energies

MDPI

Article

Stakeholders of the Multimodal Freight Transport Ecosystem in Polish–Czech–Slovak Cross-Border Area

Marzena Kramarz, Lilla Knop, Edyta Przybylska and Katarzyna Dohn *

Faculty of Organization and Management, Silesian University of Technology, Roosevelt 26–28 Str., 41-800 Zabrze, Poland; marzena.kramarz@polsl.pl (M.K.); lilla.knop@polsl.pl (L.K.); edyta.przybylska@polsl.pl (E.P.)
* Correspondence: katarzyna.dohn@polsl.pl; Tel.: +48-32-277-73-39

Abstract: The research on the multimodal transport development within the cross-border area is a result of identified gaps in the system solutions and cooperation between stakeholders of three countries: Poland, the Czech Republic and Slovakia. Freight transport is an especially complex problem. It is an area that is not comprehensively recognized in the context of cross-border cooperation. The results of the research presented in this paper are the continuation of analyses performed within the scope of the international project framework TRANS TRITIA. At the moment, transport policy assumes the struggle for the utilization of multimodality within freight transport. This is justified by the need to reduce external transport costs. At the same time, this necessitates actions of a technical, organizational, and legislation nature as well as cooperation between stakeholders. The multimodal transport ecosystem is a vision of the transport within cross-border areas that assumes the increase in the flow dynamics within the multimodal transport. The main goal of this paper was the stakeholders' analysis and identification of their roles in the ecosystem of multimodal freight transport within the Polish–Czech–Slovak cross-border area. The conceptualization of the multimodal freight transport ecosystem was essential to achieving the objective. To achieve the objective, a stakeholder analysis has been performed based on expert research. As a result of the research, organizational projects have been proposed to strengthen the idea of the coevolution of the multimodal transport ecosystem. The key conclusion from the performed research is the declaration that a holistic view of the multimodal transport ecosystem necessitates the appointment of a coordinator who will synchronize knowledge, business, and innovation ecosystems.

Keywords: ecosystem; multimodal transport; stakeholders; coordinator; cross-border area

Citation: Kramarz, M.; Knop, L.; Przybylska, E.; Dohn, K. Stakeholders of the Multimodal Freight Transport Ecosystem in Polish–Czech–Slovak Cross-Border Area. *Energies* **2021**, *14*, 2242. https://doi.org/10.3390/en14082242

Academic Editors: Amela Ajanovic and Vincenzo Bianco

Received: 24 February 2021
Accepted: 13 April 2021
Published: 16 April 2021

1. Introduction

According to the report of the Global Multimodal Freight Transportation Market (2020–2025) " ... with the increasing global economic integration, the sustainable development of the world economy and society needs the support of an efficient freight transportation system. By relying on two or more modes of transportation, multimodal transport can substantially improve transport efficiency and reduce transportation costs for the complete process integration organization transportation service. According to statistics, multimodal transport can improve transportation efficiency by 30%, reduce cargo damage by 10%, reduce transportation costs by 20%, reduce highway congestion by more than 50%, and promote energy savings and emissions reduction by more than one-third" [1]. The assumptions of the White Paper focus on the same guidelines; however, their implementation is not easy [2]. Considering the growing interest in multimodal transport, it is necessary to realize the problems and methods to overcome the most important challenges related to multimodal transport management. Problems emerging within cross-border areas become even more important in this case [3]. In this regard, the European Grouping of Territorial Cooperation TRITIA, including the Moravian–Silesian region in the Czech Republic, the Silesian Voivodeship in Poland, and the self-governing region of Žilina in Slovakia, undertook the research under the TRANS TRITIA project aimed

at increasing awareness of the problems of freight transport and improving cooperation between regional authorities responsible for shaping the regional transport policy. The TRANS TRITIA project focused on cross-border, trans-national and interregional cooperation to strengthen economic and social cohesion and achieve the objective specified in the strategy "Europa 2020" [4], Towards a Sustainable Europe by 2030 [5] and White Papers EU [2]. Activities undertaken within the scope of the international cooperation were aimed at developing a multimodal transport development strategy that focused on creating an ecosystem facilitating a noticeable increase in flow performed within multimodal transport frameworks [6]. Taking into account the results of the project and the formulated vision, the authors undertook further research on the stakeholders of such an ecosystem.

Within the last two decades, the ideas of ecosystems have become more important for organizations, especially due to the increased demand for complex, integrated solutions that require from companies the integration of knowledge, resources, and opportunities of various companies, sectors and fields [7–9]. Such increased demand, in combination with the recent advancements in information technology or the Internet-of-Things (IoT), used the opportunity of cocreating the value of companies from different sectors [10,11]. Understanding the ecosystem is understanding its limits. This paper assumes a differentiation between ecosystems based on ecosystem objectives and stakeholder roles who can be treated as a common benchmark. The Valkokari concept was used in the research, which was focused on three different types of economic ecosystems: business, innovation, and knowledge. It was assumed that at their junction, the actors of the ecosystem are able to continuously produce new results, combining artefacts, skills, and ideas as well as various business results, innovation, and knowledge [12]. The adopted approach is justified by the complexity of the multimodal transport ecosystem. Interactions between stakeholders in the business ecosystem oriented to economic results and business relations assume sharing the logistics infrastructure for the growth of added value generated by multimodal transport. The innovation ecosystem should focus on co-creating innovation in multimodal transport and the knowledge ecosystem on creating new knowledge and its exploration within the scope of freight flows within cross-border areas.

The objective of the research was the stakeholders' analysis and identification of their roles in the ecosystem of multimodal freight transport within the Polish–Czech–Slovak cross-border area. The conceptualization of the multimodal freight transport ecosystem was essential to achieving the objective. Thus, this paper begins with the analysis of contemporary approaches in the field of ecosystems, especially knowledge, business, and innovation ecosystems. In these ecosystems, particular attention has been focused on stakeholders and their roles. The assumptions of ecosystems were also searched for in the literature in the area of multimodal transport. The research methodology is then discussed, indicating the impact of the results of the TRANS TRITIA project on the research proposed in this paper.

