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INTEGRATING DYNAMIC CAPABILITIES AND SUSTAINABLE INNOVATION DESIGN IN BUSINESS TRANSFORMATION

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Purpose: The purpose of this paper is to determine to what extent sustainable innovation drives the transformation of enterprises toward sustainable development and to assess its impact on local communities.
Design/methodology/approach: The study employs a literature review and analysis of two bioeconomy case studies a model integrating dynamic capabilities (sensing, seizing, reconfiguring) with sustainable innovation design.
Findings: Early identification of market and social signals enables precise targeting of innovation efforts; stakeholder engagement from the conceptual stage strengthens acceptance and addresses local needs; and flexible reconfiguration of production and business processes minimizes unintended negative impacts while building lasting competitive advantage.
Research limitations/implications: The research is based on two case studies in the bioeconomy sector, which may limit the generalizability of the findings. Future research should include quantitative analyses and cross-industry comparisons.
Practical implications: The proposed model serves as a practical guide for managers to effectively align economic, social, and environmental objectives during the design and implementation of innovations.
Social implications: The paper emphasizes the need for continuous stakeholder dialogue and monitoring to enhance social acceptance and mitigate adverse effects on the surrounding community.
Originality/value: This paper introduces a novel model that embeds dynamic capabilities into each phase of sustainable innovation design, bridging strategic, local, and global perspectives.
Keywords: dynamic capabilities; sustainable innovation; business transformation; stakeholder engagement; socio-environmental effects.
Category of the paper: Conceptual paper.

1. Introduction

The last three industrial revolutions were largely driven by the development of technology and the elevation of procedures. The fourth revolution, on the other hand, marks a change focused on appropriately aligned capabilities and sustainable performance. Under these

circumstances, there is a growing need for companies to develop appropriately aligned dynamic capabilities for sustainable performance (Primc, Čater, 2015). The main challenge for companies in developing such dynamic capabilities is to balance the relationship between economic benefits and environmental responsibility, and ultimately to achieve the strategic goal of sustainability (Chan et al., 2017; Li et al., 2019; Nguyen et al., 2017) while taking into account social requirements.

Companies, therefore, are increasingly under pressure to grow and maximise profits from their shareholders and, on the other hand, under pressure from society in terms of ecology and responsibility for the products and services they produce. The relationship between the company and its environment is based on the implicit expectation that the company's negative impact on the environment is reduced at each stage of production (Tatić Kasim, Haračić, 2018). Therefore, it is important to match the given business operations and their volume to the existing environmental conditions, to rationally manage natural resources and produce products, to use products in a way that does not endanger the environment and society and, at the same time, to provide a competitive advantage (Wu et al., 2019).

In order to meet these demands and achieve long-term sustainability, companies take actions that stem from entrepreneurship, which translates into finding new solutions and creating innovation or new value in economic, social and environmental dimensions in addition to solving existing problems (Johnson, Schaltegger, 2019; Muñoz, Cohen, 2018; Sarango-Lalangui et al., 2018). Innovation therefore creates new practices and leads to changes in organisational structures and people's actions.

As it were, sustainable innovations should be the answer and solution to the above challenges. These have their roots in sustainable development and are based on the principles of ethical, social, economic and environmental sustainability. Similar principles can be seen in eco-innovation (Boons, Lüdeke-Freund, 2013; Hall, Clark, 2003; Rennings, 2000), in frugal innovation and engineering (Bhatti, Ventresca, 2012), and in the development of shared value thinking (Porter, Kramer, 2011), but the broader concept of sustainable innovation needs to be thoroughly refined. Especially in the area of local impact. The impact stage of an innovation is often overlooked in innovation research because an innovation is considered ready when it is implemented.

Furthermore, there is a general assumption that innovations are always useful, valuable and positive in nature. These characteristics cannot be verified without considering the impact of the innovation. An innovation could be an economic success but socially a disaster because of its impact on social practices. Some researchers have pointed out that it is possible for an innovation to be detrimental or uneconomic from an individual or social system perspective (Rogers, 2003; Rogers, Schoemaker, 1971). As the author's research has shown, a negative effect of innovation activity in the bioeconomy area is odour nuisance. Success in the environmental area, has not translated into success in the social sphere. The principle, think globally act locally, did not work. The result of the innovation in the social area was an odour

nuisance for local residents. Another example is the product innovation in the production of biopolymers, an innovative material with unique ecological characteristics. Production at scale can shake up the food market. On the one hand, it is an innovation that responds to ecological challenges, while on the other it addresses the difficult question of what is more important: food or ecology. All this means that the delight of sustainable innovation can be temporary if we do not establish design principles that take into account all stakeholders right from the innovation design stage.

