accumulation of years of challenges, compounded by limited global interactions, has not only stifled growth and development but also endangered infrastructure and the survival of some supply chain actors. Weak private sector participation in policy, strategy, and regulatory development, along with discord between executive, legislative, and judicial branches, has severely impacted ease-of-doing-business indicators, causing a sharp decline. The adoption of burdensome new laws, unreasonable government expectations regarding private sector taxation, and restrictive and interventionist views toward industry players have created significant barriers for new entrants and discouraged existing companies from remaining operational. The decrease in oil export volumes and difficulties in global financial transactions have led to a drastic decline in government funding, particularly for construction projects. Additionally, the diminished ability of the private sector to engage in economic activities has further weakened tax revenue potential. Economic volatility has fueled currency depreciation and inflation, which might initially incentivize exports. However, this advantage is negated by global pressures and limitations on financial exchanges. In this scenario, contracting and consulting companies heavily reliant on government contracts face significant liquidity challenges due to mounting unpaid claims. The government, facing funding constraints, has reduced construction and development projects. The limited remaining projects, coupled with a shrinking market, have intensified unhealthy competition among engineering and contracting companies in the petrochemical industry.

A vicious cycle emerges - reduced construction projects lead to unhealthy competition, which in turn increases demands from companies. This, coupled with limited liquidity, drives many companies to bankruptcy and exiting the market. The financial and technological decline of these companies erodes their competitive advantages, effectively shutting them out of not only global markets but also regional competition. While petrochemical companies possess some awareness of major industry trends and transformative events, their inability to invest in research and development forces them to either exit the industry entirely or shift focus toward other markets and industries for survival. As the domestic market con-

tracts and domestic companies lose liquidity and competitiveness, skilled personnel are drawn to regional and global firms. This exodus, over time, will erode the human capital advantage of Iran's petrochemical engineering and contracting sector. The Swamp scenario paints a bleak picture for Iran's petrochemical industry. A combination of strained foreign relations, incoherent domestic policies, and a declining business environment creates a stagnant and declining landscape. The industry's future hinges upon resolving these issues and fostering a more conducive environment for growth and innovation.

The Amphibian Scenario: Limited Progress in a Constrained Environment

The Amphibian scenario portrays a future where domestically implemented smart economic policies have eased the operating environment for economic actors. However, escalating tensions and restricted relations with European and American countries create significant hurdles in attracting investors, transferring technology, and facilitating financial transactions. While the government has adopted laws and regulations formulated with the private sector's input, creating platforms for domestic economic activity, limitations in interactions with developed countries dampen investments and development initiatives. The lack of robust competition at the national level has shrunk the market for engineering and contracting companies in the petrochemical industry. This has fostered unhealthy competition, reduced liquidity, and inflated demands, ultimately eroding their competitiveness on the global stage. The contracting market has diminished the financial strength of engineering and contracting companies, hindering their ability to attract and retain skilled personnel. This exodus of human capital, the industry's most vital competitive advantage, further weakens these companies. As this process continues, domestic companies not only lose their edge but also lack the capacity to undertake domestic projects. In a vicious cycle, this situation leads to the deterioration and eventual obsolescence of equipment and infrastructure.

The insular nature of activities within the rapidly evolving global petrochemical industry has not only squandered opportunities for investments in renewable energy and transformative technologies but has also gradually exhausted and challenged the industry's supply chain. The vast regional market, upon which Iranian engineering and contracting companies could have capitalized, has gradually slipped away, leaving them without a strong regional position. While the government has attempted to establish market order and stability through well-crafted economic policies, global trends and developments like declining oil and gas demand, coupled with sanctions-induced restrictions, have minimized revenue streams from oil and gas sales. This downward trend is likely to continue due to the increasing adoption of renewable energies and the emergence of new technologies. The limitations on technology exchanges, reduced research and development capacity, along with the wear and tear of assets, equipment, and infrastructure within the petrochemical industry's supply chain, will ultimately slow down or even halt the engine of growth in other industries. The Amphibian Scenario presents a future of stagnation for Iran's petrochemical industry. While domestic policies show signs of improvement, the industry remains constrained by its inability to fully engage with the international community. This isolation hinders access to critical resources, technologies, and markets, ultimately limiting the industry's potential for growth and innovation.

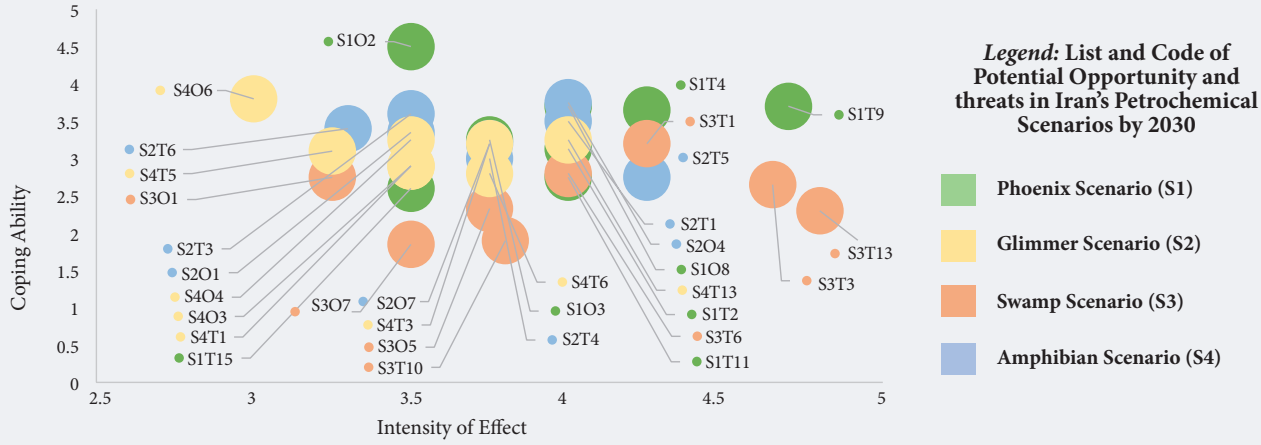
Simulating the Futures of Iranian Petrochemical Players up to 2030

To gain insights into the future of Iran's petrochemical industry, a panel discussion was held with 11 industry experts (e.g., chemical engineers, economists). The discussion focused on analyzing key challenges, opportunities, and advantages facing engineering and contracting companies. The four developed scenarios were presented to facilitate a deeper understanding of potential futures and enable decision-makers and industry players to develop informed strategies and operational plans. The first section of the panel simulated and visualized the futures depicted in the four scenarios: Phoenix, Glimmer, Swamp, and Amphibian. This exercise helped identify crucial challenges, threats, and opportunities. Subsequently, in the second section, experts evaluated these opportunities and threats based on their intensity of effect and coping ability. The findings of the panel discussion are summarized in the figure 9 below, which represents the average evaluations of the expert panelists.

Conclusion

Iran's petrochemical industry, fueled by its vast oil and gas reserves and a focus on high value-added products, plays a pivotal role in the nation's economic landscape. However, a complex and dynamic global environment presents significant challenges to strategic decision-making. This research addresses this challenge by employing scenario planning, a robust methodology for mapping out potential futures of the industry. By providing a long-term perspective, scenario planning empowers managers and decision-makers to navigate this uncertain landscape. The research findings reveal that the interplay between international political relations and domestic economic

Figure 9. **Map of Key Opportunities and Threats in 4 Scenarios for the Iranian Petrochemical Industry by 2030**



Threats and Challenges (T)

1 - Exodus of Skilled Personnel; 2 - Unhealthy Competitive Landscape; 3 - Liquidity and Financing Constraints; 4 - Dominance of International Companies; 5 - Small Size of Domestic Companies; 6 - Macroeconomic Conditions; 7 - Tax and Insurance Issues; 8 - COVID-19 and Unforeseen Events; 9 - Global Competition; 10 - Low Private Sector Participation in Policymaking; 11 - Environmental Pressures; 12 - Project Delays; 13 - Financial and Technology Sanctions; 14 - Contractual Terms; 15 - Renewable Energy Substitution

Opportunities and Advantages (O)

1 - Intelligent Empowerment; 2 - Access to Skilled Personnel; 3 - Collaboration with International Companies; 4 - Regional Comparative Advantage; 5 - Upgrading Product Portfolio; 6 - Economic Diplomacy; 7 - Smart Research and Development; 8 - Creating New Markets

Source: author.

policies acts as a critical driver shaping the future trajectory of Iran's petrochemical industry. Building upon this understanding, the research constructs four distinct scenarios: Phoenix (potential resurgence), Glimmer (moderate growth), Swamp (stagnation), and Amphibian (struggle for survival). These scenarios provide a comprehensive spectrum of possibilities for the industry's future. Furthermore, the research goes beyond simply outlining these scenarios. It establishes a practical framework to track the likelihood of each scenario unfolding. This framework functions as a dynamic tool, continuously monitoring the status of key indicators across different timeframes. This allows stakeholders to proactively adapt their strategies based on the evolving landscape.

The research's innovation lies in its application of scenario simulation. This technique facilitated the identification of forthcoming opportunities and threats, thus enriching the scenarios and providing a practical roadmap for industry strategy development (Table 4).

The analysis yielded a comprehensive picture, identifying 15 potential threats and eight opportunities mapped according to their impact intensity and the industry's ability to address them. By gaining a clear

Table 4. **Roadmap for the Occurrence of Scenarios in the Iranian Petrochemical Industry by 2030**

Parameters	Scenarios			
	I	II	III	IV
International competitiveness				
Government support				
Renewable energy				
Economic growth				
Foreign investment				
Domestic investment				
Ability to export crude oil				
Environmental pressures				
Companies' financing and liquidity				
Role of the private sector				
Coordination between government agencies				
Economic policies				
Foreign relations				
Sanctions				

Scenarios: I – Phoenix; II – Glimmer; III – Swamp; IV – Amphibian.

Color Coding: Very Favorable to Favorable ( ), Neutral ( ), Very Unfavorable to Unfavorable ( )

Source: author.

understanding of these factors, industry stakeholders are empowered to efficiently allocate resources, leverage existing capabilities, and capitalize on existing advantages. Success in this dynamic global industry hinges upon the ability to decipher emerging trends through proactive environmental monitoring and scanning. Furthermore, industry players can transform from passive observers to key drivers of change by strategically investing in various supply chain technologies. By maintaining a vigilant watch on the evolving environment and recognizing the early signs of each scenario's emergence, industry actors can anticipate future developments and actively pursue their interests on the global stage.

References

Allahy S., Shavalpour S. (2019) Economic geography and the importance of local knowledge networks in industrial clusters: A case study of the Khuzestan oil, gas, and petrochemical cluster. *Rahyaft,* 29(4), 83–99. https://doi.org/10.22034/rahyaft.2020.13800

Anwar S., Nguyen L.P. (2010) Absorptive capacity, foreign direct investment linked spillovers and economic growth in Vietnam. *Asian Business Management,* 9(4), 553–570. https://doi.org/10.1057/abm.2010.28

Blomstrom M., Zejan M., Kokko A. (2000) *Foreign Direct Investment: Firm and Host Country Strategies*, London: Macmillan Press.

Bollino C.A., Efird B., Hasanov F., Hatipoglu E. (2019) Iran Sanctions: Implications for the Oil Market. *Heliyon,* 9(2), e13793. https://doi.org/10.1016/j.heliyon.2023.e13793

Bonyani A., Alimohammadlou M. (2018) Identifying and prioritizing foreign companies interested in participating in post-sanctions Iranian energy sector. *Energy Strategy Reviews,* 21, 180–190. https://doi.org/10.1016/j.esr.2018.05.008

Brem A., Utikal V. (2019) How to manage creativity time? Results from a social psychological time model lab experiment on individual creative and routine performance. *Creativity and Innovation Management,* 28(3), 291–305. https://doi.org/10.1111/caim.12309

Doulabi H., Khamseh A., Torabi T. (2022) Evaluation of Key Factors Influencing Technological Innovation Management in the Petrochemical Industry with a Focus on Chemical Companies. *Petroleum Business Review*, 6(3), 1–16.

Farashah V.H., Sazvar Z., Hosseini S.H. (2021) A dynamic model to formulate effective capacity expansion policies in Iranian petrochemical industry to complete the value chain. *Energy Policy,* 148, 111992. https://doi.org/10.1016/j.enpol.2020.111992

Fartash K., Ghorbani A. (2023) Under domination of oil and gas: Future scenarios of renewable energy development in Iran. *Foresight,* 25(3), 367–383. https://doi.org/10.1108/FS-08-2021-0157 https://www.emerald.com/insight/content/doi/10.1108/FS-08-2021-0157/full/html

Fayez S., Faqih A.H., Sayadshirkesh S. (2021) Revising and fitting the public-private partnership model in Iran's downstream oil industries. *Iranian Journal of Management Sciences,* 16(62), 1–27.

Ghaithan A., Khan M., Mohammed A., Hadidi L. (2021) Impact of industry 4.0 and lean manufacturing on the sustainability performance of plastic and petrochemical organizations in Saudi Arabia. *Sustainability,* 13(20), 11252. https://doi.org/10.3390/su132011252

Ghandi A., Lawell C.-Y. C. L. (2017) On the rate of return and risk factors to international oil companies in Iran's buy-back service contracts. *Energy Policy,* 103, 16–29. https://doi.org/10.1016/j.enpol.2005.08.011

Goldsby T.J., Zinn W. (2016) Technology innovation and new business models: Can logistics and supply chain research accelerate the evolution? *Journal of Business Logistics,* 37(2), 80–81. https://doi.org/10.1111/jbl.12130

Golshen M.H., Mazinni A.H., Najarzadeh R. (2022) The impact of exchange rate shocks on the performance of energy companies in the Tehran Stock Exchange: A case study of petrochemical and oil product distribution industries. *Strategic Budget and Financial Research,* 3(1), 11–43.