The results of the research on multimodal transport development obtained within the TRANS TRITIA project have led to the preparation of a strategy for the development of multimodal freight transport in the TRITIA cross-border area and detailed action plans: cross-border action plans and sectoral action plans (railway, inland waterways, intermodal logistic terminals). The results of the project work became an inspiration to further research on developing the formulated vision of the multimodal transport ecosystem, that is: creating an ecosystem for multimodal freight transport in the Tritia area. The holistic ecosystem model was based on the Valkokari concept. It has been extended to the study of stakeholders, leading to the determination of their role within the ecosystem. As a result, this article indicates the objectives of ecosystems, identifies the stakeholders of individual ecosystems, assigns them a role, and determines the relationship of the leader towards each of the stakeholders. Detailed research questions are given in the methodological part of the paper. Among the methods used, apart from literature analyses, stakeholder analyses were used, which were based on expert assessments. In addition, during the workshops with experts, the specific objectives of ecosystems (business, knowledge and innovation)

were defined, the roles of stakeholders in the ecosystem were discussed, and the project proposals necessary to implement the adopted vision in the TRITIA cross-border area were verified.

2. Theoretical Background

2.1. Ecosystems in Economy, Its Components and Features

The concept of "ecosystem" has its origin in the biological sciences and is defined as a system composed of animate and inanimate components in different relations with each other [13]. According to the biological sciences assumptions, ecosystems are dynamic, continuously changing, reacting to natural disruptions, and competing also between species and co-evolving [14–17].

Many researchers have compared and discussed the similarities and differences between biological ecosystems and ecosystems in the economy [18–20]. J. Moore was the first to use the term ecosystem in economy. According to his approach, the business ecosystem is: "an economic community supported by a foundation of interacting organizations and individuals—the organisms of the business world" [21]. Knop and Odlanicka-Poczobutt underline that from economic and social standpoints, one may perceive an ecosystem as a multistage, multimodal, multinodal, and multiagent system of systems that on the one hand consists of planned, specified elements and relations between them and on the other it lives its own life, depending on the activity of current and new actors, it is open to experimenting and creating new ideas and concepts as well as searching for distinguishing domains and values that because of the developed relations will differentiate ecosystems and its entities [22]. Moreover, alike in biological systems, ecosystems can be affected by legal regulations, social standards, or ethical principles. It is noticed that ecosystem rules result from co-evolution and interactions between participants [17]. Studies over ecosystems have led to many papers that within the past two decades allowed for the development of this issue in economic practice [23–25].

When defining an ecosystem, its key elements are distinguished. Based on the basic definition of an ecosystem, it is possible to distinguish a set of organization—actors (biocenosis), connected by relationships thanks to the infrastructure (i.e., a biotope), among which there is the flow and exchange of knowledge, energy and matter circulation. This allows assuming that the studied ecosystems characterize with an inherent structure that includes specified relations [23]. The ecosystem actors include companies and other organizations that are keystones and are responsible for the directions and strategic development of the whole ecosystem. They are part of the ecosystem, meaning that they benefit from the ecosystem and are the initiators of changes and are responsible for their spreading within the ecosystem [26]. At the same time, decisions about creating and shaping relationships within the ecosystem (both inside the ecosystem and with outside entities) directly affect other members of the ecosystem. As a consequence, ecosystem members show an increased inclination for cooperation, strengthening the effect of knowledge transfer between the actors. A factor that integrates the ecosystem is the flow of assets both tangible (e.g., products) and intangible (know-how, finance, information) [23]. Moreover, organizations perceive the ecosystem as a place or opportunity to gain benefits resulting from the economy of scale, outreach, time, synergy, and flexibility. In the ecosystem, organizations co-create and develop their potential work together, compete and cooperate at the same time, implement new generation innovations, etc. [21,27]. Within the scope of ecosystems, standards (technical, technological), norms, and know-how are developed that are recognized and used by many organizations [28,29]. This allows for the common development of key skills that become the grounds for creating a competitive edge because of the learning ecosystem. Strategic directions for the whole ecosystem, based on co-evolution principles are identified using the skills [27]. Isenberg [30] says that each ecosystem has specified features. Different types of ecosystems have both specific features conditioned by socio-economic and cultural factors related to the environment they are part of as well as some common features. The literature review allowed for determining typical ecosystem features: (1) a large number

of different organizations, (2) mutual relationships and interdependencies, (3) common potential of knowledge and skills, (4) dynamic coevolution [26,31–37]. Ecosystems should be self-sustainable and develop through self-organization, emergence, and co-evolution that result in adaptation abilities [31,38]. However, Sako [39] defined three meta-features of ecosystems, i.e., (1) balance, meaning that the ecosystem can develop without the external impact or support, (2) self-governance, meaning that the ecosystem is neither dependent on an external forces nor controlled by one dominating actor in the ecosystem, (3) evolution, meaning the ability of the business ecosystem to evolve through competition and experiments. The conceptualization of the multimodal transport ecosystem includes the features mentioned by the authors.