The selection of two examples from the bioeconomy sector was deliberate and exploratory in nature—both cases were chosen for their significance to Poland's sustainable development strategy and their visible impact on local communities. The example of innovation in biopolymer production reflects the global dimension of the challenges associated with balancing ecological and food needs, while the example of innovation causing odor nuisance shows the complexity of local impacts. In this way, both studies capture the contrast between the "global" and "local" perspectives, which was key to developing the proposed model.

The bioeconomy was chosen as the area of analysis due to its growing importance in sustainable development strategies at both the European and national levels. This sector combines three key perspectives:

- global – through innovations such as biopolymers, which respond to global environmental challenges,
- local – through projects related to bio-waste management, the effects of which are felt directly in communities,
- strategic – as an area for testing and implementing the dynamic capabilities of enterprises in the context of the transition to sustainable development.

As a result, the bioeconomy is a unique example of a sector in which the tensions between global trends and the local consequences of innovation are clearly visible. The following table presents a comparative analysis of two cases in the context of dynamic capabilities.

Table 1.
Comparative analysis

Criterion / Dimension	Case A: Biopolymer innovation	Case B: Innovation in bio-waste management (odour nuisance)
Sensing (signal recognition)	Early identification of global trends in ecology and the demand for alternatives to plastics.	Identification of local needs related to organic waste management.
Seizing (exploiting opportunities)	Investment in the development of a new material with unique ecological properties; commercialization on the international market.	Implementation of an innovative technological process on a local scale, supported by environmental policy.
Reconfiguring (transforming resources)	Adaptation of production lines to biopolymer production; creation of new partnerships in the supply chain.	Reorganisation of waste management processes; insufficient adaptation to social sensitivity.
Economic effect	Potential opening of new markets and sources of revenue; risk of disruption in the food market.	Reduction of waste storage costs; limited profitability in the absence of social acceptance.

Cont. table 1.

Environmental effect	Reduction of CO_2 emissions by replacing conventional plastics with biopolymers.	Positive environmental effects (waste reduction), but accompanying odor nuisance reduces environmental value.
Social effect	Positive global image of the company; controversy over priorities (food vs. ecology).	Negative impact on the local community (nuisance effect); reduction of social acceptance of innovation.

With these assumptions in mind, the main objective of the article will be to determine to what extent sustainable innovation is a factor influencing the transformation of companies towards sustainability. A second complementary research objective will be to determine the impact effect of sustainable innovation. It will therefore be crucial to answer the following questions:

1. How companies shape sustainability policies: whether based on individual sustainable innovations or whether these actions are directed towards a strategic direction of sustainable transformation activities.
2. Whether sustainable innovation is instrumentally used consistently with the organisation's strategy, as well as whether it influences stakeholder engagement and who participates in the design process.
3. To what extent sustainable innovation impacts on the local community.

2. Transforming access to technology into green business practices: dynamic capabilities as an engine for sustainable development strategies

The rapid advances in technology over the past few decades have dramatically improved organisational efficiency, but at the same time created higher expectations for making business operations more sustainable (Ruiz-Mercader et al., 2006). Furthermore, unlike in the past, when only a few organisations had access to the latest technologies, today organisations have relatively wide access to technology (Chen et al., 2019). However, this state of affairs has led them to be sceptical of technology investments, as these do not achieve sustainable competitive advantage (Dubey et al., 2019).

Hence, the way to achieve this advantage seems to be through achieving sustainability by implementing green practices in strategy. Recent research findings indicate that companies can achieve a competitive advantage if they meet economic, social and environmental requirements (Jabbour et al., 2018). Its sustainability in turn depends on business operations (Pfeffer, 2010), which are largely driven by purpose and strategy. Green and transparent business practices are also crucial for developing adequate dynamic capabilities, which, properly developed, can ensure the sustainability of performance. Hence, researchers argue that business practices and performance are closely linked and influence organisational sustainability (Gupta et al., 2020).