Guivarch C., Lempert R., Trutnevyte E. (2017) Scenario techniques for energy and environmental research: An overview of recent developments to broaden the capacity to deal with complexity and uncertainty. *Environmental Modelling and Software,* 97, 201–210. https://doi.org/10.1016/j.envsoft.2017.07.017

Harrell M.C., Bradley M.A. (2009) *Semi-structured interview protocol (SSIP),* Santa-Monica, CA: RAND Corporation.

Heo S., Byun J., Ifaei P., Ko J., Ha B., Hwangbo S., Yoo C. (2024) Towards mega-scale decarbonized industrial park (Mega-DIP): Generative AI-driven techno-economic and environmental assessment of renewable and sustainable energy utilization in petrochemical industry. *Renewable and Sustainable Energy Reviews,* 189, 113933. https://doi.org/10.1016/j.rser.2023.113933

Hoshdar F., Ghazinoory S., Arasti, M., Fassihi, S. F. (2017). Technology planning system for the Iranian petroleum industry: Lessons learned from sanctions. *Technological Forecasting and Social Change*, 122(C), 170–178. https://doi.org/10.1016/j.resourpol.2022.102625

Hwangbo S., Heo S., Yoo C. (2022) Development of deterministic-stochastic model to integrate variable renewable energy-driven electricity and large-scale utility networks: Towards decarbonization petrochemical industry. *Energy,* 238, 122006. https://doi.org/10.1016/j.energy.2021.122006

Khosala K., Kotzur L., Röben F.T., Stenzel P., Blum L., Robinius M., Stolten D. (2021) Hybrid hydrogen home storage for decentralized energy autonomy. *International Journal of Hydrogen Energy,* 46(42), 21748–21763. https://doi.org/10.17632/zhwkrc6k93.1

Kieser A., Nicolai A., Seidl D. (2015) The practical relevance of management research: turning the debate on relevance into a rigorous scientific research program. *Academy of Management Annals,* 9(1), 143–233. https://doi.org/10.1080/19416520.2015.1011853

Lee S.M., Tae K.S., Choi D. (2012) Green supply chain management and organizational performance. *Industrial Management & Data Systems,* 112(8), 1148–1180. http://doi.org/10.1108/02635571211264609

Malik D., Manchanda P., Simons T.J., Wallach J. (2021) *The impact of COVID-19 on the Global Petrochemical Industry*, Chicago, IL: McKinsey & Company.

Mamarzadeh A., Ansari Nasab M., Rahimi Sh. (2020) The interaction between global crude oil market dynamics and the Iranian petrochemical stock index (with an emphasis on oil sanctions). *Journal of Economic Strategy,* 9(32), 105–134.

Matsumoto K.I., Voudouris V. (2015). Potential Impact of Unconventional Oil Resources on Major Oil-Producing Countries: Scenario Analysis with the ACEGES Model. *Natural Resources Research,* 24(1), 107–119. https://doi.org/10.1007/s11053-014-9246-8

Min Q., Lu Y., Liu Z., Su C., Wang B. (2019) Machine learning based digital twin framework for production optimization in petrochemical industry. *International Journal of Information Management,* 49, 502–519. https://doi.org/10.1016/j.ijinfomgt.2019.05.020

Mirjalili F. (2023) Evaluation of the Effects of Laws and Regulations on the Balanced and Sustainable Development of the Petrochemical Industry Value Chain. *Monthly Expert Reports of the Research Center of the Islamic Consultative Assembly*, 31(6), 19257.

Mottaghi M. (2019) Futures of Iran's Oil and Gas: Scenarios by 2035. *Petroleum Business Review,* 3(4), 63–86. https://doi.org/10.22050/pbr.2019.119195

Murayama K., Nirei M., Shimizu H. (2015) Management of science, serendipity, and research performance: Evidence from a survey of scientists in Japan and the US. *Research Policy,* 44(4), 862–873. https://doi.org/10.1016/j.respol.2015.01.018

Nagy D., Schuessler J., Dubinsky A. (2016) Defining and identifying disruptive innovations. *Industrial Marketing Management,* 57, 119–126. https://doi.org/10.1016/j.indmarman.2015.11.017

Nejati M., Bahmani M. (2020) The economic impacts of foreign direct investment in oil and gas sector: A CGE analysis for Iranian economy. *Energy Strategy Reviews,* 32, 100579. https://doi.org/10.1016/j.esr.2020.100579

Paltsev S. (2014) Scenarios for Russia's natural gas exports to 2050. *Energy Economics,* 42, 262–270. https://doi.org/10.1016/j.eneco.2014.01.005

Parajuli R., Ntoka C., Charisoulis G., Tulucan T., Sperling K. (2015) Beyond oil and gas: Possible future scenarios for the electricity sector in Saudi Arabia. *International Journal of Sustainable Energy*, 34(2), 71–92. https://doi.org/10.1080/14786451.2013.821991

Porter M.E. (1979) How Competitive Forces Shape Strategy. *Harvard Business Review*, March issue. https://hbr.org/1979/03/how-competitive-forces-shape-strategy

Rao P. (2002) Greening the supply chain: A new initiative in South East Asia. *International Journal of Operations & Production Management*, 22(6), 632–655. https://doi.org/10.1108/01443570210427668

Renwick D.W.S., Breslin D., Price I. (2019) Nurturing novelty: Toulmin's greenhouse, journal rankings and knowledge evolution. *European Management Review,* 16(1), 167–178. https://doi.org/10.1111/emre.12334

Richter N., Jackson P., Schildhauer T. (2018) Outsourcing creativity: An abductive study of open innovation using corporate accelerators. *Creativity and Innovation Management,* 27(1), 69–78. http://dx.doi.org/10.1111/caim.12252

Rubio A., Agila W., González L., Ramirez M., Pineda H. (2023) *A Critical Analysis of the Impact of the Pandemic on Sustainable Energy Scenarios*. Paper presented at the 11th International Conference on Smart Grid (icSmartGrid), Paris, France. https://doi.org/10.1109/icSmartGrid58556.2023.10171066

Saberi A., Sharif R., Ramazani I. (2023) *Strategic Issues in the Energy Sector in the Seventh Development Plan: Renewable Energy Development,* Tehran: Research Center of the Iranian Parliament.

Sarin S., Haon C., Belkhouja M. (2018) A twenty-year citation analysis of the knowledge outflow and inflow patterns from the journal of product innovation management. *Journal of Product Innovation Management,* 35(6), 854–863. https://doi.org/10.1111/jpim.12469

Sazvar Z., Sepehri M. (2020) An integrated replenishment-recruitment policy in a sustainable retailing system for deteriorating products. *Socio-Economic Planning Sciences,* 69, 100686. https://doi.org/10.1016/j.seps.2019.02.001

Scearce D., Fulton K. (2004) *What if?: The art of scenario thinking for nonprofits,* Emeryville, CA: Global Business Network.

Shafiei Nataghi M.M., Rashidi M.A., Tohady M. (2023) Designing a structural interpretive model for identifying and categorizing strategic financial risks in the petrochemical industry of the Islamic Republic of Iran. *Journal of Asset and Financial Management,* 11(1), 29–52. https://doi.org/10.22108/amf.2023.135670.1765

Shokouhi M.R., Khademvatani A., Beiky F. (2024) Analyzing economic and financial risk factors affecting profitability of oil refinery investment projects: A case study from an Iranian Oil Refinery. *Energy Strategy Reviews*, 52, 101348. https://doi.org/10.1016/j.esr.2024.101348

Sternberg R.J., Lubart T.I. (1991) An Investment Theory of Creativity and its Development. *Human Development*, 34, 1–31. https://doi.org/10.1159/ 000277029

Sun Y. (2023) The Effect of War Risks on the Petroleum and Petrochemical and Renewable Energy Industries: Evidence from Chinese Stock Market. *Highlights in Business, Economics and Management*, 5, 279–287. http://dx.doi.org/10.54097/hbem.v5i.5092

Van de Ven A.H. (2017) The innovation journey: you can't control it, but you can learn to maneuver it. *Innovation,* 19(1), 39–42. https://doi.org/10.1080/14479338.2016.1256780

Walsh J., Winsor B. (2019) Socio-cultural barriers to developing a regional entrepreneurial ecosystem. *Journal of Enterprising Communities: People and Places in the Global Economy,* 13(3), 263–282. https://doi.org/10.1108/JEC-11-2018-0088

Wu M., Dong Y., Liu Z. (2023) Research on the Impact of Environmental Regulation on the Financial Performance of Petrochemical Enterprises. *SHS Web of Conferences,* 170, 03024. https://doi.org/10.1051/shsconf/202317003024

Zarei S. (2020) Analyzing the Asymmetric Effects of Inflation and Exchange Rate Misalignments on Petrochemical Stock Index: The Case of Iran. *International Journal of Economics, Management and Accounting*, 28(2), 457–482. https://doi.org/10.31436/ijema.v28i2.788

Zhu Q., Sarkis J., Geng Y. (2005) Green supply chain management in China: Pressures, practices and performance. *International Journal of Operations & Production Management,* 25(5), 449–468. https://doi.org/10.1108/01443570510593148

Ziyae B., Jusoh R., Madadian H. (2020) Innovative scenario planning of petrochemical enterprises in the Iranian community. *Journal of Enterprising Communities*, 14(3), 465–480. https://doi.org/10.1108/JEC-04-2020-0054

Integrating Reverse Cycle Strategy in Circular Business Model Innovation: A Case Study

Ahmad Fatih Fudhla

Doctoral Student*, Assistant Professor, ahmadfatihfudhla@gmail.com

Department of Industrial Engineering, Universitas Maarif Hasyim Latif, Raya Ngelom str. 30, Taman, Sidoarjo, East Java, Indonesia, 61257

Budisantoso Wirjodirdjo

Doctor of Engineering, Professor*, budisantoso.wirjodirdjo@gmail.com

Moses Laksono Singgih

Doctor of Philosophy, Professor*, moseslsinggih@ie.its.ac.id

*Department of Industrial and Systems Engineering, Institut Teknologi Sepuluh Nopember, Kampus ITS Keputih, Sukolilo, Surabaya, East Java, Indonesia, 60111

Abstract

This study integrates the Reverse Cycle Strategy (RCS) framework within circular business model innovation, focusing on sugarcane agribusiness as part of an innovative foresight study. Employing a qualitative method, the research utilizes the Business Model Canvas (BMC) to visually articulate and analyze business operations, interactions, and the impact of the RCS's ten principles (10R). These principles aim to facilitate a transition from linear to circular business practices, encompassing R0 – Refuse, R1 – Rethink, R2 – Reduce, R3 – Reuse, R4 – Repair, R5 – Refurbish, R6 – Remanufacture, R7 – Repurpose, R8 – Recycle, and R9 – Recover. The findings reveal that incorporating the full spectrum of the RCS enhances the business models' circularity and significantly influences sustainability outcomes. Unlike previous studies focusing on one to three RCS principles, this research demonstrates that a holistic approach can lead to more substantial environmental and operational improvements. This study offers a robust model for practitioners implementing sustainable business practices under the auspices of the circular economy paradigm.

Keywords: business model innovation; reverse cycle strategy; business model canvas; sugarcane agribusiness; circular economy

Citation: Fudhla A.F., Wirjodirdjo B., Singgih M.L. (2024) Integrating Reverse Cycle Strategy in Circular Business Model Innovation: A Case Study. *Foresight and STI Governance*, 18(3), pp. 69–88. DOI: 10.17323/2500-2597.2024.3.69.88

Introduction

In an era of pursuing sustainability and environmental responsibility, business model innovation has emerged as a critical enabler in driving the transformation toward a circular economy (Brenner, Drdla, 2023). The Circular Economy addresses environmental and social concerns by moving away from unsustainable linear economics, focusing on restorative systems, and reducing resource inputs, waste, and emissions (Morseletto, 2023). This shift is crucial given the challenges of global population growth and consumption patterns (Lauten-Weiss, Ramesohl, 2021). Transitioning requires managing changes in technology, resources, costs, and strategies under sustainability indicators, which support the adoption of circular economy principles and holistically pave the way for companies to transition to more sustainable practices (Garza-Reyes et al., 2019). An alternative circular innovation business model framework is provided through this research.

The Circular Economy Framework aims for a closed-loop system, minimizing waste and pollution while maintaining the usefulness of products and regenerating natural systems (Ellen Macarthur Foundation, 2012). The shift toward a circular economic paradigm prompts changes and refinements of strategies. Circular business model innovation is based on changes in opportunities, regulatory encouragement, and shifts in circular strategy (Brenner, Drdla, 2023; Donner, de Vries, 2021; Pollard et al., 2021). The circular strategy has been widely developed by following the Reverse Cycle Strategy (RCS), which consists of ten principles: Refuse, Rethink, Reduce, Reuse, Repair, Refurbish, Remanufacture, Repurpose, Recycle, and Recover (Pegorin et al., 2024), and applied them as a primary driver in innovating the circular business model (Bressanelli et al., 2022; Costanza, 2023; Goyal et al., 2018; Kuzma, Sehnem, 2023; Saleh, Ost, 2023; Valencia et al., 2023; Villalba-Eguiluz et al., 2023).

However, all previous research shows that business model innovation tends to focus only on one or at most three principles (Rethink, Reuse, Recycle), leading to possibly incomplete sustainability outcomes. This results in imperfections in achieving overall sustainability and leaves potential that has not been fully utilized. Therefore, this study integrates the overall RCS as a circular strategy framework. This study offers a more holistic and integrated approach. Integrating ten aspects of circular strategy in the reverse cycle strategy is expected to drive business model innovation toward more circularity and sustainability. It expands the number of principles and increases their interconnectedness and mutual influence. Each principle does not function in isolation but contributes to a synergistic system in which the output of one principle can be an input to another.