2.2. Types of Ecosystems

An ecosystem evolves together with the changing environment through the dynamic optimization of complementing opportunities, resources, and actors [40]. There are many types of them depending on the active actors, relations between them, types of flow, and especially objectives the ecosystems serve for. As a result, the ecosystems of innovation, start-ups and entrepreneurship appeared next to the business ecosystem. According to the research [22,41], most papers (acc. to database, WoS and SCOPUS) are registered about innovation, business and entrepreneurship ecosystems. Another type of ecosystem that is often distinguished is the knowledge ecosystem, next to the corporate ecosystem, the SME ecosystem, the cluster ecosystem or the start-up ecosystem. Objectives have special meaning in specifying the type of ecosystem and their boundaries may be determined based on the relationships of cooperation and competition of the engaged entities, geographical outreach (local vs. regional or national vs. global), time scale (from history to future or statistical clips) or types of flow (knowledge, value, material) [42–44]. Clarysse et al. [37] differentiate the knowledge and innovation ecosystem using a few criteria, i.e., objectives, relationships and actors. Pilinkiene and Maciulis [45] use the type of environment, actors, micro and macro results, and key success factors to differentiate industrial, innovation, business, digital and entrepreneurial ecosystems. Valkokari [12], based on similar criteria, identifies three different types of ecosystems: business, innovation, and knowledge. Scaringella and Radziwon [46] as well as Aarikka-Stenroos and Ritala [47] differentiate business, innovation and entrepreneurial ecosystems and focus on geographical aspects and economic problems. The approach proposed by Valkokari who has differentiated three ecosystem types: business, innovation, and knowledge, was used in the paper.

Discussions on ecosystems causes knowledge to grow, including the emergence and exploration of different types of ecosystems that at the same time overlap [46], intertwine [12], and are interdependent [48].

The key assumption, defining the business ecosystem, adopted by J. Moore, was the perception of a company not as a member of one sector but as a part of the business ecosystem that crosses different sectors [27]. Therefore, business ecosystems create large, loosely related networks of entities. Key actors of the business ecosystem include business partners, competitors, clients, government institutions, and other important stakeholders [49,50]. The concept of business ecosystem evolved [51], showing that business ecosystems have a dynamic structure that include cooperating organizations, e.g., universities, research centers, etc. [38]. The efficiency of entities, organizations composing business ecosystems, depends not only on their own competences but on interactions with different entities and conditions of the whole ecosystem [52]. Boundaries of the ecosystem are determined by the relationships of cooperation and competition, the development of which is based on the struggle for the implementation of business objectives such as production operations, customer service, or innovation generation [21]. In the opinion of Adner [23], the business ecosystem is "the alignment structure of the multilateral set of partners that need to interact in order for a focal value proposition to materialize". That is why, so as not to lose the ecosystem perspective, companies and their representatives must define, gather, analyze, and disseminate information on the ecosystem concerning "partners, competitors, prod-

ucts, and any aspects of the environment necessary to support strategic decision making by organizations" [53]. Business ecosystems underline the idea of society, often related to a given geographical region and the creation of society protection mechanisms against attacks [54], which in fact derives from natural ecosystems.

Another type of ecosystem, most frequently defined in the literature, is the ecosystem of innovation. Its concept is based on the business ecosystem idea; however, it differs from it in that it has defined innovative objectives and associated risks in creating value [55]. Chesbrough [56] says that an ecosystem is a way to obtain knowledge in the context of open innovation. Adner defines the innovation ecosystem concept in the context of implementing breakthrough innovations within the whole sector. In this definition, an ecosystem means consideration of the level of maturity of all players: suppliers, recipients, clients, and competitors in the process of creating value for a client and determining the maturity of the sector for the dissemination of innovation [23]. However, the basis of the innovation ecosystem was the concept of the national innovation system [57]. This approach is developed by Stanford University, which defines the innovation ecosystem as the interorganizational, political, economic, environmental, and technological systems of innovation through which a milieu conducive to business growth is catalyzed, sustained and supported. An innovation ecosystem is a network of relationships through which information and talent flow through systems of sustained cocreation [58]. It is characterized by the atmosphere and conditions for creating innovations and the ability for self-improvement. It generates coordinated activities strengthening elements and internal relations, and on the other hand, it gains resources and develops relationships to a larger scale, and skillfully uses its assets and advantages over others [59].

Key actors of the innovation ecosystem include research institutions, incubators and accelerators, angel investors, venture capitalists, private equity firms, government, civil society organizations, development agencies, professionals (human capital), start-ups and enterprises, market facilitators and intermediaries, and private companies. An important role in innovation ecosystems is played by governments, the impact of which can be of top–down structure in the form of, e.g., donations for research and technology commercialization process support, the creation of top–down mechanisms that enable interactions between universities and industry (most of the European Union members, Japan) and bottom–up (USA or UK) where the rules based on competition are created to grant an opportunity to create different connections, networks among universities, entrepreneurs, accelerators, high risk capital, large companies and experts. Another important actor of the innovation ecosystem is universities and research institutes that are the initiators of innovative actions. To ensure development, it is important to achieve a proper level of entity diversification. According to Katz and Wagner, the innovation ecosystem is similar to the Innovation District concept. Brooking Institution defines the Innovation District as "geographical areas wherein leading institutions and firms concentrate and combine with start-ups, business incubators and accelerators" [60]. The successful Innovation Districts (Boston, Barcelona, Cambridge, Seattle) appear in the areas of suitable combination of economic assets (universities and research institutes), physical assets (transport and infrastructure of buildings), and network aspects (formal/informal concerning the exchange of knowledge and cooperation). A similar definition has been presented by Klimas and Czakon in their deliberations: an innovation ecosystem as a cooperation environment surrounding the innovation activities of its co-evolving actors, organized across co-innovation processes, and resulting in the co-creation of new value delivered through innovation [61]. Knowledge on the innovation ecosystem is being continuously developed, as expressed by studies performed within international teams [62–64].