The last three industrial revolutions were largely driven by the development of technology and the elevation of procedures (Gupta et al., 2020). The fourth revolution, on the other hand, marks a change focused on the right fit between capabilities and sustainable performance. According to Lin and Chen (2012), the initial application of these capabilities may be more expensive, but in the long run they will strengthen the organisation's structure and give it a competitive advantage. In these circumstances, there is a growing need for companies to develop dynamic capabilities that are properly aligned with sustainability (Primc, Čater, 2015).

Dynamic sustainability capabilities refer to the ability of firms to sense, acquire and reconstruct internal, and external organisational resources, including ecological (green) and technological resources, to cope with changing business environments and through the primary path - dependency and creation of new organisational resources and strategic practices (Eisenhardt, Martin, 2000; Wohlgemuth, Wenzel, 2016). These capabilities actively support circular strategies and ecological innovation practices in turbulent business environments and are one source of competitive advantage for firms (Dangelico et al., 2015).

The main objective of companies in developing this type of dynamic capability is to balance the relationship between economic benefits and environmental responsibility, ultimately achieving the strategic goal of sustainable development (Chan et al., 2017; Li et al., 2019; Nguyen et al., 2017).

The literature points out that there is a link between dynamic capabilities in the area of sustainability and innovation. For example, dynamic capabilities have been found to actively influence an organisation's green behaviour (Huang, Li, 2017). The dynamic capabilities of organisations dedicated to sustainability are not homogeneous. In their structure, one can distinguish between the ability to sense the environment, the ability to capture resources and the ability to reconfigure resources.

Environmental sensing capability can determine the future direction of a business by identifying and managing potential opportunities (or risks) in the current business environment (Teece, 2010). Environmental sensing capability requires businesses to identify opportunities (or risks) and exploit them by re-allocating organisational resources according to their strategic needs. This capability can be seen as most closely related to dynamic capability (Hartman et al., 2017). In particular, it refers to companies that are able to identify future development trends in their business environment through data collection (Salunke et al., 2019). This information includes information related to green customer preferences, market demand and the development of clean technologies.

The ability to capture resources enables a commercial growth strategy. Businesses need to assimilate and learn from the data, information and experience that creates and maintains a competitive resource base (Teece, 2010). On the one hand, the acquisition of resources highlights which information is worthy of being used by the enterprise, i.e. which has the greatest value (Dangelico, 2016). In addition, this capability requires the firm to use the newly acquired technological information for its routine activities, e.g. through the technology

commercialisation process. In summary, this capability can be defined as a firm's ability to absorb green growth-related information and use it for its technology commercialisation activities.

In turn, the ability to reconfigure resources enables a firm to maintain its competitive advantage in the market after successfully sensing and exploiting the opportunities (or risks) that exist in the business environment (Wang, Ahmed, 2007). However, the key to sustainable competitive advantage is having the ability to reconfigure resources as the firm grows and the environment changes (Lin, Wu, 2014). In this context, firms need to reconfigure resources to remain adaptable to the external business environment and, if obstacles arise, adopt alternative ways of business development.

In this strand, it is legitimate to pay attention to sustainable innovation. Taking the right perspective when analysing the idea of sustainable innovation, Boons, Montalvo, Quist and Wagner propose a general explanation stating that a sustainable innovation is an innovation that improves sustainability performance in terms of environmental, economic and social criteria (Boons et al., 2013, p. 4). In a similar vein, Bos-Brouwers and Calik and Bardudeen argue that a 'sustainable' innovation can be called an innovation where improvements in products, services, technological or organisational processes commercialised or implemented internally not only improve economic performance. but also improve environmental and social performance. In this way, both in the short and long term, sustainable innovation can generate positive social and environmental impacts (Bos-Brouwers, 2010; Horbach, 2005; Calik, Bardudeen, 2016). Furthermore, Tello and Yoon particularly emphasise the concern for resource use, pointing out that sustainable innovation can be defined as new products, processes, services and technologies that contribute to the development and well-being of human needs and institutions by respecting worlds.