With abundant renewable natural resources like plants and animals, agribusiness presents a prime opportunity to foster a circular business model (Nasution et al., 2020). Its reliance upon sustainable raw materials and involvement in regenerative natural systems make it conducive to circular economy principles (Klein et al., 2022). Practices such as recycling organic waste into fertilizers and repurposing agricultural residues for other industries exemplify this potential. Thus, exploring agribusiness through circular business innovation is vital for industry sustainability and global environmental goals.

As the largest agricultural commodity in the world, sugarcane agribusiness is gaining attention as a sector ripe for circular economy initiatives. Its production yields significant by-products, including leaves, tips, pulp, and molasses, which, if managed effectively, can align with Circular Economy objectives (Costa et al., 2014). Adopting circular practices in sugarcane farming involves closing nutrient loops, reducing reliance on external inputs like chemical fertilisers, and minimizing the environmental impact of agricultural waste disposal (Amini et al., 2022). Through innovative business models, sugarcane agribusiness has the potential to lead to more sustainable practices and expedite the shift toward a circular economy.

This study can significantly contribute to developing thinking and practices to achieve more holistic sustainability in a circular business model. This study also contributes significantly to the academic discourse on circular economy practices while providing practical insights for industry practitioners, policymakers, and stakeholders in the agribusiness sector. Through careful analysis of sugarcane agribusiness, it is hoped that broader conversations and steps toward more sustainable and economical practices in the agribusiness landscape could emerge.

Circular Economy Business Model

Adopting circular principles in business models is crucial for implementing the circular economy (Lewandowski, 2016). Business models, which are defined as creating, delivering, and capturing value, offer a comprehensive perspective on organizational activities (Osterwalder, Pigneur, 2010; Schneider, Spieth, 2013). The circular economy business model concept appeared much more recently than the circular economy literature. The concept of circular business models emerged in 2006 and gained traction around 2012-2014 with the dissemination of circular economy ideas (Schwager, Moser, 2006; The Ellen MacArthur Foundation, 2012; WEF, 2014). Scholars like Rashid et al. (2013) emphasize the role of business models in addressing alignment issues for technology uptake in recycling, while Schulte (2013) highlights their importance for the

long-term development of the circular economy. Research on circular business models has steadily increased, mirroring the growing shift toward circularity across sectors, as shown in Figure 1.

Cradle-to-cradle (McDonough, Braungart, 2002) and performance economy (Stahel, 2010) have discussed the initial idea of a circular business model before or simultaneously with the emergence of the modern version of the business model concept (Wirtz et al., 2016). Similarly, the subfield of sustainable business model innovation, which emerged in the late 2000s (Birkin et al., 2009; Lüdeke-Freund et al., 2019; Stubbs, Cocklin, 2008) consider circular business models (e.g., creating value from waste) as one of the archetypes or sub-categories of sustainable business models (Bhatnagar et al., 2022; Bocken et al., 2014; Brenner, Drdla, 2023), with a narrower primary focus on environmental and economic outcomes (Geissdoerfer et al., 2018). In their review, Geissdoerfer et al. (2020) define the circular economy business model as recycling, expanding, intensifying, and/or dematerializing material and energy cycles to reduce resource input into and leakage of waste and emissions from organizational systems. It consists of cycling steps, extending the use phase, intensifying, and replacing products with service and software solutions (dematerializing). The Circular Economy Business Model is intended to provide an economically viable circular system that creates commercial value for an organization (Bocken et al., 2018; Ferasso et al., 2020).

Table 1. **Circular Economy Business Model Article Review Distribution**

Journal Name	Scopus Best Quartile 2022	WoS Journal Citation Index 2022	Number of Documents
Journal Articles			
Sustainability	Q1	0.67	4
Business Strategy and the Environment	Q1	2.52	2
British Food Journal	Q2	0.91	1
Resources, Conservation and Recycling	Q1	1.66	1
Science of the Total Environment	Q1	1.68	1
Sustainability Science	Q1	0.99	1
Proceedings Article			
IOP Conference Series: Earth and Environmental Science	—	—	1
Total			**11**

Source: authors.

Circular Economy Business Model (CEBM) in Agricultural Business

Previous research was reviewed to understand how the CEBM is developed in the agricultural or agribusiness sector. As presented in Figure 2, the search step begins with a search to answer the question, "What is the current trend of business models in the agricultural or agribusiness sector?" The search was sourced from the Scopus and Web of Science databases with the keywords: business AND model AND agriculture OR agro-industry OR agroindustry OR agribusiness. This search revealed 527 documents comprising 383 journal articles and 144 proceedings, published from 1989 to early 2023. Bibliometric data from all of them are then analyzed and plotted using thematic maps to understand the research trends on the current agribusiness/agriculture/agroindustry business model.

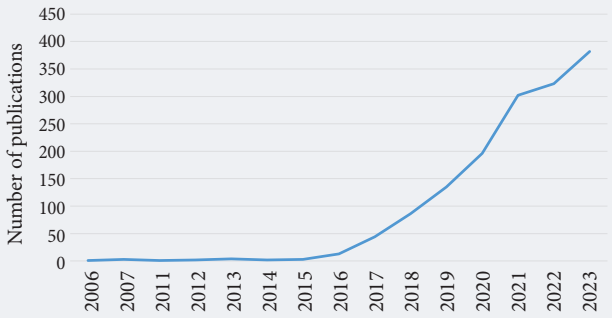
Based on the thematic map in Figure 3, which is built from 527 articles, it was found that the research theme on innovation as a part of more sustainable business models (more friendly to social, economic and environmental aspects) in the influential agricultural and agribusiness sectors today leads to a circular economy. The position in quadrant IV and the novelty map of the theme is relatively recent, indicating that the research theme has not yet been widely explored (the number of documents is low) but significantly influences research (the citation level is high).

Thus, the focus of the search shifted to the circular economy business model in the agricultural or agroindustrial sector. The circular economy is one of the paradigms used to achieve sustainability goals with a focus on creating closed systems where resources are used for as long as possible, waste is minimized, and natural systems are regenerated (Evans et al., 2017; Nosratabadi et al., 2019), then the next search also included the keyword, sustainability. Twenty-two documents were obtained, traced by the abstract and content of the research discussion, and narrowed down to 11 research documents (10 journal articles and one proceedings article), as shown in Table 1 below.

Research in Circular Economy Business Models (CEBM) in agribusiness and agroindustry, particularly concerning sustainability, remains limited. Table 2 summarizes some of them.

This presentation shows that research on circular economy business models in agriculture, agribusiness, and the agroindustry has primarily focused on mapping business models under the circular economy paradigm since the beginning of business operations. Nevertheless, little research still builds business models by moving away from the original linear paradigm to a more innovative circular para-

Figure 1. **The Number of Articles on Circular Business Models**



Source: authors' research results from Scopus database journals and conference articles.

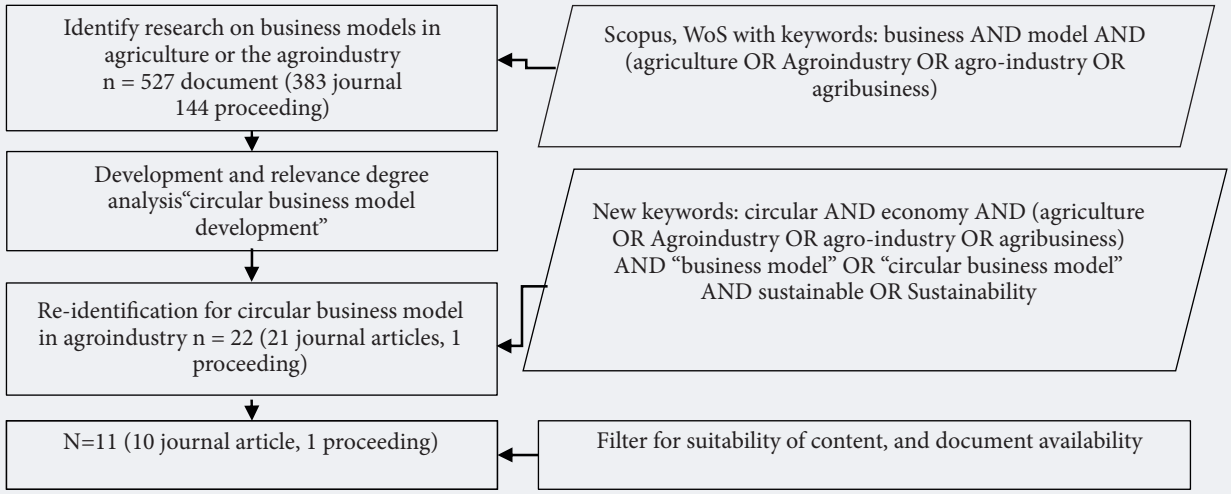
digm, or from an original circular model to a more circular one, especially in agroindustry or sugarcane agribusiness with varying levels of potential even though the circular transformation process becomes critical.

Capturing Circular Value through the 10R Principles in the Reverse Cycle Strategy (RSC)

Minimizing waste and maximizing resource efficiency are critical for sustainable business. Restorative and regenerative flows are essential in the circular economy (Ellen Macarthur Foundation, 2012; Ferasso et al., 2020). Restorative flow involves reintroducing resources into the economic cycle, reducing waste, and restoring value (Zucchella, Previtali, 2019), while regenerative flow focuses on maintaining natural resources and ecosystem sustainability (Morseletto, 2020a; Némethy, 2021). This approach also involves restoring ecosystems affected by human activities. The regenerative reverse cycle in agriculture is crucial due to the organic nature of the commodities. Both flows require a deep understanding of local ecosystems and agricultural practices (Novara et al., 2022). By embracing these concepts, the circular economy can support a more sustainable economic model, particularly in agriculture (Barros et al., 2023; Nasution et al., 2020). The reverse cycle, detailed in the 10R principles derived from the Waste Management Hierarchy, provides a roadmap for achieving these goals.

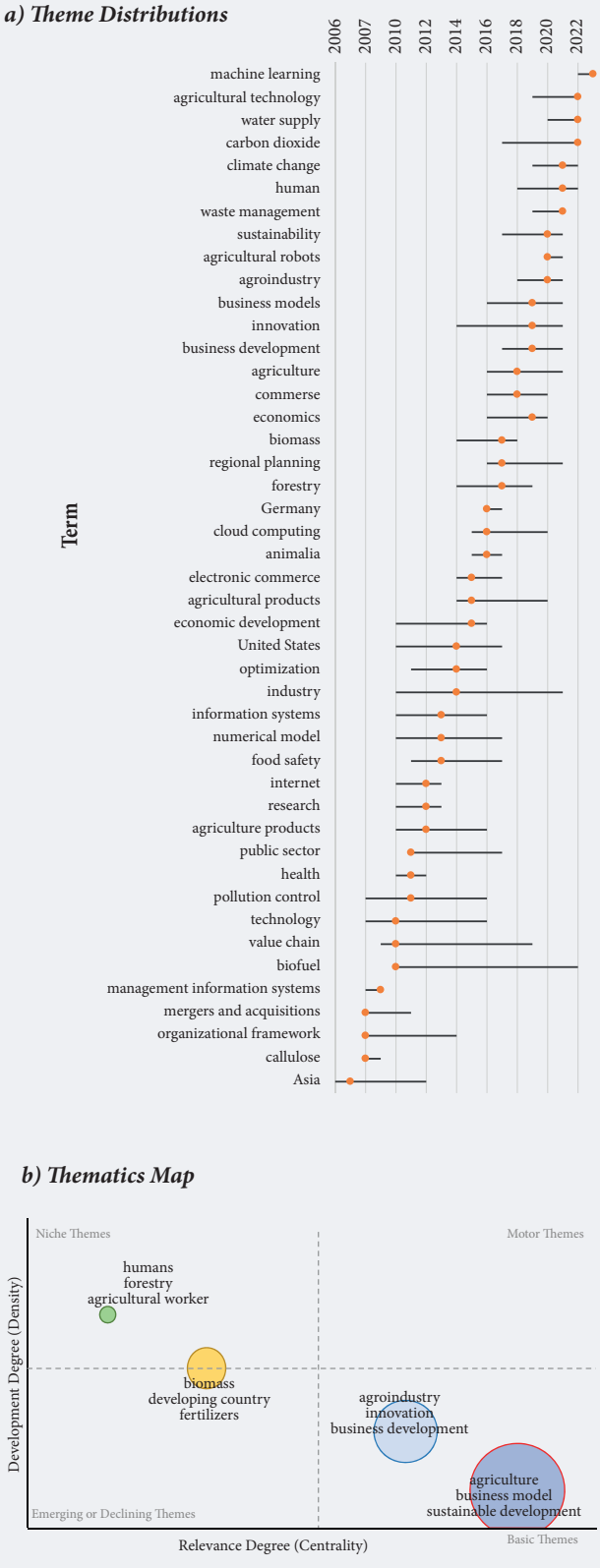
In the 19th and early 20th centuries, environmental concerns arising from the Industrial Revolution led to recognizing the need for better waste management to address air, water, and soil pollution. Originating from the 3R Movement in the mid-20th century, the Waste Management Hierarchy prioritized reducing consumption, reusing goods, and recycling waste (Awino, Apitz, 2024; Van Ewijk, Stegemann, 2016). In the 1970s, the Council of the European Union adopted the "Waste Hierarchy" to guide waste management, initially focusing on Prevention, Recovery, and Disposal, with Prevention akin to the "Refuse" concept in the Waste Management Hierarchy (Nilsen, 2019). By the early 2000s, the "Cradle to Cradle" concept influenced product design and waste management, emphasizing a sustainable product life cycle (McDonough, Braungart, 2002). The Waste Management Hierarchy has evolved to include repair, refurbishing, remanufacturing, and repurposing measures, providing a more comprehensive approach to sustainable waste management (Awino, Apitz, 2024). Global environmental regulations increasingly promote sustainable waste management practices, including recycling targets, bans, and innovation incentives. Public awareness of en-

Figure 2. **Flow Chart of Article Searches on the Circular Business Model in Agribusiness/Agroindustry**



Source: authors.