The main result of the knowledge ecosystem is "new knowledge". It can be shaped by identifying network nodes where the knowledge is created and kept [65]. In other words, the main objective of knowledge ecosystems is exploration, but not exploitation. Open-source societies are a well-known example of this type of ecosystem based on knowledge exchange [66,67]. Knowledge ecosystems are emerging collectives in which actors

such as universities, public research institutions, and for-profit firms collaborate to create new knowledge in a precompetitive setting [12,37,68,69]. Individual organizations are specialized and each one of them has a special role in creating the value and structure of the ecosystem. The knowledge ecosystems focus on generating new knowledge, therefore research institutes and innovators, such as technological entrepreneurs, play a centralized role in these ecosystems. A special role in the knowledge ecosystem is played by universities that by performing basic and applied research are the stimulator for creating new products and technologies, an analytical center for strategy and government regulations, suppliers of a qualified labor force in the industry and society as well making a valuable contribution to the society.

2.3. Ecosystem Stakeholders

As it results from the presented deliberations, the key component of the ecosystem is its actors who determine the objectives implemented by the ecosystem and the kind of flows they are dealing with, how the system co-evolves, etc. Actors play an active role in the ecosystem [70]; however, their assessment during project implementation identified the necessity to also cover passive actors, e.g., society, in the research. That is why the paper is related to wider studies that include wider groups—ecosystem stakeholders. The role of stakeholders in ecosystems has been studied for a few decades and the concept of stakeholders itself was formulated in the mid-1980s by R.E. Freeman [71,72] and is related to units or groups that may affect the operations of organizations or are subject to the impact of actions taken by organizations.

As shown in current deliberations, the role of stakeholders in the ecosystem is undeniable. Ecosystems are economic societies supported by a group of cooperating organizations and persons. It produces goods and services valuable for clients who are part of the ecosystem themselves. Stakeholders include suppliers, leading manufacturers, competitors, scientific units, business-related institutions, governments, and self-government. In time, stakeholders change their abilities and roles and have the tendency to adapt to directions determined by one or a few leaders [73]. Organizations playing the leading role may change in time, but the function of the ecosystem leader is valued by stakeholders, because it allows the members to follow the path of common vision to adapt their investments and find mutually supporting roles. Analyses of stakeholder roles in ecosystems are the subject of many studies. The selected ones have been synthetically presented in Table 1.

Table 1. Role of stakeholders in the ecosystem.

Authors	Roles	Description
Iansiti and Levinen, 2004	Keystone	Provides a stable and predictable set of common assets (e.g., a platform) that other actors use to build their own offerings.
	Dominator	Control a large part of the ecosystem and take most of the value for themselves, while leaving little for other companies.
	Niche player	Develops specialized capabilities that differentiate it from other companies in the network.
Bosch-Sijtseemaa and Bosch, 2015	Keystone	Central player in the ecosystem that provides a platform.
	Dominator	Major players in the development of the platform.
	Complementor	Develops complementary innovations, e.g., apps toincrease in value on an existing platform.
	Integrator	Integrates multiple elements and complements from multiple actors.
Adner 2017	Leader	Shapes the ecosystem by designing the alignment structure and sets the governance rules and timings.
	Follower	Agree to act in accordance with the leader's plan.
Dedehayir et al., 2018	Leader	Conducts activities related to ecosystem governance, platform management,, value management and forging partnerships.
	Direct Value Creators	Suppliers, assemblers, complementors, and users that are directly associated with value creation.
	Value Creator Supporters	Provides peripheral supporting elements that facilitate the value creation process.
	Entrepreneurs	Entrepreneurs, sponsors, and regulators that facilitate and support the creation of an ecosystem.

Source: [23,31,74,75].

The role of stakeholders in creating ecosystems is undoubted; however, the assessment of their engagement is complex [70,76,77]. This means that the inclusion of many interested parties in the process of creating and coordinating the ecosystem may be difficult. Gathering stakeholders representing sometimes conflicting opinions may lead to never-ending discussions and poor results, at least within a short period of time. Similar conclusions have been presented by Kaufmann [78] and Schippl et al. [79] when studying stakeholders in complex systems of multimodal transport.

2.4. Multimodal Transport within the International Space

According to the World Trade Organization, globalization and international trade ensure long-term relationships between economies, wherein a single entity has the opportunity to influence the management of an element from different economies [80]. This way, globalization allows the organization to gain international experience. Regardless of this, international trade or globalization cannot be implemented without transport.

However, the dynamic development of transport has become an important source of problems in local scale, especially in large urban agglomerations. The unfavorable effects of transport are noticed by both the environment and society. These effects, named external transport costs, differ depending on the level of economic development, the degree of advancement and utilization of various transport sectors (different transport branches), geographical location (including climate), as well as the susceptibility of environment elements (including fauna and flora) [81–83]. Pollution emitted to the environment by transport may spread far beyond the transport network. Relieving the freight transport network of cargo transported by roads and shifting part of the material flow to other branches of transport allows for reducing external freight transport costs, including social costs related to noise, pollution, congestion and accidents. Such direction of change is marked out by multimodal transport development. Multimodal transport, understood as the transport of cargo using at least two different branches of transport, based on the multimodal transport contract, from a location in one country, where the cargo is taken by the multimodal transport operator, to a dedicated location in another country [84] generates a series of benefits such as the reduction in external transport costs, improvement of the product path from manufacturer to client, increase in possible transport variants, and the reduction in product damage hazard. The development of multimodal transport matches the sustainable development strategy assumption that allows for ensuring the long-term improvement of life quality [85]. Its pace, however, does not correspond to the pace declared in the White Paper and faces a series of barriers, where the quality and availability of the infrastructure of other transport branches than roads is the most important. All these issues—both environmental and social aspects—represent a challenge that necessitates new thinking in transport system organization, new technologies improving the availability and limiting damage to the environment, and new approaches to the systemic development of transport. In other words, the whole freight transport system must change due to environmental, social, and technological pressure. Recently, the impact of transportation infrastructure has been a hot topic, and the economic effect of transportation infrastructure has been receiving more attention and debate because of the pursuit to direct economic growth of both regions and sectors [81].