In other words, the term 'sustainable innovation' refers to new products and processes that use fewer environmental resources, promote human health and are affordable for both consumers and producers. Secondly, the aforementioned author argues that sustainable innovation is also about building an organisation capable of maintaining the pace of innovation for several years (ten or more). He offers his second explanation with the observation that a single innovation will not support a company or cause fundamental changes in an industry (Hargadon, 2015). An interesting point of view is presented by Dyck and Silvestre, who distinguish between 'sustainable innovation 1.0' and 'sustainable innovation 2.0'. According to the aforementioned authors, the term 'sustainable innovation 1.0' refers to innovations that aim to both reduce the negative socio-ecological externalities of an organisation and enhance its financial interests. On the contrary, they describe as 'sustainable innovation 2.0' innovations that are driven by the social and environmental benefits they will bring. In other words, Dyck and Silvestre emphasise that the ultimate goal of 'sustainable innovation 2.0' is to improve overall social and environmental well-being. This type of innovation enables organisations to enhance positive socio-ecological externalities while maintaining financial viability, but without maximising financial returns (Dyck, 2018).

3. The complexity of sustainable development and the need for sustainable innovation

Sustainability is a complex issue and, despite many studies and publications in recent years, remains poorly recognised (Ramcilovic-Suominen, Pulzl, 2018; Johnson, Schaltegger, 2019; Muñoz, Cohen, 2018). Achieving the Sustainable Development Goals under the 2030 Agenda for Sustainable Development for the production and consumption of safe and healthy food and promoting sustainable business practices depends on research and innovation (Schutte, 2018). Therefore, the transition to a sustainable economy requires investments in technology, new business models and social and environmental innovations that help shape new business trends (Zilberman et al., 2018).

In order to achieve long-term sustainability, companies undertake actions driven by entrepreneurship, which translates into finding new solutions and creating innovation or new value economically, socially and environmentally in addition to solving existing problems (Johnson, Schaltegger, 2019; Muñoz, Cohen, 2018; Sarango-Lalangui et al., 2018). Sustainability has been one of the drivers of innovation. Nidumolu, Prahalad and Rangaswami (2009) argue that there is no alternative to sustainability, and this principle has challenged companies to develop products and services for new cleantech markets, for better life-cycle control of products and services, for the use of recycled materials to increase energy efficiency and improve quality of life.

The relationship between the company and its environment is based on the implicit expectation that the company's negative impact on the environment is reduced at each stage of production (Tatić Kasim, Haračić, 2018).

Therefore, it is important to match the given business operations and their size to the existing environmental conditions, to rationally manage natural resources and produce products, to use products in a way that does not endanger the environment and society and, at the same time, to ensure competitive advantage (Wu et al., 2019). On the other hand, in order to meet demand, enterprises are producing more and more products, which in turn entails the need for more resources, materials, energy, water, fuel and other consumables necessary for production purposes.

The increased consumption and the huge number of new products appearing on the market each year, combined with the reduced life span of products, translates into increased consumption of raw materials, energy and more solid waste generated by agglomerations and other residential areas. Companies are therefore increasingly under pressure to grow and maximise profits from shareholders and, on the other hand, pressure from society to be environmentally friendly and responsible for the products and services they produce.

The solution may lie in sustainable innovation, rooted in sustainability, which is based on the principles of ethical, social, economic and environmental sustainability. Similar principles can be seen in eco-innovation (Boons, Lüdeke-Freund, 2013; Rennings, 2000), in frugal innovation and engineering (Bhatti, Ventresca, 2012), and in the development of shared value thinking (Porter, Kramer, 2011), but the broader concept of sustainable innovation needs to be thoroughly refined.

One of the challenges in innovation design is the impact stage, which is often overlooked in innovation research because an innovation is considered ready when it is implemented. In addition, there is a general assumption that innovations are always useful, valuable and of a good nature. These characteristics cannot be verified without considering the impact of the innovation. An innovation could be an economic success but socially a disaster because of its impact on social practices.

Some researchers have pointed out that it is possible for an innovation to be harmful or wasteful from an individual or social system perspective (Rogers, 2003; Rogers, Schoemaker, 1971), but the given nature of the innovation requires further research. When considering sustainable innovation, it can be argued, following Zeng et al. that this is difficult to achieve within a single organisation (Zeng et al., 2017). The aforementioned authors emphasise the need for sustainable innovation ecosystems created by continuous interactions between organisations, policies, society and the environment. Finally, some authors identify sustainable innovation as a concept consisting of several approaches to sustainability-related (sustainability-oriented) innovation, such as green innovation, eco-innovation, environmental innovation, bottom-up innovation, socially responsible innovation, etc. In business, innovation was created by the need to create superior competitiveness in the market. This has traditionally been achieved through two basic strategies: cost-cutting or creating products that are better than those of competitors (i.e. cost leadership or differentiation strategies) (Porter, 1980).