Figure 3. **Theme Distribution and Thematic Maps (Keyword Plus Title) Research on Business Models in the Agricultural Sector**



Source: authors' output from a bibliometrics analysis using R-biblioshiny.

vironmental issues and climate change has been crucial in shaping the Waste Management Hierarchy. The emergence of the 10R principles highlights the value of the reverse cycle in creating a sustainable economic model (Potting et al., 2017), enabling companies to integrate sustainability principles throughout the product life cycle, focusing on waste reduction and resource efficiency (Nilsen, 2019; Pires, Martinho, 2019).

Capturing value through the 10R principles in developing a circular business model is crucial for sustainability innovation (Morseletto, 2020b), including in the agricultural sector (Ciccullo et al., 2021). Circular business strategies with R0-Refuse enable the evaluation and rejection of unsustainable materials or processes. R1-Rethink facilitates a revolution in product design and production processes for efficiency and environmental friendliness. R2-Reduce focuses on lessening resource usage, and R3-Reuse and R4-Repair emphasize product reuse and repair, instead of buying a new item. R5-Refurbish and R6-Remanufacture involve updating and restoring products, and R7-Repurpose encourages creativity in reusing products or materials in different contexts. R8-Recycle and R9-Recover create opportunities to generate value through reprocessing and extracting value from waste (Potting et al., 2017). These strategies align with the circular economic paradigm's values of waste reduction, resource efficiency, innovation, environmental responsibility, and sustainable economic growth (Aguilar-Rivera, 2022; Ellen Macarthur Foundation, 2012).

Previous studies have partially utilized reverse cycle strategies to promote more circular business models. For example, rethink strategies focus on social contributions to the business model (Valencia et al., 2023), reuse strategies adapt circular business models for cultural heritage (Saleh, Ost, 2023), and remanufacture drives business model innovation (Bressanelli et al., 2022; Koop et al., 2021; Souza, 2019). Recycle strategies have been emphasized (Costanza, 2023; Parte, Alberca, 2023), along with recovery strategies (Kuzma, Sehnem, 2023). Refuse, Rethink, and Reduce are used in designing integrated circular business models (Villalba-Eguiluz et al., 2023), and reduce, reuse, and recycle drive business model shifts in developing countries (Goyal et al., 2018). However, these partial approaches may overlook the circular potential of business model innovation. Hence, this study proposes integrating the 10R strategies into a circular business model innovation framework. By doing so, agribusiness players can create a sustainable economic environment, enhance operational efficiency, and meet consumer demands for eco-friendly products and services while fostering innovation in products, services, and business methods for long-term sustainability.

Reverse Cycle Driven Circular Business Model Innovation Framework

Adopting a circular economy in agribusiness involves strategic steps with far-reaching implications. This process drives fundamental changes in value orientation within industrial systems or organizations, leading to strategic business model transformations (Uvarova et al., 2020). Most agricultural land is in developing countries.[1] Farmers in developing countries are predominantly poorly educated (FAO, 2017; Zhang et al., 2023); for example, more than 60% of farmers in Indonesia did not graduate from elementary school.[2] It is necessary to describe a business model that farmers can easily understand as the primary entity in agribusiness.

The Business Model Canvas (BMC) by Osterwalder and Pigneur (2010) is used to model the circular business in this study. BMC is widely used for CEBM modeling (Donner et al., 2020; Franceschelli et al., 2018; Klein et al., 2022; Lewandowski, 2016; Nußholz, 2017; Pollard et al., 2021). BMC simplifies key business elements into an easily understandable format. It offers a clear overview of business interconnections. It uses visual representations for quick comprehension by various stakeholders, including farmers (Braun et al., 2021). BMC's flexibility allows stakeholders to adapt business elements to agribusiness contexts, accommodating changes in agricultural practices, production, marketing, and circular economy adoption.

As illustrated in the schematic in Figure 4, the first stage of this study involves visualizing the ongoing business using the BMC, which comprises nine building blocks covering the essential aspects of the business. This process comprehensively depicts the business's operations and interactions with the surrounding environment. Information about each BMC building block, including market segmentation, value proposition, distribution channels, customer relationships, revenue sources, key resources, key activities, and key partnerships, is compiled into a representative BMC for the sugarcane agribusiness. The identification and canvasing process includes brainstorming sessions or Focus Group Discussions (FGDs) with sugarcane agribusiness leaders at the strategic level to gain insights into various aspects of the business. Collaboration during these sessions lays the foundation for creating a comprehensive BMC. The innovation process considers internal and external factors categorized by Lewandowski (2016). Internal factors relate to the organization's readiness for circular economy adoption. In contrast, external factors encompass technological, political, sociocultural, and economic aspects. Brenner and Drdla (2023) and Pollard et al. (2021) elaborate on factors such as changes in business strategy, circular business model challenges and opportunities, government regulations, and circularity indicators, which drive business model innovation in this study.

The second stage of this study is identifying factors driving innovation in circular sugarcane agribusi-

Table 2. **Review of Business Models Used in Circular Economy Business Models (CEBM) in Agribusiness and Agroindustry**

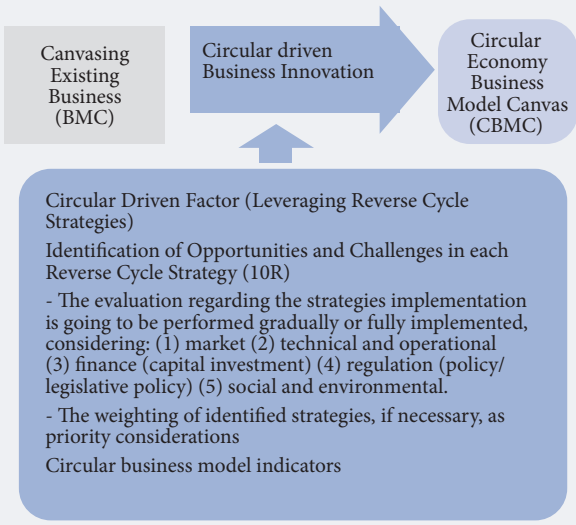
Sources	Summary of findings
Barth et al., 2017	Implemented a systematic literature review to outline business models in the agro-food industry, emphasizing sustainability as a strategic approach.
Franceschelli et al., 2018	Analyzed innovations in food start-up business models, focusing on enhancing social and environmental performance
Nosratabadi et al., 2019	Highlighted technological innovation's role in sustainable business models.
Zucchella, Previtali, 2019	Presented circular business model cases in Italian agribusiness
Donner et al., 2020	Identified six circular business models in agricultural waste valorization, emphasizing waste as a resource
Uvarova et al., 2020	Discussed CEBM application in the Latvian milk processing industry, showcasing waste recycling for value-added products
Donner, de Vries, 2021	Stressed the need for new business models to support the circular economy transition.
Hamam et al., 2021	Reviewed circular economy models in agro-food, highlighting their significance in agro-food system organizations
Dagevos, Lauwere 2021	Examined farmers' perceptions of circular agriculture in the Netherlands, emphasizing policymakers' role in integrating the circular economy into agricultural business models
Klein et al., 2022	Discussed CEBM development in the potato agroindustry, focusing on waste reduction, global sustainability, and supply chain collaboration

Source: authors.

[1] https://www.worldbank.org/en/topic/agriculture/overview, accessed 13.03.2024.

[2] https://satudata.pertanian.go.id/assets/docs/publikasi/Statistik_Ketenagakerjaan_Sektor_Pertanian_(Februari_2023).pdf, accessed 06.06.2024 (in Indonesian).

Figure 4. **Business Model Innovation Scheme with the Reverse Cycle Strategy (10R) as the Main Driving Factor)**



Source: authors.

ness models and considering feasibility. The business strategy uses the reverse cycle (10R) framework as the main trigger for innovation. Identifying opportunities and challenges follows these principles, where each "R-Strategy" is evaluated to identify possible or feasible opportunities. Brainstorming sessions and FGDs are also employed at this stage. Furthermore, each identified strategy is then assessed to see whether it can be done immediately or gradually. Studies have shown that aspects of feasibility studies are directly related to the successful implementation of business strategies (Chen, 2021). Thus, various aspects of business feasibility are considered, which consist of market, technical and operational, finance-capital investment (Laverty, Littel, 2020), regulation, and social environment factors (Bansal, 2023). These considerations inform the implementation approach for new business strategies, facilitating informed decisions. Agribusiness leaders, often with expert assistance, meticulously analyze each aspect of the business, including varying potentials of primary products and by-products. In the agribusiness context, the primary product is the one resulting from the main process of agricultural production that has direct economic value and is the primary goal of production activities (Hussain et al., 2022). Meanwhile the products produced as a by-product of the primary production process or the valorization of waste can have added value with further processing are considered secondary products (Yadav et al., 2020). Potential 10R strategies are compared pairwise to establish priority weighting and guiding strategy implementation. This data-driven approach ensures the careful selection of strategies, maximizing the potential for the successful integration of circular business models.

Once the drivers of circular business innovation are identified, the next step is visualizing circular business innovation in the Business Model Canvas (BMC). At this stage, each identified reverse strategy/10R is analyzed to map the impact of the change on each building block in the business canvas. Next, the results of this analysis are added to the BMC from the first stage.

The final stage of this research involves validating the circular business model canvas by reviewing circularity indicators across all canvas blocks. Circularity indicators are essential metrics used to assess the sustainability and efficiency of business models in a circular economy. These indicators help businesses evaluate their practices regarding resource use, waste management, collaboration, and technology integration. Table 3 provides an overview of these indicators and refers to various official sources, highlighting their importance and widespread recognition.

Table 3. **Circularity Indicators on Business Model Innovation**

Circularity indicator in Business model	Sources					
	(Ellen MacArthur Foundation, 2012)	(Lewandowski, 2016)	(Rossi et al., 2020)	(Geissdoerfer et al., 2020)	(Pollard et al., 2021)	(Rukundo et al., 2021)
Material or energy backflow in the business system (reverse cycle flow)	√	√	√	√	√	√
Collaborative action (including the sharing economy)	√	—	√	√	√	√
The use of information technology in the flow of the production process and after-sales (dematerializing)	√	√	—	√	√	—
Waste management	√	√	—	—	—	√
Non/slow renewable resource reductions	√	√	√	—	—	√
Circular investment	—	√	√	—	—	—

Source: authors.

Material or energy backflow in a business system (CI-1) measures the extent to which materials and energy are reintegrated into the production cycle. CI-1 demonstrates effective circular practices, reducing waste and dependence upon raw materials. Creating a closed-loop system where products and materials are continuously reutilized is fundamental. The comprehensive referencing across multiple sources underscores its critical role in achieving circularity. Collaborative Actions (including the sharing economy) (CI-2) evaluates the level of collaboration and sharing economy practices in business models, including partnerships, resource sharing, and collaborative consumption. It drives resource efficiency and innovation. By sharing resources and collaborating, businesses can reduce costs and environmental impacts. The consistent recognition of this indicator by multiple sources highlights its importance in harnessing collective efforts to achieve sustainability. Information Technology in the Flow of the Production Process and After-Sales (CI-3) measures the integration of information technology to optimize production and after-sales processes, thereby reducing material use and improving operational efficiency. Using IT in the production process can result in significant dematerialization, reducing the need for physical resources and increasing efficiency. Including this indicator in several key references emphasizes the transformative potential of digital technologies in achieving circular economy goals. Waste Management (CI-4) focuses on the effectiveness of waste management strategies. Effective waste management is essential to minimize the environmental impact and conserve resources. The presence of this indicator in various sources reflects this importance in a circular economy, where waste is seen as a resource that must be managed and utilized efficiently. No/Slow Renewable Resource Reduction (CI-5) evaluates efforts to reduce non-renewable or slow renewable resources and encourages the sustainable use of materials. Reducing one's reliance on non-renewable resources is critical for sustainability. High performance in CI-5 demonstrates a commitment to long-term resource sustainability and reduced environmental impacts. The recognition of this indicator by various sources highlights its importance. Circular Investment (CI-6) assesses the level of investments in circular practices and technologies which support the transition to more sustainable business models. Investments in circular economy practices and technologies is critical to driving innovation and scaling up sustainable business models. Including this indicator in references indicates the need for a financial commitment to achieve substantial progress in circularity. Using circularity indicators in the business model is an initial validator of its qualification as a circular economy business model (Pollard et al., 2021).

This research was conducted by studying the sugarcane agribusiness in East Java, the largest sugarcane-producing province in Indonesia. Smallholder sugarcane farmers are the leading agribusiness, and in 2022, 86.96% of the 14.2 million tons of sugarcane came from plantations managed by smallholder farmers. It is far greater than that produced on private and government estates, which only account for 0.21% and 12.83%, respectively.[3] In East Java, each smallholder sugarcane farmer manages an average of 10 hectares. There is a uniqueness in the smallholder sugarcane agribusiness: sugarcane becomes a sugar product, and various by-products/waste is still in the hands of farmers until they are sold at auction. Sugar mills are in a position to provide services for processing sugarcane into sugar. Smallholder sugarcane farmers in East Java practice sugarcane cultivation from planting to harvesting and engage in business affairs related to derivative products from the commodities grown.