In this area, studies over intelligent transport systems (ITS) that are an important technological impulse for the development of modern transport networks are being strongly developed [86]. The development of mobility ecosystems is a consequence of the development of an intelligent transport system (ITS) [87,88]. The development of technology related to mobile devices and common access to the Internet creates the basis for offering new services in the transport sector. Their development and diffusion necessitate system integration on three planes: institutional, technological, and operational [89]. The direction of the research on digital ecosystems in the context of logistics and transport is continued in the literature by many different authors and it is the most common direction of research over transport ecosystems [90,91]. The different perceptions of the logistic ecosystem are

exemplified by Lagorio et al. [92], who presented the urban logistics ecosystem as an evolution of transport systems within a city. The authors define it as a system of systems binding stakeholders in the area of flows in a city. Such an outlook on the ecosystem is allied with the definition of the multimodal transport ecosystem within cross-border areas, proposed in Chapter 3 of the paper.

The problem with the integration of intelligent transport systems as well as challenges related to the uneven development of transport infrastructure, is that different legal regulations and approaches to the cooperation between stakeholders of multimodal transport are especially fragile, valid, and important problems within cross-border areas. According to the challenges identified both in the literature and the reports on implementation of the TRANS TRITIA project, the sustainable development of foreign trade requires efficient coordination of transport systems. It is assumed that the currently operating transport system will be subject to technological and process changes leading to the formation of new transport ecosystems.

3. Materials and Methods

The multimodal transport ecosystem is a vision of freight transport within cross-border areas that has been identified as a result of the research project INTERREG TRANS TRITIA. The study concerned the cross-border region of Poland, Slovakia, and the Czech Republic associated in the European Grouping of Territorial Cooperation TRITIA (EGTC TRITIA). It was established on 25 February 2013 by the decision of the Minister of Foreign Affairs of the Republic of Poland No. 1/2013, named EGTC TRITIA and entered into the Register of European Groupings of Territorial Cooperation administered by the Ministry of Foreign Affairs of Poland. The decision to establish the EGTC TRITIA was already taken in 2009 by the leaders of local governments from the Moravian–Silesian region (Cz), the Opole Voivodeship (PL), the Silesian Voivodeship (PL) and the Žilina self-governing region (SK), and based on this decision, steps were taken to establish the grouping. The decision of the regional authorities followed the positive experience of cross-border and interregional cooperation and its impact on the quality of life of the inhabitants of the cross-border areas.

The issue of multimodal transport within the TRITIA cross-border area was raised by Kramarz, Dohn, Knop, Przybylska (2020) in the context of the multimodal transport development scenario within cross-border areas. In the multimodal transport development scenarios proposed in the publication, the multimodal transport ecosystem is a revolutionary scenario. The transport ecosystem presents various visions of a business system, change in the TSL sector, and the results of such changes. The transport ecosystem is a vision that necessitates organizational changes, new network agents, such as the observatory of multimodal transport, and a coordinator.

Stages preceding the development of such a vision was, among other things, the SWOT analysis, combining the TRITIA region potential and weaknesses with the close and distant surrounding factors affecting the freight transport development in this area [6]. Based on the performed studies, the same stimulants of multimodal transport development in the cross-border area have been shown both in Poland, the Czech Republic, and Slovakia, meaning:

- Economical—reduction in expenses for the service, longer life of trucks, lower cost of road tolls, lower consumption of road surfaces.
- Ecological—less pollution of the natural environment, lower emissions, reduction in noise in urban areas.
- Social—increasing road safety, increasing the quality of life in urban areas by reducing the external costs of transport.

The main threats resulting from the SWOT analysis related to the multimodal freight transport development within cross-border areas: legislative delays and delays in the implementation of the adopted strategies, improper proposals in the state and regional budgets related to the division of financial resources between vehicular transport and other branches of transport, obsolete railway infrastructure as well as insufficient quality

of waterways. The main opportunities identified by all three countries included the strategic position of transport, the stability of the European policy that includes intermodal transport, the intensification of cooperation between stakeholders of multimodal transport development within the cross-border area, the strong development of containerization and other standardized solutions, the development of information technologies and telematics, and increasing external costs of road transport. The TRITIA cross-border area differentiates with strengths including: the dynamics of the logistic services, the market, available resources, including the number and location of intermodal terminals, the number of multimodal operators, access to different branches of transport (including inland navigation and freight air transport), knowledge resources in the region (large number of universities educating on the faculties of transport and logistics), research institutions, and increasing flows between studied countries. The weaknesses of the TRITIA region in the context of multimodal freight transport development include low social awareness of the meaning of multimodal freight transport for the environment and society, insufficient supply of qualified low-level employees, a low level of innovation within logistics services in the region, and a long lead time of a transport service within multimodal transport comparing to the lead time related to the same service performed using only vehicular transport.

The multimodal transport ecosystem as a vision of freight transport development has been built in the project using detailed strategic objectives assigned to six perspectives of the Balanced Scorecard. The process of creating and implementing the Balanced Scorecard is used both at the stage of preparing the multimodal transport development strategy within the TRITIA area and the operational plans presenting concrete projects that will be translated into the implementation of the assumed strategy. According to the adopted methodology, the identified strategic goals have been detailed and a map of objectives within the perspective of the Balanced Scorecard has been created [93,94]. The results of these studies are the basis for the adoption of VISION: creating the ecosystem for multimodal freight transport in the TRITIA area, and MISSION: the sustainable development of multimodal freight transport in the cross-border area, based on the support system of TRITIA territory, to increase the functionality, effectiveness, complementarity, cooperation, and regulation of multimodal freight transport.