Sustainable innovation offers a third competitive strategy: creating products or processes with market-demanded characteristics such as sustainability, localisation or material and energy efficiency (Rennings, 2000). As consumers demand sustainable products and services and are willing to pay more for them, the market for sustainable innovation is growing. Sustainable innovations help customers and citizens manage their lifestyles, enabling them to live happier lives in ways that support sustainability. Sustainable innovation is the foundation of future business. The tasks that sustainable innovation serves are of global importance, but they start with the local community.

4. Final conclusions

Social pressures, concerns about resource depletion and legislation are driving companies to make the transition towards sustainability. An example of this is the chemical industry, which is hardly identified with a sustainable approach, yet has projects that are firmly in the sustainability strand, such as the conversion of glycerol to biopolymers. It is therefore crucial that attention is paid to the need for companies to develop dynamic capabilities that are properly aligned with sustainability. These capabilities refer to the ability of companies to sense, acquire and reconstruct internal, and external organisational resources, including environmental (green) and technological resources, in order to cope with changes in the business environment and through the primary path - dependency and creation of new organisational resources and strategic practices.

As indicated in the rationale for addressing the research problem, the impact phase is often overlooked in innovation. It is therefore necessary to determine the impact of an innovation taking into account the sustainability triad, i.e. the economic, environmental and social aspects. To this end, it is necessary to take into account all stakeholders (the quadruple helix). This will appeal to the gap signalled in the literature, about the need to create sustainable innovation ecosystems created by continuous interactions between organisations, policies, society and the environment.

The quadruple helix model (science – business – administration – civil society) allows us to capture the systemic nature of sustainable innovation. Incorporating this approach into the analysis emphasizes that:

- the ability to sense market and social signals is supported by cooperation with science and citizens,
- the ability to seize opportunities requires the involvement of business and public administration, which create regulatory and financial conditions,
- the ability to reconfigure resources is made possible by cooperation in networks involving various stakeholder groups.

The integration of the quadruple helix with the dynamic capabilities framework indicates that true sustainable transformation requires not only internal organizational efficiency, but also openness to cooperation within the innovation ecosystem. It is also crucial to treat sustainable innovation as a solution that responds to the local situation and the interests and values of the communities involved. There is an assumption that grassroots initiatives operate in the civil society arena and involve committed activists experimenting with social innovations as well as using greener technologies. This makes it possible to identify future customer needs. This will allow us to develop objective criteria for sustainable innovation.

It also makes sense to establish a so-called renewed balance between local and global approaches, i.e. a balance between local and global activities. If global trends influence local activities, but local or regional organisations do not have the capacity to influence these trends, alienation of these organisations can occur. So local solutions should be stimulated where possible and useful.

The above considerations can contribute to further research and will allow a better understanding of the mechanisms of the organisation.

They will enable the development of knowledge in the transformation of businesses towards sustainability. and the concept of dynamic capabilities in sustainability. The research will allow the adaptation of the concept of measuring dynamic capabilities, in terms of: the ability to sense the environment, the ability to capture resources, the ability to reconfigure resources.

In addition, traditionally the understanding of competitive advantage has consisted of two basic strategies: a cost leadership strategy or a differentiation strategy. The development of research in this area will advance the knowledge of sustainability-based strategy and the understanding of the extent to which strategy should reflect the variability and dynamics of the environment

It should also be noted that the public's high awareness of ecology makes consumers demand sustainable products and services. Further research will develop knowledge in the design of innovations taking into account all stakeholders. This will allow for a better understanding of the needs of the audience and thus negate the negative effects of innovations.

The case studies analyzed show that the success of sustainable innovations largely depends on the quality and nature of interactions with stakeholders:

- in the case of biopolymer innovation, cooperation with industry organizations, scientific institutions, and partners in the value chain was crucial, enabling both commercialization and social and environmental acceptance of the product;
- in the case of innovation in biowaste management, contacts with local authorities and neighboring communities were important; however, a lack of sufficient communication and participatory activities led to a decline in social acceptance, despite a positive environmental balance.

In conclusion, carrying out research in this area will contribute to the development of the scientific field, especially under the dynamic conditions of the fourth industrial revolution, which very much influences the need to redefine organisational structures in relation to a sustainable model of business management, defining strategic objectives based on the concept of sustainability and complementing innovation creation processes with stages relevant to all stakeholders, maintaining a balance of economic, social and environmental aspects.

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