Results and Discussion

In this study, three people representing the Sugarcane Farmers Association participated in FGDs relevant to smallholder sugarcane agribusiness in East Java. With over 25 years of experience in the region, each manages their own sugarcane fields: one with 15 hectares, another with 20 hectares, and the third with two hectares. As owners and controllers of their sugarcane agribusinesses, they possess deep insights into the challenges and opportunities faced by sugarcane farming communities in East Java. The researcher moderated the discussions, benefiting from their expertise to gain insights into industry dynamics and potential solutions to enhance smallholder sugarcane farmers' welfare.

Stage 1 provides an overview of the sugarcane agribusiness in East Java, covering operations from planting to sugar auctions while introducing reverse cycle strategies and identifying existing principles. An initial business model canvas is created. In Stage 2, the FGDs identify challenges and opportunities for reverse cycle strategies, assessing their feasibility for gradual or direct implementation and assigning priority weights through pairwise comparison. Stage 3 updates the initial BMC with additional content, resulting in an innovative BMC. Stage 4 assesses the circularity of the innovated BMC.

Stage 1: Initial Sugarcane Agribusiness Model Canvasing

Sugarcane agribusiness in East Java, Indonesia, led by smallholder farmers, is vital to the regional economy. These farmers typically own plots of land

[3] https://www.bps.go.id/en/statistics-table/2/NzY4IzI=/production-of-smallholder-estate-crops-by-type-of-crop.html, accessed 12.06.2024.

ranging from 0.5 to 20 hectares and rely on inherited knowledge for crop management. Despite limited formal education, they strive for optimal yields. Tasks such as planting, cultivation, harvesting, and transportation to processing factories are managed independently or with community assistance. Challenges include limited access to capital and market price fluctuations. After processing, sugarcane is auctioned based on market prices. Despite challenges, these farmers are crucial in supplying raw materials for the sugar industry while preserving sustainable practices. With improved support, such as education and technology access, sugarcane agribusiness in East Java can enhance regional economic development and farmers' welfare.

In the context of the reverse cycle strategy, although the slogan has not mentioned its application, in the sugarcane agribusiness, several applications of operations are found that are in line with several principles in the Reverse Cycle Strategy. As shown in Table 4, in R0-Refuse, because the characteristics of the land are different, some plots have abundant water sources and some are dry, during the planting period the farmers have refused the use of seeds that are not compatible with the conditions of the land. Furthermore, reusing agricultural equipment from the previous cultivation cycle mirrors the R3-Reuse strategy.

In addition, the R4-Repair strategy is reflected in the improvement at a certain point when abnormal growth is found without replacing entire plants. The implementation of R6-Remanufacture strategy is seen through the practice of "*bongkaratun*", a local term which describes the process of dismantling sugarcane plantation land and replacing all sugarcane weevils to their roots every three harvests. The R7-Repurpose strategy was identified as intercropping by planting chili plants and updating soil quality by planting other commodities, such as corn and rice. Furthermore, the R8-Recycle strategy is reflected in collecting pesticide bottles by scrap collectors to be recycled and producing sugarcane seeds from the best sugarcane crop harvest every harvest cycle.

The results of canvasing the business model of smallholder sugarcane agribusiness are shown in Table 5. In the dynamics of smallholder sugarcane agribusiness in East Java, partnerships with stakeholders are an integral element supporting this sector's operational continuity and growth. The involvement of sugar mills, sugarcane farmer's associations, fertilizer and herbicide suppliers, trucking service providers, cooperatives, and land owners allows for mutually beneficial cooperation. This collaboration enables the implementation of several key activities covering various stages, from land preparation to the final product marketing process. Land preparation includes preparing planting areas, selecting sugarcane seedlings in line with land conditions, and preparing necessary irrigation infrastructure.

Table 4. **Identification of Reverse Cycle Strategy Practices (R0-R9) in the Initial Sugarcane Agribusiness**

a) Essence of strategies

Reverse Cycle Strategy	Definition
R0 – Refuse	Refusal of unnecessary or non-environmental-friendly use of goods or services.
R1 – Rethink	The search for more sustainable solutions by revisiting the mindsets and habits of consumers and producers.
R2 – Reduce	Reduction of consumption of goods and resources to reduce waste.
R3 – Reuse	Reuse of goods or components that can still be used.
R4 – Repair	Repair damaged items rather than replace them.
R5 – Refurbish	Cleaning, repairing, or updating items to look and function like new.
R6 – Remanufacture	Fabricate components from unused products to create new products.
R7 – Repurpose	Transfer of use of goods or materials for different purposes.
R8 – Recycle	Recycling products into raw materials
R9 – Recover	Retrieval of nutrients, organic matter, or energy from waste or agricultural products

b) Strategies Already Running

Strategy	Area of use
R0	Do not use seedlings that are not suitable for field conditions
R1	—
R2	—
R3	The use of agricultural equipment from the previous cultivation cycle
R4	Repair at a particular point of the field when abnormal growth is found; not all are replaced.
R5	—
R6	*Bongkaratun*
R7	• Intercrop with chilli plants • The field is planted with corn or rice commodities every three harvests to restore soil quality
R8	• Pesticide bottles picked up by scrap collectors to be recycled • Sugarcane seeds are produced from the best sugarcane crop harvested every harvest cycle
R9	—

Source: authors.

The process of planting and cultivating sugarcane is carried out with due observance of agronomic principles, including selecting fertilization techniques, pest and weed control, and using appropriate herbicides and fertilizers. It is important to note that the practice of "*Bongkaratun*" is an integrated strategy to maintain soil fertility and increase land productivity by utilizing internal resources. In addition, intercropping with chili plants demonstrates a sustainable approach to optimizing land use and diversifying the sources of income for sugarcane farmers.

The sugarcane harvesting process ensures a high-quality yield, which is vital for producing large

quantities of sugar and clean cane stalks and enhancing final product quality. Sugar auctions maintain partnerships with sugar mills (70:30), catering to customer segments such as white crystal sugar wholesalers, flavoring manufacturers, and molasses brokers, ensuring a steady income stream for farmers. Key resources include sugarcane plantation land, carefully selected seeds, and using fertilizers, herbicides, and appropriate agricultural equipment to boost productivity and quality. Distribution channels, primarily via trucks transporting harvested sugarcane to sugar mills, facilitate the connection between production and end consumers. However, operational costs, including land rental, cultivation expenses, seedling purchases, labor, equipment rentals, and transportation, significantly impact financial management. Revenue primarily stems from sugar and molasses sales, supplemented by income from supporting recyclers. Diversification in revenue sources underscores the resilience of the sugarcane agribusiness ecosystem. Success in running smallholder sugarcane agribusiness in East Java hinges on strong integration among partners, resources, activities, and customer relationships. Table 5 highlights the reverse cycle strategies in the initial business model canvas.

Stage 2. Identification of Circular-Driven Factors Based on Reverse Cycle Strategies (RCS)

At this stage, circular improvement opportunities that may be carried out by sugarcane agribusiness are identified using the Reverse Cycle Strategies. Each strategy is studied, including the opportunities and challenges. The identified strategies are then listed in Table 6 below.

Table 6 summarizes the results of identifying potential RCS strategies with unique codes, which was carried out through FGDs with farmers as the main actors in the sugarcane agribusiness. This participatory method combines direct knowledge from key stakeholders. RCS strategies are developed by considering the available resources, challenges faced, and strategies that can be applied in the sugarcane agribusiness. In contrast, the opportunities and challenges associated with each strategy are presented comprehensively. The strategies cover critical aspects of the circular sugarcane agribusiness, from the use of organic fertilizers and herbicides to the application of technologies such as the use of drones for fertilizer spraying. The "Opportunity" column provides an overview of the opportunities that arise from each strategy, including increased market demand for organic products or additional revenue potential from product diversification. Meanwhile, the "Challenges" column details the challenges that must be overcome, such as limited access to technology or cost issues associated with repairing agricultural equipment.

Table 5. **BMC for Smallholder Sugarcane Agribusiness in East Java**

Key Partners (KP)
Sugar Mill Sugarcane Farmers Association Fertilizer Supplier Herbicides Supplier Trucking Service Provider Cooperative (Cooperation) Land Owner
Key Activities (KA)
Land preparation Planting Cultivating (Shredding, Irrigating, fertilizing, weeds controlling) • Improvement of sugarcane plants that are not good growth is carried out partially (R1 – Rethink) • Intercrop with chili plants (R7 – Repurpose) • *Bongkaratun* is carried out after three harvest cycles (R3 – Reuse), with seedlings prepared from the plants, not from others (R5 - Refurbish). • *Bongkaratun* Interspersed with rice/corn commodities (R7 – Repurpose) Harvesting
Key Resources (KR)
Sugarcane plantation land Sugarcane seeds • The type of seedling is selected according to the condition of the land (R0 – Refuse) Fertilizer Herbicides Farmworkers Truck carrier Irrigation water Agricultural equipment and supplies (R6 – Remanufacture) • Tractors rented from cooperatives • Farm light equipment does not have to be new in every cycle
Value Propositions (VP)
High sugarcane yield produces more sugar Clean cane stalks produce clean white crystal sugar The volume of sugarcane (tonnage) harvested per hectare is high
Customer Relationships (CR)
The auction process for sugar produced from farmers' sugarcane
Channels (C)
The mechanism of transporting harvested sugarcane to the sugar mill using trucks
Customer Segment (CuS)
White crystal sugar wholesaler Flavoring manufacturing companies Molasses broker
Cost Structure (CS)
Land rental costs Sugarcane cultivation/production costs (seeds, herbicides, fertilizers, labor costs, tractor rental costs, irrigation costs) Transportation costs of transporting sugarcane to the mill
Revenue Streams (RS)
Sugar Sales (profit sharing with sugar factories — 70% farmers: 30% sugar factories as sugar processing services) Sales of molasses (80% by volume of molasses produced by sugar mills) Extra income from recycler bottles or jerrycans used for herbicides and pesticides (R8 – Recycle).
Source: authors.

Although all the potential of the 10R principles have been reviewed, in this agribusiness, there are some principles whose potential has not been identified for several reasons. For example, the Refurbish (R5) is less feasible because the refurbishing process is usually more suitable for industrial products than agricultural crops. Although the new potential of the Remanufacture (R6) and Recycle (R8) principles has not been identified, farmers have been implementing it from the beginning through "Bongkaratun" and "Pesticide bottles picked up by scrap collectors to be recycled," which will continue to be practiced.

The holistic approach can be seen where each principle is interrelated and mutually reinforcing. For example, Rethink (R1) to evaluate the use of chemical fertilizers leads to a reduction (R2) of its use, which in turn facilitates the Recovery (R9) of organic waste combined with manure from cattle that fed on sugarcane shoots (strategy repurpose R7) as a sustainable fertilizer. The fertilizers used for sugarcane cultivation are a substitute for chemical fertilizer reduction. This integration decreases the environmental impact and lowers production costs, creating a positive feedback loop. In addition, Repair (R4) and Remanufacturing (R6) agricultural equipment ensure resource optimization and extend the life cycle of machinery. At the same time, Repurposing (R7) sugarcane by-products for energy production creates new revenue streams and reduces waste. These interrelated strategies collectively improve the sustainability and efficiency of the overall agribusiness model.

A capability analysis of each identified strategy is carried out to determine whether it can be implemented directly in full or gradually in stages. Table 7 shows the results of the capability analysis. All identified strategies (S1-S7) were studied from several aspects of consideration: marketing, technical operations, finance (capital investment), regulations, and the socioenvironment aspects. "Gradually implemented" refers to strategies implemented gradually or with slow progression. The strategy is not implemented instantaneously but through successive stages or with gradual adoption over time. Meanwhile, "Fully implemented" indicates that the strategy is fully adopted or implemented without any progressive stages. It means that the strategy is implemented directly and without delay, thus reaching full or maximum conditions from the beginning of its implementation.

Table 6. **Potential Strategies and their Challenges and Opportunities through the RCS Framework**

Opportunities (RCS)		Challenges	Potential Strategy Identified (PSI)
R0-A	Refuse to use chemical fertilizers and herbicides	• Limitations of organic fertilizer alternatives • Farmworkers' knowledge • Plant quality	Use of organic fertilizers and herbicides
R1-A	Use of organic herbicides	• Limitations of organic herbicides • Farmworkers' knowledge • Plant quality	Use of organic fertilizers and herbicides
R1-B	The use of drone providers for agriculture in spraying fertilizer	• Limited availability of service providers • Cost per hectare compared to manual.	Use of fertilizer spray services with drones
R2	Reduced use of chemicals	• Limitations of organic herbicides • Farmworkers' knowledge • Plant quality and productivity	Use of organic fertilizers and herbicides
R3	Reuse of Polybag when implementing "Bongkaratun"	• Quality of Polybag	The utilization of polybags for multi-planting
R4	Scheduled equipment repairs before the harvesting period	• Availability of spare parts • Repairman technical support • Cost and quality of repair	Scheduling repairs for harvesting equipment before the cutting season
R7-A	Diversion of sugarcane to be processed into Javanese brown sugar	• Market and demand for brown sugar • Production process and technology • Budgeting processing facilities investment	Sugarcane is processed by itself into Javanese brown sugar
R7-B	Sugarcane shoots after harvest for animal feed	• Limited uptake by cattle farmers in East Java • Processing or storage, if needed	Sugarcane shoots for cattle feed
R9-A	Utilization of waste from crops to be processed into fertilizer	• Processing fertilizer from the leaves and sugarcane stalks • Investment in fertilizer processing facilities • Standardization of the composition of fertilizer processing from crop-waste • Addition of labor functions	Production of organic fertilizers based on sugarcane agricultural waste
R9-B	The use of the remaining pieces of sugarcane seedlings as fertilizer	• Processing fertilizer from the remaining pieces of sugarcane • Investment in fertilizer processing facilities • Standardization of the composition of fertilizer processing from crop-waste • Addition of labor functions	Production of organic fertilizers based on sugarcane agricultural waste

Source: authors.