The performed literature research aimed at the conceptualization of the multimodal transport ecosystem within the cross-border area and the adopted assumption of a holistic approach are the basis to formulate the research questions:

1. What types of ecosystems are part of the multimodal transport ecosystem within cross-border areas?
2. What is the role of stakeholders within individual multimodal transport ecosystem subsystems?
3. What kind of projects would strengthen the vision of the multimodal freight transport ecosystem within the TRITIA cross-border area?

A model of empirical research has been developed when searching for the answers to the aforementioned questions (Figure 1).

The first stage of the research was the conceptualization of the multimodal freight transport ecosystem model (Figure 2). The model includes a holistic approach combining the business ecosystem with the innovation and knowledge ecosystem. Such a model approach of the ecosystem decided about the following stages wherein the stakeholders' analysis was performed, breaking it down to the business ecosystem, innovation ecosystem, and knowledge ecosystem (Figure 2), and as a consequence, the results obtained at the level of individual ecosystems have been combined into a synthetic knowledge for the holistic multimodal transport ecosystem.

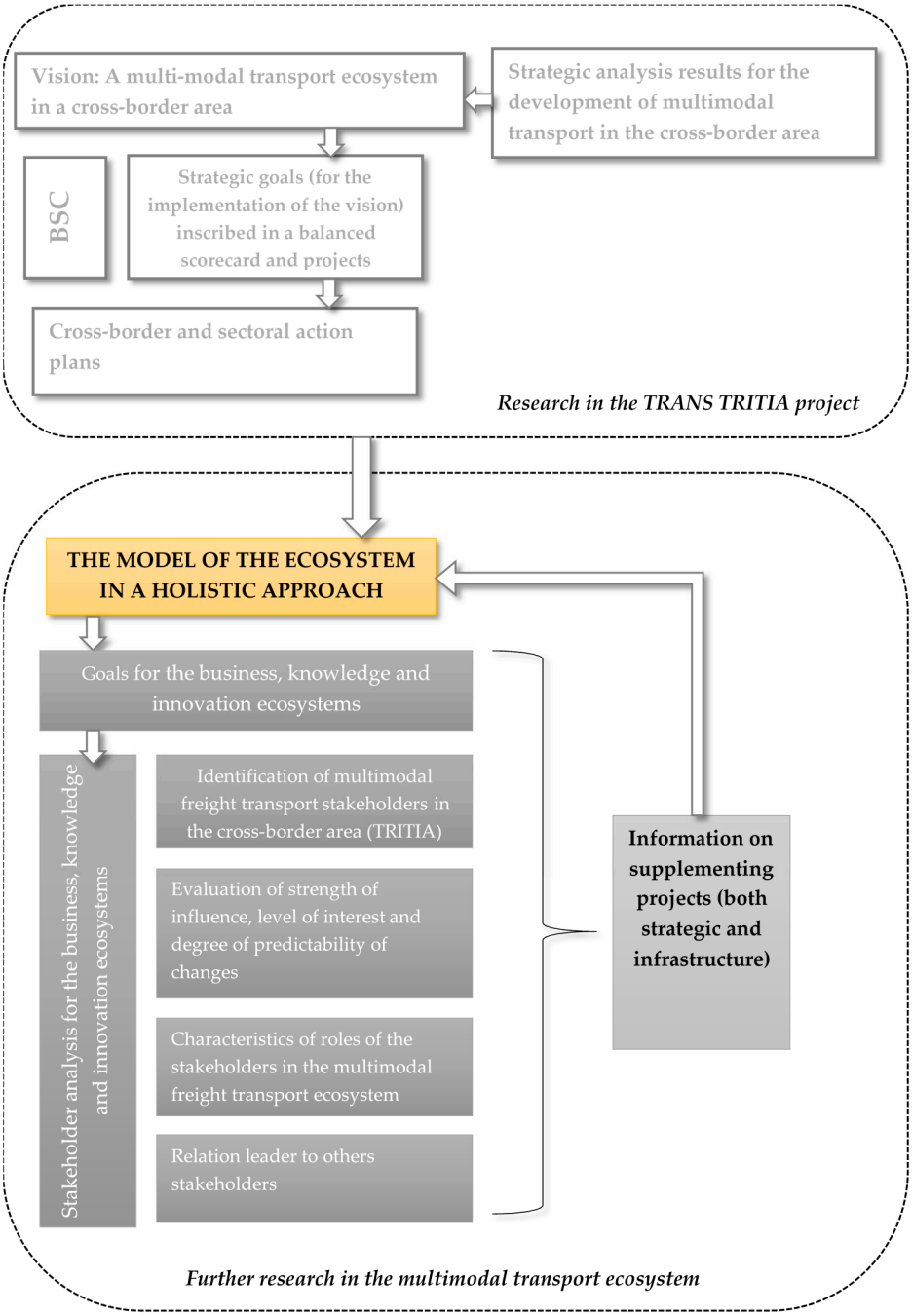

Figure 1. Research methodology (own study).

The basis for ecosystem construction is the characteristics of its actors and the relations between them. An efficient tool within this scope are the developed methodologies of stakeholder assessment that were used in the paper. As a result, stakeholder assessment for the multimodal transport ecosystem was made based on three research methods: questionnaire method, expert opinions, and expert panel.

In the first place, stakeholder groups for each multimodal freight transport ecosystem subsystem were identified. Groups of stakeholders were identified in the cycle of workshops within the scope of the TRANS TRITIA project. Then, the stakeholder groups were subjected to further analysis. To carry this out, a questionnaire were developed and passed to 18 experts having adequate competence resulting from the knowledge of multimodal transport issues and its development as well as the considered cross-border area. The experts were scientists and representatives of self-government and institutions

responsible for financing transport-related projects. The experts were representatives of all three countries. In the questionnaire, the participants were asked to analyze the indicated stakeholders in terms of several criteria (Table 2).