If resources are limited, then the implementation of the strategy should be carried out on a priority scale. Major sugarcane agribusiness players can use pairwise comparison with a scale of 1-9 to identify their priorities. Table 8 summarizes the prioritization results among the seven identified strategies.

Table 8 shows that the first strategic priority for innovation is the processing of sugarcane into brown sugar (S5). It received the highest priority weight for several reasons. Among them, because the glycemic brown sugar index is lower than crystal white (Azlan et al., 2022), this strategy provides an extensive market opportunity because Javanese brown sugar has a high demand among households and the food-beverage industry as consumption patterns shift toward healthier options. By producing brown sugar, farmers can significantly increase the added value of their products. In addition, brown sugar production can be done gradually, minimizing the need for initial investments and making it easier for farmers to start this business without the need for complicated and expensive equipment. This strategy also does not violate existing regulations but requires caution when honoring cooperation contracts with sugar mills. In addition, S5 opens up new opportunities for employment for the surrounding community, strengthens the local economy, and supports social sustainability.

This priority step not only expands the market for the final product but also increases the product's added value, opens up business expansion opportunities, and increases profitability significantly. The strategic innovation that also received significant attention was scheduling equipment repairs and the maintenance of harvesting equipment before the harvesting period (S4). Efficient repair scheduling increases equipment availability, reduces the likelihood of operational disruptions, and increases productivity and efficiency. The third most prioritized strategy is using a drone fertilizer services provider (S2). This technology offers cost-effective, scalable solutions that enhance crop monitoring, reduce environmental impact, and improve farm safety.

Stage 3: Innovated Circular Agribusiness Sugarcane Model Visualization

At this stage, the identified potential Reverse Cycle Strategy is analyzed and translated into every key element of the BMC building blocks as a circular business innovation. BMC's elements include all nine building blocks. An analysis of the impact of the Reverse Cycle Strategy on each element of the BMC enables an in-depth understanding of how the strategy affects overall business operations and the potential for improving the performance and sustainability of the sugarcane agribusiness.

Table 9 illustrates the various implementation paths for key BMC elements in each identified strategy. One standout strategy, "Brown Sugar (S5)," comprehensively covers critical BMC elements, offering high-quality Javanese sugar with natural flavors and textures from cultivation to distribution. Essential resources like processing locations and labor support these activities, while potential partners aid product distribution. However, some strategies may not fully impact BMC elements due to an internal focus or innovation on internal business aspects. For instance, strategies like "Use of Organic Fertilizers and Herbicides" may not directly influence customer segments or relationships. Evaluating such strategies requires considering their context and objectives relative to the BMC elements.

The key elements that have been translated into the identified reverse cycle innovations are then merged into the initial business model canvas and made into a new, more circular business model canvas, as described in Table 10. Integrating reverse cycle innovations into a new business model canvas offers a holistic approach to business model development. Each BMC element is examined in relation to the others, emphasizing how they interconnect and influence one another. For instance, incorporating the "Use of Organic Fertilizers and Herbicides" strategy directly aligns "Key Activities" and "Key Resources" with "Value Proposition" and "Customer Segments," allowing businesses to focus on delivering unique

Table 7. **Implementation of Capabilities of Identified Potential Reverse Cycle Strategies**

a) Basic indicators of potential reverse cycle strategies

Potential Strategies Identified (PSI)	RCS's element	Planned implementation
S1 - Use of organic-based fertilizers and herbicides	R0-A, R1-A, R2	Gradual
S2 - Use of fertilizer spray services with drones	R1-B	Full
S3 - The utilization of polybags for multi-planting	R3	Gradual
S4 - Scheduling repairs to harvesting equipment before the cutting/harvesting period	R4	Full
S5 - Sugarcane is processed into Javanese brown sugar	R7-A	Gradual
S6 - Sugarcane shoots for animal feed	R7-B	Gradual
S7 - Production of organic fertilizers based on sugarcane agricultural waste	R9-A, R9-B	Gradual

Source: authors.

Table 7 continued

b) Dimensions of Implementation Capabilities for the Potential Reverse Cycle Strategies

Dimension	Description
S1 - Use of organic fertilizers and herbicides	
Market	There is no encouragement or resistance from the sugar market regarding using organics in East Java.
Technical And Operational	Feasible for the same or more straightforward application process. Gradually because non-chemical suppliers are limited.
Financial (Capital Investment)	The most significant expense of farmers after labor costs is fertilizer; it does not matter if the price is the same or cheaper
Regulation	Not violating regulations in East Java
Social And Environment	Because of its organic nature, it is safe for human and animal safety. It minimizes environmental degradation due to chemical materials.
S2 - Use of fertilizer spray services with drones	
Market	There is no encouragement or resistance from the sugar market regarding drone spray services.
Technical And Operational	Several farmers in 2023 are already getting trials on some of their sugarcane fields, a faster process.
Financial (Capital Investment)	In total, the cost is lower than that of manual labor.
Regulation	Not violating regulations, and drones flying as high as 1-2 meters from sugarcane shoots do not interfere with flight regulations.
Social And Environment	The drone is operated by a vendor (certified drone pilot) and is relatively safe in terms of work safety.
S3 - The utilization of polybags for multi-planting	
Market	There is no encouragement or resistance from the sugar market regarding the use of polybags during hatchery.
Technical And Operational	Gradual, especially because farm workers must understand how to treat polybags after planting seedlings. Polybags have a service life of 2-3 years.
Financial (Capital Investment)	Although not significant, it can save more polybag procurement costs
Regulation	Not violating regulations
Social And Environment	Positive impact on the environment by reducing plastic waste
S4 - Scheduling repairs for harvesting equipment before the cutting/harvesting period	
Market	There is no encouragement or resistance from the sugar market regarding scheduling repairs.
Technical And Operational	It is possible to overhaul a thorough check for all fixtures and equipment. It can increase equipment and equipment utilization.
Financial (Capital Investment)	Less expensive than corrective maintenance
Regulation	Not violating regulations
Social And Environment	Technicians' schedules are more organized, and there is no pressure to rush.
S5 - Sugarcane is processed into Javanese brown sugar	
Market	The market for brown sugar is wide open. The people of East Java need this type of sugar, not to mention the potential of the food and beverage industry that is increasingly massive using brown sugar ingredients.
Technical And Operational	It must be implemented gradually, considering multi-year contracts bind some farmers to sugar mills.
Financial (Capital Investment)	It is possible to do it gradually because it requires uncomplicated and inexpensive equipment.
Regulation	Not violating regulations; it is only necessary to be careful to respect the relationship of cooperation contracts with sugar mill factories.
Social And Environment	Opening new job potential for residents
S6 - Sugarcane shoots for animal feed	
Market	Market absorption of sugarcane shoots allows for areas near large cattle farms. For areas where the type of feed needs to be arranged gradually.
Technical And Operational	It is feasible but needs to be pre-processed before cattle consumption (chopping/ boiling). It can be done gradually, including considering the existence of cattle farms that present potential clients.
Financial (Capital Investment)	It is possible to do it gradually because it requires uncomplicated and inexpensive equipment.
Regulation	Not violating regulations
Social And Environment	Unlocking the potential of cattle farming by sugarcane farmers or residents. Reduce the volume of waste burned from the harvest.
S7 - Production of organic fertilizers based on sugarcane agricultural waste	
Market	It will be beneficial if the fertilizer matches the characteristics of sugarcane growing soil environment. If intended for wood/field plants in general, it can potentially be absorbed by ornamental plant traders/field services or horticultural farmers
Technical And Operational	Long-term application may be possible, but it seems challenging to make changes in the subsequent one to three cycles. As a fertilizer, it is necessary to prepare the land for fermentation and provide knowledge to farmers of efficient organic fertilizer processing techniques.
Financial (Capital Investment)	Requires cost allowance budgeting
Regulation	There are no regulatory obstacles
Social And Environment	Previously collected and burned, it is better if it is processed and fermented into fertilizer.

Source: authors.

value while considering resource needs. This updated BMC reflects a more robust integration of reverse cycle innovations and the overall business strategy, providing a holistic view of the business model.

With regard to value proposition, the focus on phased movement to organic options highlights a shift in value toward reducing agricultural waste and maximizing natural resources. It aligns with the reverse cycle principles, where agricultural waste is reused, for example as fodder or fertilizer. Introducing brown sugar as an alternative product expands the market and meets broader consumer needs. In the Key Activities section, reusing polybags for seedlings demonstrates efficiency and recycling, while processing agricultural waste into organic fertilizers reflects resource utilization efforts. Incorporating sugarcane processing for Javanese brown sugar diversifies products and adds value. Drone-based fertilizer spraying is applied to improve efficiency (Wadod, Mohammed, 2023). A challenge faced here is the lack of affordable drone service providers, which can be overcome by working with drone technology providers for pilot and training programs for farmers. In the Key Partners (KP) section, collaboration is carried out with sugar mills and sugarcane farmers' associations. The possibility of difficulties in coordination and communication between partners can be minimized by establishing regular communication forums and using information technology to facilitate coordination. In the Cost Structure (CS) section, cost reduction innovations are carried out using organic materials and repairing equipment before harvest. In the context of this sugarcane agribusiness, at the level of innovation implementation, besides the immense potential benefits, it could face several obstacles, such as limited access to technology, regulatory barriers, and lack of knowledge among farmers. Applicable solutions include building strategic partnerships, accessing support funds from governments or international organizations, and training for farmers to adopt new practices. Overall, the BMC innovation aims to adopt sustainable circular practices and minimize negative environmental impacts in sugarcane agribusiness.

Stage 4. Validation Using Circular Business Indicators

At this stage, a validation process is carried out to determine whether the business model built is circular or not. Validation was carried out by identifying business models before and after the innovation of the reverse cycle strategies. Table 11 shows how the circularity changes between the two.

Table 11 indicates that the set of indicators identified from various studies, consisting of six business model circular indicators, proved capable of capturing the interventions resulting from the change from the current business model to the innovative RSC business model. In the initial BMC, two indicators were identified: material and/or energy backflow in the business system and collaborative action (including the sharing economy), which were spread across key elements such as Key Activities, Key Resources, Key Partnerships, and Revenue Streams. The initial BMC also implemented circularity practices in its business model.

In the updated, innovative BMC, six indicators of all key elements were identified. First, Reverse Cycle Flow was noted in seven potential proposed strategies. Second, Collaborative Action is strengthened by expanding collaborative relationships with cooperatives and sugar mills and adding collaborations with agricultural drone service providers, equipment workshop service providers, organic fertilizer processing experts, and farmers as potential customers for sugarcane shoots. Third, information technology emerged as an effort to develop potential marketing channels for different products, such as brown sugar. Fourth, Waste Management would be improved by innovation in the processing of leaf waste into organic fertilizer and using sugarcane shoots as a component of cattle feed. Fifth, Circular Investment is seen in the commitment to gradual investment allocation in agribusiness toward producing different products and gradual investment in constructing agricultural waste processing facilities for the production of organic fertilizers that have commercial value. Based on these indicators, it can be concluded that the innovated BMC can be considered more circular than the initial BMC. Thus, the evolution of BMC through a reverse cycle strategy represents a significant step forward in realizing a more adabtable, sustainable, and technology-oriented business model with reverse cycle flow as the backbone of innovation. The implementation of this BMC would demonstrate a solid commitment to innovation, improved business performance, and environmental sustainability.

Several important lessons can be applied in other segments of the agricultural sector, national economy, and the global economy. First, the collaboration between various stakeholders is essential for successfully implementing circular business models. Second, providing adequate education and training for farmers and workers to adopt new technologies and circular practices is crucial. Knowledgeable agricultural instructors can liaise with researchers and farmers, providing the necessary knowledge through live demonstrations and visual media. In addition, cooperation with educational institutions and non-governmental organizations can provide functional literacy programs and vocational training. Third, policies and regulations that support circular practices can accelerate the transition to a

Table 8. **Identified Strategic Priorities**

Potential Strategies Identified (PSI)	Priority Weight
S1	0.07
S2	0.14
S3	0.07
S4	0.20
S5	0.36
S6	0.06
S7	0.10

Source: authors.