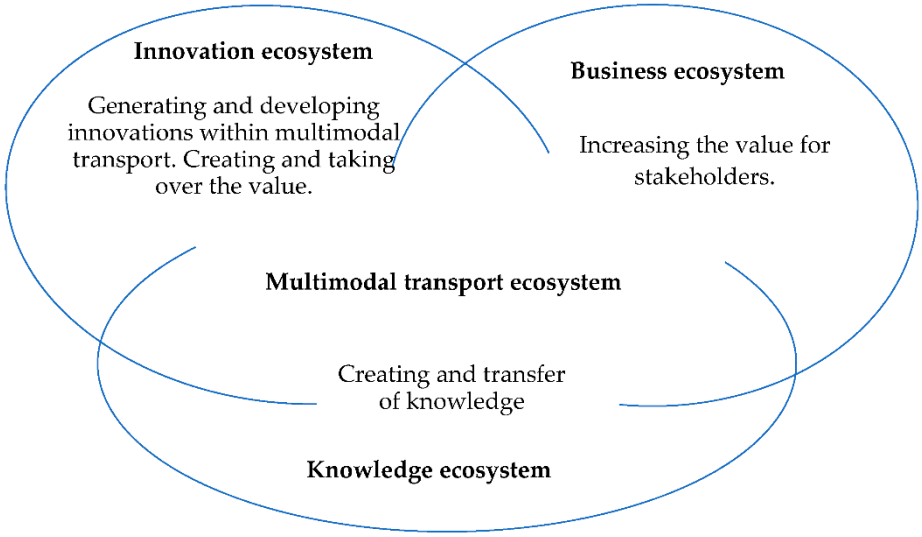

Figure 2. Types of ecosystems in the holistic multimodal transport ecosystem (own study).

Table 2. Stakeholder characteristics criteria.

No.	Criterion	Score	Characteristics
1.	Force of impact	high impact	Entities exerting high influence on the direction and level of multimodal transport development.
		low impact	Entities exerting low influence on the direction and level of multimodal transport development.
2.	Direction of influence	exerting positive influence	Entities that support multimodal transport development with their operations and decisions.
		exerting negative influence	Entities that decelerate multimodal transport development with their operations and decisions.
		exerting neutral influence	Entities that do not exercise positive or negative influence on their operations and decisions, the direction of influence is difficult to determine.
3.	Degree of interest	high level	Entities that can directly benefit from multimodal transport development.
		low level	Entities that do not perceive direct interest in the multimodal transport development.
4.	Degree of changes predictability	high degree	Entities whose direction of changes and approach to the multimodal transport development are predictable.
		low degree	Entities whose direction of changes and approach to multimodal transport development are difficult to predict.

Source: own study based on [95–98].

Averaged results of the expert's assessment allowed for developing stakeholder maps in terms of influence strength and predictability criteria as well as in terms of influence strength and interest level criteria for business, innovation and knowledge ecosystems. The stakeholder maps were discussed on 3 workshops with experts. The inclusion of each stakeholder on two maps for each ecosystem was the basis of role assignment. The stakeholder roles in the ecosystem depend on the location within individual quarters on

the stakeholder maps. Considering current work within the field of stakeholder roles in ecosystems, the authors proposed an elaboration of the so far presented roles and their adaptation to multimodal transport ecosystem stakeholders. The identified stakeholder roles included a leader of ecosystem development. Leaders were assigned tasks related to all stakeholder roles within ecosystems. At the same time, a gap was identified at the junction of all three ecosystems. Next, based on the identified gaps, organizational projects were proposed that are to support multimodal transport ecosystem development within the TRITIA cross-border area. The projects that strengthen the implementation of the multimodal transport ecosystem vision have been selected by comparing the identified challenges resulting from a holistic approach to the multimodal transport ecosystem with the proposal of projects developed at the stage of study within the INTERREG project for the implementation of the multimodal transport development strategy within the TRITIA area.

4. Results—Model of Multimodal Transport Ecosystem for the TRITIA Area-Tri-System Concept

From the standpoint of the ecosystem, holism is especially important and must be related to the recognition of environmental, social, and economic factors, especially in the context of transport. Without consideration of safety, durability as well as social and economic effectiveness, it is difficult to notice the significant development of the whole ecosystem, especially because the external results are considered within each standard analysis of transport investment costs and benefits.

Considering the definition of ecosystems, the authors assumed that the multimodal transport ecosystem within the TRITIA cross-border area is a peculiar economic community, assembled of cooperating logistics organizations, infrastructure administrators, forwarders and receivers of material flows, state and regional authorities, universities, business-related institutions and the remaining stakeholders creating a holistic system together, continuously improving due to new services, the exchange of knowledge, development of technology, including information technology, strengthened by competence centers. The ecosystem is based on three mutually strengthening pillars: business, innovation, and knowledge flow. The basis for the description of the multimodal transport ecosystem model is its components: ecosystem objectives, stakeholders as well as their roles and relations between them.

Such an interpretation points to an important role of the central organization/leader of the multimodal transport ecosystem within the TRITIA cross-border area. Such an organization, in the context of the adopted multimodal transport model, should allow for a smooth combination of three ecosystem perspectives: business, knowledge, and innovation. The literature interpretation of the ecosystems allowed for adopting assumptions for the multimodal transport ecosystem model (Table 3).

Economic results and business relationships between entities are underlined in the literature as devoted to business ecosystems. Innovation ecosystems are focused on mechanisms and policies favoring the creation of innovation. Knowledge ecosystems are the consequence of creating new knowledge based on common research works, cooperation, or development of the knowledge base. Each of these ecosystems plays a special role in creating conditions for the development of multimodal transport. The crossing of the business and innovation objectives as well as the generation and flow of knowledge causes the holistic approach to be the only way to combat the problems of multimodal transport within the TRITIA area.