Table 9. **Reverse Cycle Strategy Innovations that Have Been Identified in Every Key Element of the Building Blocks**

Item	Description
S1 – Use of organic fertilizers and herbicides	
VP	Organic matter-based operations
KA	Gradually use organic fertilizers and herbicides
KR	Organic fertilizers and herbicides
KP	Vendors of Organic Herbicides and Fertilizers
CuS	—
CR	—
C	—
CS	Cost of organic herbicides and pesticides
RS	—
S2 – Use of fertilizer spray services with drones	
VP	Efficient and high productivity
KA	Spraying fertilizer with drones
KR	—
KP	Drone service provider for agriculture
CuS	—
CR	—
C	—
CS	The cost of spraying drones
RS	—
S3 – The utilization of polybags for multi-planting	
VP	Reduction of non-renewable materials
KA	Reuse of polybags that can still be used for seedlings
KR	Polybag
KP	Polybag seller
CuS	—
CR	—
C	—
CS	Reduced costs for new polybags
RS	—
S4 – Scheduling repairs to harvesting equipment before the cutting/harvesting period	
VP	Efficient and high productivity
KA	Repair and overhaul of equipment before harvest
KR	Truck and other spare parts
KP	Cooperation with workshops/technicians
CuS	—
CR	—
C	—
CS	Planned maintenance costs
RS	—

Table 9 continued

S5 – Sugarcane is processed into Javanese brown sugar	
VP	High-quality Javanese brown sugar with a natural taste and texture
KA	(1) Javanese sugar processing, including cooking and refining. (2) Stock management and product distribution.
KR	Processing location, sap squeezer, furnace, pan, processing labor
KP	(1) Distributors (2) Cooperation with restaurants, cafes, or the food and beverage industry for the use of products in their recipes
CuS	(1) Retailers and connoisseurs of brown sugar (2) Restaurants, cafes, and food and beverage industries looking for high-quality ingredients for their products
CR	Build awareness and understanding of the benefits and uniqueness of brown sugar.
C	(1) Direct sales to consumers through online or offline stores. (2) Distribution through local food shops or traditional markets.
CS	Operational, marketing, and distribution costs.
RS	Sales of brown sugar to consumers and businesses
S6 – Sugarcane shoots for animal feed	
VP	(1) Sugarcane shoots as high-quality forage for cattle. (2) Reduce agricultural waste.
KA	Harvesting
KR	Farm labor
KP	—
CuS	Farm owner or rancher
CR	Long-term partnerships with farms or ranchers
C	—
CS	—
RS	Sales of sugarcane shoots for animal/cattle feed
S7 – Production of organic fertilizers based on sugarcane agricultural waste	
VP	Reduce agricultural waste by turning waste into valuable products.
KA	(1) Collection and processing of crop waste into organic fertilizer. (2) Packaging and distribution of organic fertilizer products.
KR	(1) Waste from crop residues (leaves and stem tips). (2) Treatment facilities to process waste into organic fertilizer. (3) Manpower in waste management and organic fertilizer production.
KP	(1) Partnership with farmers to supply waste from crop residue. (2) Partnerships with agricultural stores or distributors for product distribution.
CuS	Farmers looking for an alternative to organic fertilizers
CR	(1) Customer service that provides information about the benefits and how to use organic fertilizers. (2) Long-term partnerships with farmers to understand their needs and provide suitable solutions.
C	Direct sales to farmers or via online marketplaces
CS	(1) Production and packaging costs (2) Marketing and distribution costs.
RS	Direct sale of organic fertilizers to farmers (both sugarcane and non-sugarcane)

Items: VP — Value Proposition; KA — Key Activities; KR — Key Resources; KP — Key Partners; CuS — Customer Segments; CR — Customer Relationship; C — Channel; CS — Cost Structures; RS — Revenue Stream.

Source: authors.

Table 10. **Circular Business Model Canvas Innovated with the Use of Reverse Cycle Strategies**

Item	Contents
Key Partners (KP)	• Sugarcane Mill • Sugarcane Farmers Association • Fertilizer Supplier • Herbicide supplier • Transporter Service Provider • KUD • Landowners • Drone service provider for agriculture • Workshop / Truck technician • Academics who understand how to process agricultural waste into organic fertilizer

Key Activities (KA)	• Land preparation
	• Planting
	  ○ Reuse of polybags that can still be used as seedling beds (R3 – Reuse)
	• Cultivating (shredding, irrigating, fertilizing, weed controlling)
	  ○ Gradual fertilization using organic matter (from agricultural waste recovery) (R8 – Recycle)
	  ○ Improvement of crops while waiting for harvest is carried out partially (R9 –Recovery).
	  ○ Intercrop with chili plants (R7 – Repurpose)
	  ○ "*Bongkaratun*" is carried out after three harvesting cycles, which will later prepare seedlings from the plants themselves (R6 – Remanufacture, R8 – Recycle).
	  ○ Field production interspersed with rice/corn commodities (R7 – Repurpose)
	  ○ Gradual weed controlling and fertilizing using organic matter and spraying with drones (R2 – Reduce, R4 – Repair)
	• Harvesting
	• Equipment repair before harvest (preventive maintenance) (R9 – Recovery)
	• Processing of sugarcane into Javanese brown sugar (R7 – Repurpose)
	• Processing of sugarcane agricultural waste into organic fertilizer (R5 – Refurbish)

Key Resources (KR)	• Sugarcane plantation land
	• Sugarcane seeds
	  ○ The type of seedling is selected according to the condition of the land (R0 – Refuse)
	• Fertilizer
	• Herbicides
	• Farmworker
	• Agricultural equipment and supplies (Reuse)
	  ○ tractors rented from cooperatives
	  ○ Farm light equipment does not have to be new in every cycle
	• Transport truck
	• Irrigation water
	• Facilities of processing sugarcane into Javanese sugar
	• Agricultural waste processing facilities into organic fertilizers

Value Propositions (VP)	• High sugarcane yield produces more sugar • Clean cane stalks produce clean white crystal sugar • The volume of sugarcane (tonnage) harvested per hectare is high (high productivity) • Phased operation oriented to organic matter (R6 - Remanufacture) • High-quality Javanese sugar (brown sugar) with a natural taste and texture (R7 – Repurpose) • Reduce agricultural waste and efficient use of resources (R2 – Reduce) • Reduction of non-renewable materials (R3 – Reuse)
Customer Relationships (CR)	• The auction process for sugar produced from farmers' sugarcane • Build awareness and understanding of the benefits and uniqueness of Javanese brown sugar.
Channels (C)	• The mechanism of transporting harvested sugarcane to sugar processing factories using open-bed trucks • Sales of Javanese sugar directly to consumers through online or offline stores. • Distribution through local food shops or traditional markets.
Customer Segment (CuS)	• Granulated white crystal sugar merchant • Granulated white crystal sugar broker • Flavoring manufacturing companies • Molasses broker • Retailers and connoisseurs of Javanese sugar • Restaurants, cafes, and food and beverage industries that are looking for high-quality Javanese sugar raw materials for their products
Cost Structure (CS)	• Land rental fees • Sugarcane cultivation/production costs (seeds, herbicides, fertilizers, labor costs, tractor rental costs, drone spraying costs, irrigation costs) • Planned equipment maintenance costs • Costs of transporting sugarcane to the mill • Cost of processing sugarcane into sugar palm • Cost of processing sugarcane waste into organic fertilizer
Revenue Streams (RS)	• Sugar sales (profit sharing with sugar mills — 70% farmers: 30% sugar mills) • Sales of molasses (80% by volume of drops produced by sugar mills) • Income from recycled bottles or *jirigen* used for herbicides and pesticides (R8 – Recycle). • Sales of Javanese sugar to consumers and businesses

Source: authors.

Table 11. **Comparison of Circularity Indicators Before and After the Reverse Cycle Innovation in the Sugarcane Agribusiness Model**

Initial BMC of the sugarcane agribusiness									Circularity indicator in business model	BMC of circular innovated sugarcane agribusiness								
VP	KA	KR	KP	CuS	CR	C	CS	RS		VP	KA	KR	KP	CuS	CR	C	CS	RS
—	√	√	—	—	—	—	—	√	CI-1	√	√	√	—	—	—	—	—	√
—	—	√	√	—	—	—	—	–	CI-2	—	—	√	√	—	√	—	—	—
—	—	—	—	—	—	—	—	–	CI-3	—	—	—	—	—	—	√	—	—
—	—	—	—	—	—	—	—	–	CI-4	√	√	√	√	—	—	—	—	—
—	—	—	—	—	—	—	—	–	CI-5	√	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	–	CI-6	—	—	—	—	—	—	—	√	—

Source: authors.

circular economy. Fourth, innovation must be sustainable and responsive to environmental and market changes. Fifth, access to funds and investments for new technologies and practices is essential for effective implementation.

Conclusion

This study confirms that the innovations are crucial for developing sustainable business models in the sugarcane agribusiness sector. The integration of ten aspects of the reverse cycle strategy has successfully transformed the business model into a circular one. The findings highlight evidence that this framework could help move existing agricultural operations toward more circularity.

Integrating the 10R principles into the reverse cycle strategy as a critical innovation driver has identified significant potential changes, ranging from micro-operating adjustments (polybag reuse) to optimizing efficiency to capturing the potential for revenue increases through product differentiation (brown sugar) and waste management. The significance of these findings should not be overlooked, especially given the global challenges in achieving environmental and social sustainability. By providing a conceptual and practical framework for applying circular economy principles in the sugarcane agribusiness, this research paves the way for further transformations in this sector and others.

The potential applications of these findings are vast. They can be applied in various industrial sectors, including agribusiness, manufacturing, technology, and services. Thus, this study contributes to the academic literature on circular economy and provides practical guidance for industry practitioners, policymakers, and other stakeholders to drive the transformation toward a more sustainable business.

Future research can expand the scope of this study by applying the same framework to other industry contexts and evaluating the impact and effectiveness of the resulting business models. In addition, further research can also explore the integration of other aspects of the circular economy and how more circular business models in the sugarcane agribusiness can help achieve global sustainability goals.

This research was funded by "Balai Pembiayaan Pendidikan Tinggi/BPPT" and "Lembaga Pengelolaan Dana Pendidikan/LPDP" through Indonesian Education Scholarships (BPI) No. 00778/J5.2.3./BPI.06/9/2022 with BPI Id. 202209091259.

References

Aguilar-Rivera N. (2022) Bioindicators for the Sustainability of Sugar Agro-Industry. *Sugar Tech,* 24(3), 651–661. https://doi.org/10.1007/s12355-021-01105-z

Amini Z., Self R., Strong J., Speight R., O'Hara I., Harrison M.D. (2022) Valorisation of sugarcane biorefinery residues using fungal biocatalysis. *Biomass Conversion and Biorefinery,* 12(3), 997–1011. https://doi.org/10.1007/s13399-021-01456-3

Awino F.B., Apitz S.E. (2024) Solid waste management in the context of the waste hierarchy and circular economy frameworks: An international critical review. *Integrated Environmental Assessment and Management*, 20(1), 9–35. https://doi.org/10.1002/ieam.4774

Azlan A., Ebadi S., Yusof B.N.M., Othman N.M.H., Kannar D., Sultana S., Mahmood Z. (2022) Satiety, glycemic profiles, total antioxidant capacity, and postprandial glycemic responses to different sugars in healthy Malaysian adults. *Nutrition,* 97, 111551. https://doi.org/10.1016/j.nut.2021.111551

Bansal A.K. (2023) Feasibility analysis and business plan. In: *Basic Biotechniques for Bioprocess and Bioentrepreneurship* (eds. A.K. Bhatt, R.K. Bhatia, T.C. Bhalla), Amsteredam: Elsevier, pp. 427–440, https://doi.org/10.1016/B978-0-12-816109-8.00029-5

Barros M.V., De Jesus R.H.G., Ribeiro B.S., Piekarski C.M. (2023) Going in Circles: Key Aspects for Circular Economy Contributions to Agro-industrial Cooperatives. *Circular Economy and Sustainability*, 3(2), 861–880. https://doi.org/10.1007/s43615-022-00211-8

Barth H., Ulvenblad P.-O., Ulvenblad P. (2017) Towards a Conceptual Framework of Sustainable Business Model Innovation in the Agri-Food Sector: A Systematic Literature Review. *Sustainability,* 9(9), 1620. https://doi.org/10.3390/su9091620

Bhatnagar R., Keskin D., Kirkels A., Romme A.G.L., Huijben J.C.C.M. (2022) Design principles for sustainability assessments in the business model innovation process. *Journal of Cleaner Production,* 377, 134313. https://doi.org/10.1016/j.jclepro.2022.134313

Birkin F., Polesie T., Lewis L. (2009) A new business model for sustainable development: an exploratory study using the theory of constraints in Nordic organisations. *Business Strategy and the Environment,* 18(5), 277–290. https://doi.org/10.1002/bse.581

Bocken N.M.P., Short S.W., Rana P., Evans S. (2014) A literature and practice review to develop sustainable business model archetypes. *Journal of Cleaner Production,* 65, 42–56. https://doi.org/10.1016/j.jclepro.2013.11.039

Bocken N.M.P., Schuit C.S.C., Kraaijenhagen C. (2018) Experimenting with a circular business model: Lessons from eight cases. *Environmental Innovation and Societal Transitions,* 28, 79–95. https://doi.org/10.1016/j.eist.2018.02.001

Braun A.-T., Schöllhammer O., Rosenkranz B. (2021) Adaptation of the business model canvas template to develop business models for the circular economy. *Procedia CIRP,* 99, 698–702. https://doi.org/10.1016/j.procir.2021.03.093

Brenner B., Drdla D. (2023) Business Model Innovation toward Sustainability and Circularity—A Systematic Review of Innovation Types. Sustainability, 15(15), 11625. https://doi.org/10.3390/su151511625

Bressanelli G., Saccani N., Perona M. (2022) Remanufacturing for the Circular Economy: A Business Model analysis. In: Smart Services Summit (SMSESU) 2022 Proceedings (eds. J. Meierhofer, S. West, T. Buecheler), Cham: Springer, pp. 133–143. https://doi.org/10.1007/978-3-031-36698-7_14 s

Chen T.-Y. (2021) A Business Model Feasibility Evaluation Method for Enterprise Collaborative Business Innovation. *International Journal of E-Collaboration,* 18(1), 1–19. https://doi.org/10.4018/IJeC.290291

Ciccullo F., Cagliano R., Bartezzaghi G, Perego A. (2021) Implementing the circular economy paradigm in the agri-food supply chain: The role of food waste prevention technologies. *Resources, Conservation and Recycling*, 164, 105114. https://doi.org/10.1016/j.resconrec.2020.105114

Costa P.F.F., Silva M.S., Santos S.L. (2014) Sustainable Development of The Sugarcane Agribusiness. *Ciência & Saúde Coletiva,* 19(10), 3971–3980. https://doi.org/10.1590/1413-812320141910.09472014

Costanza F. (2023) When the business is circular and social: A dynamic grounded analysis in the clothing recycle. *Journal of Cleaner Production,* 382, 135216. https://doi.org/10.1016/j.jclepro.2022.135216

Dagevos H., Lauwere C. (2021) Circular Business Models and Circular Agriculture: Perceptions and Practices of Dutch Farmers. *Sustainability,* 13(3), 1282. https://doi.org/10.3390/su13031282

Donner M., Gohier R., de Vries H. (2020) A new circular business model typology for creating value from agro-waste. *Science of the Total Environment,* 716, 137065. https://doi.org/10.1016/j.scitotenv.2020.137065

Donner M., de Vries H. (2021) How to innovate business models for a circular bio-economy? *Business Strategy and the Environment*, 30(4), 1932–1947. https://doi.org/10.1002/bse.2725

Ellen Macarthur Foundation (2012) *Towards A Circular Economy,* Isle of Wight (UK): Ellen Macarthur Foundation.

Evans S., Vladimirova D., Holgado M., Van Fossen K., Yang M., Silva E.A., Barlow C.Y. (2017) Business Model Innovation for Sustainability: Towards a Unified Perspective for Creation of Sustainable Business Models. *Business Strategy and the Environment,* 26(5), 597–608, https://doi.org/10.1002/bse.1939

FAO (2017) *The Future of Food and Agriculture – Trend and Challenges,* Rome: FAO.

Ferasso M., Beliaeva T., Kraus S., Clauss T., Ribeiro-Soriano D. (2020) Circular economy business models: The state of research and avenues ahead. *Business Strategy and the Environment,* 29(8), 3006–3024. https://doi.org/10.1002/bse.2554

Franceschelli M.V., Santoro G., Candelo E. (2018) Business model innovation for sustainability: A food start-up case study. *British Food Journal,* 120(10), 2483–2494. https://doi.org/10.1108/BFJ-01-2018-0049

Garza-Reyes J.A., Kumar V., Batista L., Cherrafi A., Rocha-Lona L. (2019) From linear to circular manufacturing business models. *Journal of Manufacturing Technology Management,* 30(3), 554–560. https://doi.org/10.1108/JMTM-04-2019-356

Geissdoerfer M., Morioka S.N., de Carvalho M.M., Evans S. (2018) Business models and supply chains for the circular economy. *Journal of Cleaner Production,* 190, 712–721. https://doi.org/10.1016/j.jclepro.2018.04.159

Geissdoerfer M., Pieroni M.P.P., Pigosso D.C.A., Soufani K. (2020) Circular business models: A review. *Journal of Cleaner Production,* 277, 123741. https://doi.org/10.1016/j.jclepro.2020.123741

Goyal S., Esposito M., Kapoor A. (2018) Circular economy business models in developing economies: Lessons from India on reduce, recycle, and reuse paradigms. *Thunderbird International Business Review*, 60(5), 729–740. https://doi.org/10.1002/tie.21883

Hamam M., Chinnici G., Di Vita G., Pappalardo G., Pecorino B., Maesano G., D'Amico M. (2021) Circular Economy Models in Agro-Food Systems: A Review. *Sustainability,* 13(6), 3453. https://doi.org/10.3390/su13063453

Hussain A., Jehangir I.A., Sofi N.R., Anwar Bhat M., Sheraz Mahdi S. (2022) Linkage Between Primary and Secondary Agriculture: Role of High-Value Field Crops in Increasing Farmers' Income. In: *Secondary Agriculture* (eds. F.A. Bahar, M. Anwar Bhat, S.S. Mahdi), Cham: Springer, 1–11. https://doi.org/10.1007/978-3-031-09218-3_1

Klein O., Nier S., Tamásy C. (2022) Circular agri-food economies: Business models and practices in the potato industry. *Sustainability Science,* 17(6), 2237–2252. https://doi.org/10.1007/s11625-022-01106-1

Koop C., Grosse Erdmann J., Koller J., Döpper F. (2021) Circular Business Models for Remanufacturing in the Electric Bicycle Industry. *Frontiers in Sustainability,* 2, 785036. https://doi.org/10.3389/frsus.2021.785036

Kuzma E., Sehnem S. (2023) Proposition of a structural model for business value creation based on circular business models, innovation, and resource recovery in the pet industry. *Business Strategy and the Environment*, 32(1), 516–537. https://doi.org/10.1002/bse.3158

Lauten-Weiss J., Ramesohl S. (2021) The Circular Business Framework for Building, Developing and Steering Businesses in the Circular Economy. Sustainability, 13(2), 963. https://doi.org/10.3390/su13020963

Laverty M., Littel C. (2020) *Business Model Plan: Conducting a Feasibility Analysis,* Houston, TX: OpenStax.

Lewandowski M. (2016) Designing the Business Models for Circular Economy — Towards the Conceptual Framework. *Sustainability,* 8(1), 43. https://doi.org/10.3390/su8010043

Lüdeke-Freund F., Gold S., Bocken N.M.P. (2019) A Review and Typology of Circular Economy Business Model Patterns. *Journal of Industrial Ecology,* 23(1), 36–61. https://doi.org/10.1111/jiec.12763

McDonough W., Braungart M. (2002) *Cradle to Cradle: Remaking the Way We Make Things,* New York: North Point Press.

Morseletto P. (2020a) Restorative and regenerative: Exploring the concepts in the circular economy. *Journal of Industrial Ecology,* 24(4), 763–773. https://doi.org/10.1111/jiec.12987

Morseletto P. (2020b) Targets for a circular economy. *Resources, Conservation and Recycling,* 153, 104553. https://doi.org/10.1016/j.resconrec.2019.104553

Morseletto P. (2023) Sometimes linear, sometimes circular: States of the economy and transitions to the future. *Journal of Cleaner Production,* 390, 136138. https://doi.org/10.1016/j.jclepro.2023.136138

Nasution A.H., Aula M., Ardiantono D.S. (2020) Circular economy business model design. *International Journal of Integrated Supply Management,* 13(2/3), p. 159–177. https://doi.org/10.1504/IJISM.2020.107848

Némethy S. (2021) New, regenerative approaches to sustainability: Redefining ecosystem functions, environmental management, and heritage conservation. *Ecocycles, European Ecocycles Society,* 7(2), 86–91. https://doi.org/10.19040/ecocycles.v7i2.212

Nilsen H.R. (2019) The hierarchy of resource use for a sustainable circular economy. International Journal of Social Economics, 47(1), 27–40. https://doi.org/10.1108/IJSE-02-2019-0103

Nosratabadi S., Mosavi A., Shamshirband S., Kazimieras-Zavadskas E., Rakotonirainy A., Chau K.W. (2019) Sustainable Business Models: A Review. *Sustainability,* 11(6), 1663. https://doi.org/10.3390/su11061663

Novara A., Sampino S., Paternò F., Keesstra S. (2022) Climate Smart Regenerative Agriculture to Produce Sustainable Beauty Products: The Case Study of Snail Secretion Filtrate (LX360®). Sustainability, 14(4), 14042367. https://doi.org/10.3390/su14042367

Nußholz J. (2017) Circular Business Models: Defining a Concept and Framing an Emerging Research Field. *Sustainability,* 9(10), 1810. https://doi.org/10.3390/su9101810

Osterwalder A., Pigneur Y. (2010) *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers*, Hoboken, NJ: John Wiley & Sons.

Parte L., Alberca P. (2023) Circular Economy and Business Models: Managing Efficiency in Waste Recycling Firms. *Business & Society,* 63(6), 1426–1461. https://doi.org/10.1177/00076503231205798

Pegorin M.C., Caldeira-Pires A., Faria E. (2024) Interactions between a circular city and other sustainable urban typologies: A review. *Discover Sustainability,* 5(1), 14, https://doi.org/10.1007/s43621-024-00184-8

Pires A., Martinho G. (2019) Waste hierarchy index for circular economy in waste management. *Waste Management*, 95, 298–305. https://doi.org/10.1016/j.wasman.2019.06.014

Pollard J., Osmani M., Cole C., Grubnic S., Colwill J. (2021) A circular economy business model innovation process for the electrical and electronic equipment sector. *Journal of Cleaner Production,* 305, 127211. https://doi.org/10.1016/j.jclepro.2021.127211

Potting J., Hekkert M., Worrell E., Hanemaaijer A. (2017) *Circular Economy: Measuring Innovation in The Product Chain,* The Hague: Planbureau voor de Leefomgeving.

Rashid A., Asif F.M.A., Krajnik P., Nicolescu C.M. (2013) Resource Conservative Manufacturing: an essential change in business and technology paradigm for sustainable manufacturing. *Journal of Cleaner Production*, 57, 166–177. https://doi.org/10.1016/j.jclepro.2013.06.012

Rossi E., Bertassini A.C., Ferreira C., Neves do Amaral W.A., Ometto A.R. (2020) Circular economy indicators for organisations considering sustainability and business models: Plastic, textile and electro-electronic cases. *Journal of Cleaner Production,* 247, 119137. https://doi.org/10.1016/j.jclepro.2019.119137

Rukundo R., Bergeron S., Bocoum I., Pelletier N., Doyon M. (2021) A Methodological Approach to Designing Circular Economy Indicators for Agriculture: An Application to the Egg Sector. *Sustainability,* 13(15), 8656. https://doi.org/10.3390/su13158656

Saleh R., Ost C. (2023) Innovative business model for adaptive reuse of cultural heritage in a circular economy perspective. *International Journal of Entrepreneurship and Small Business,* 48(1), 39. https://doi.org/10.1504/IJESB.2023.10053086

Schneider S., Spieth P. (2013) Business Model Innovation: Towards An Integrated Future Research Agenda. International Journal of Innovation Management, 17(1), 1340001. https://doi.org/10.1142/S136391961340001X

Schulte U.G. (2013) New business models for a radical change in resource efficiency. *Environmental Innovation and Societal Transitions*, 9, 43–47. https://doi.org/10.1016/j.eist.2013.09.006

Schwager P., Moser F. (2006) The Application of Chemical Leasing Business Models in Mexico. *Environmental Science and Pollution Research – International,* 13(2), 131–137. https://doi.org/10.1065/espr2006.02.294

Souza G.C. (2019) Remanufacturing Business Models. In: *Remanufacturing in the Circular Economy* (ed. N. Nasr), New York: Wiley, pp. 61–84. https://doi.org/10.1002/9781119664383.ch3

Stahel W.R. (2010) *The Performance Economy,* London: Palgrave Macmillan.

Stubbs W., Cocklin C. (2008) Conceptualising a 'Sustainability Business Model. *Organization & Environment*, 21(2), 103–127. https://doi.org/10.1177/1086026608318042

Uvarova I., Atstaja D., Grinbergs U., Petersons J., Gegere-Zetterstroma A., Kraze S. (2020) Transition to the circular economy and new circular business models – an in-depth study of the whey recycling. *IOP Conference Series: Earth and Environmental Science*, 578(1), 012019. https://doi.org/10.1088/1755-1315/578/1/012019

Valencia M., Bocken N., Loaiza C., De Jaeger S. (2023) The social contribution of the circular economy. *Journal of Cleaner Production,* 408, 137082. https://doi.org/10.1016/j.jclepro.2023.137082

Van Ewijk S., Stegemann J.A. (2016) Limitations of the waste hierarchy for achieving absolute reductions in material throughput. *Journal of Cleaner Production,* 132, 122–128. https://doi.org/10.1016/j.jclepro.2014.11.051.

Villalba-Eguiluz U., Sahakian M., González-Jamett C., Etxezarreta E. (2023) Social and solidarity economy insights for the circular economy: Limited-profit and sufficiency. *Journal of Cleaner Production*, 418, 138050. https://doi.org/10.1016/j.jclepro.2023.138050

Wadod M.M., Mohammed F.G. (2023) Review on Drone application methodologies in agriculture precision. *IOP Conference Series: Earth and Environmental Science,* 1202(1), 012001. https://doi.org/10.1088/1755-1315/1202/1/012001

Wirtz B.W., Pistoia A., Ullrich S., Göttel V. (2016) Business Models: Origin, Development and Future Research Perspectives. *Long Range Planning,* 49(1), 36–54. https://doi.org/10.1016/j.lrp.2015.04.001

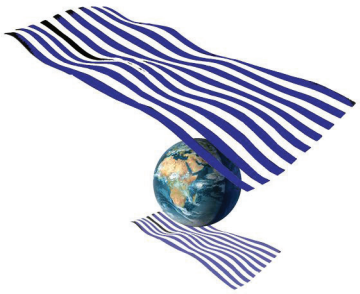
WEF (2014) *Towards the Circular: Accelerating the Scale-up across Global Supply Chains,* Geneva: World Economic Forum.

Yadav S.K., Kauldhar B.S., Sandhu P.P., Thakur K., Sucheta T., Sharma R. (2020) Retrospect and prospects of secondary agriculture and bioprocessing. *Journal of Plant Biochemistry and Biotechnology*, 29(1), 1–14. https://doi.org/10.1007/s13562-020-00550-3

Zhang M., Qin J., Tan H., Mao H., Tu X., Jian J. (2023) Education level of farmers, market-oriented reforms, and the utilisation efficiency of agricultural water resources in China. *Economic Change and Restructuring*, 56(6), 3927–3947. https://doi.org/10.1007/s10644-022-09474-5

Zucchella A., Previtali P. (2019) Circular business models for sustainable development: A 'waste is food' restorative ecosystem. *Business Strategy and the Environment,* 28(2), 274–285. https://doi.org/10.1002/bse.2216

ISSN 1995-459X



Вебсайт

Website

Загрузите в App Store

Download on the App Store

ДОСТУПНО В Google Play

GET IT ON Google Play