The multimodal freight transport system involves many stakeholders who have a strong influence on the development of transport, and who are also affected by this development. Considering the perspective of cross-border freight transport network, the set of stakeholders is still growing. The stakeholders should include all participants involved in the flow of goods between countries, both regionally and in terms of individual countries, as well as EU, international and national institutions and bodies (in countries

outside the TRITIA region), committees, associations and various forms of agreements between countries.

Table 3. Assumptions of the multimodal transport ecosystem model.

Ecosystem Model Elements	Business Ecosystems	Innovation Ecosystems	Knowledge Ecosystem
Ecosystem basis (objective)	Sharing the logistics infrastructure including information infrastructure for the growth of added value, generated by entities engaged in the development of multimodal transport within cross-border areas.	The co-creation of new values based on innovation within multimodal transport.	Gathering, exploring, and sharing knowledge within the scope of freight flows within the area and determinants of multimodal transport system development.
Main stakeholders	Network of multimodal transport within cross-border area built around key actors (carriers, logistics centers, terminals, etc.) who create its core.	The network of innovations within multimodal transport is created by investors, universities and research centers, TSL sector companies, competence centers, self-governments, and governments as well as organizations that financially support innovation.	Scientific and research entities, innovators, and TSL sector companies, serving as knowledge nodes. Entities that support gaining, processing, and transferring knowledge, e.g., IT sector companies.
Relationship, cooperation, logic of operations	Business relationships at least within cross-border areas, based on coopetition. Within the scope of common platforms, stakeholders share resources, assets, and benefits or aggregate different entities within combined business operations.	Building cooperation planes that allow for creating and implementing innovations. Openness of solutions is to facilitate the flow of knowledge and strengthen relationships striving for creating new values and their capturing.	The relationships are shaped based on the need to gain, gather, process, and transfer knowledge in the network of multimodal transport within a cross-border area. Relationships necessitate decentralization on the level of gaining knowledge and centralization on the remaining stages of knowledge management.

The result of workshops performed within the scope of the TRANS TRITIA project was the identification of stakeholders in each country.

Intermodal transport in Poland is at an early stage of development. Poor promotion of this solution means that road transport is currently the most commonly used solution. Factors inhibiting the development of intermodal transport are primarily: the lack of legal regulations, the poor condition of infrastructure, the uneven location of terminals in Poland, high costs of the construction and modernization of transhipment terminals, a lack of cooperation between carriers, and a limited number of specialized rolling stock. However, the most important factor is the poor condition of the infrastructure. Changing this state of affairs requires an intensification of actions on the part of various stakeholder groups, including a special role in the actions of the authorities that are responsible for creating the transport policy. Intermodal transport in Poland is carried out by land–sea and rail-road transport using containers, which constitute 98% of all integrated loading units.

The most important players in the Śląskie Voivodeship are three entities: ŚCL SA in Gliwice on the Port of Gliwice, MPL Katowice in Pyrzowice, and Euroterminal Sławków Sp. z o.o. Due to their potential, they can be seen as future hubs for goods exchange in multimodal transport. In addition, key stakeholders can be identified: logistics operators, transport companies from various transport branches, managers of interbranch reloading terminals.

The most important stakeholders in the Silesia–Moravia are: logistics operators, carriers (transportation companies—road, rail, inland, waterways, air), manufacturing and trade companies, national authorities (central policy makers), regional authorities (regional policy makers), and local governments.

The most important stakeholders in the Žilina region are: carriers (transportation companies—road, rail, inland waterways, and air), manufacturing and trade companies, roads administration, railway administration, reloading terminals administration, national authorities (central policy makers), regional authorities (regional policy makers), and local governments.

A detailed list of stakeholders, cohesive for all countries, is presented in Table 4.

Table 4. List of multimodal transport development stakeholders in the selected cross-border area.

No.	Stakeholder Name	No.	Stakeholder Name	No.	Stakeholder Name
1	Logistic centers	12	Managers and administrators within railway transport	23	Media
2	Air ports	13	Managers and administrators in inland navigation	24	Development agencies
3	Intermodal reloading terminals	14	Warehousing developers	25	Experts and specialists
4	Logistic operators	15	Human capital	26	Market animators and agents
5	Road carriers	16	Road transport associations	27	EU institutions
6	Railway carriers	17	Transport associations (railway, air, inland)	28	Governments
7	Air carriers	18	R&D institutions	29	Local authorities
8	Inland navigation carriers	19	Ecological organizations	30	Visegrad group
9	Trade and production companies	20	Potential investors	31	Regulatory institutions (Office of Rail Transport)
10	Information services suppliers	21	Financial institutions	32	Technological observatory
11	Managers and administrators in road transport	22	Regional society	33	Schools and training institutions
				34	Universities

When analyzing the stakeholders given in Table 4, the authors adopted the approach presented in the literature [95–98], within the scope of which stakeholder maps are built. According to these assumptions, as a result of the research, six maps have been developed: two maps for each of the ecosystems (business, innovation, and knowledge) (Figures 3–8). In each of the ecosystems, the first map included the division of stakeholders based on two criteria: the strength of influence and predictability of stakeholder behavior; on the second map, the strength of influence has been presented again, however the second parameter was the level of stakeholder interest. When assigning stakeholders to individual parts of the map (to individual quarters: I–IV), the authors made the following assumptions:

- I quarter of the map—strength of influence within the range (2.5–5> and the level of interest/degree of predictability within the range (0–2.5>;

- II quarter of the map—strength of influence within the range (0–2.5> and the level of interest/degree of predictability within the range (0–2.5>;
- III quarter of the map—strength of influence within the range (0–2.5> and the level of interest/degree of predictability within the range (2.5–5>;
- IV quarter of the map—strength of influence within the range (2.5–5> and the level of interest/degree of predictability within the range (2.5–5>.

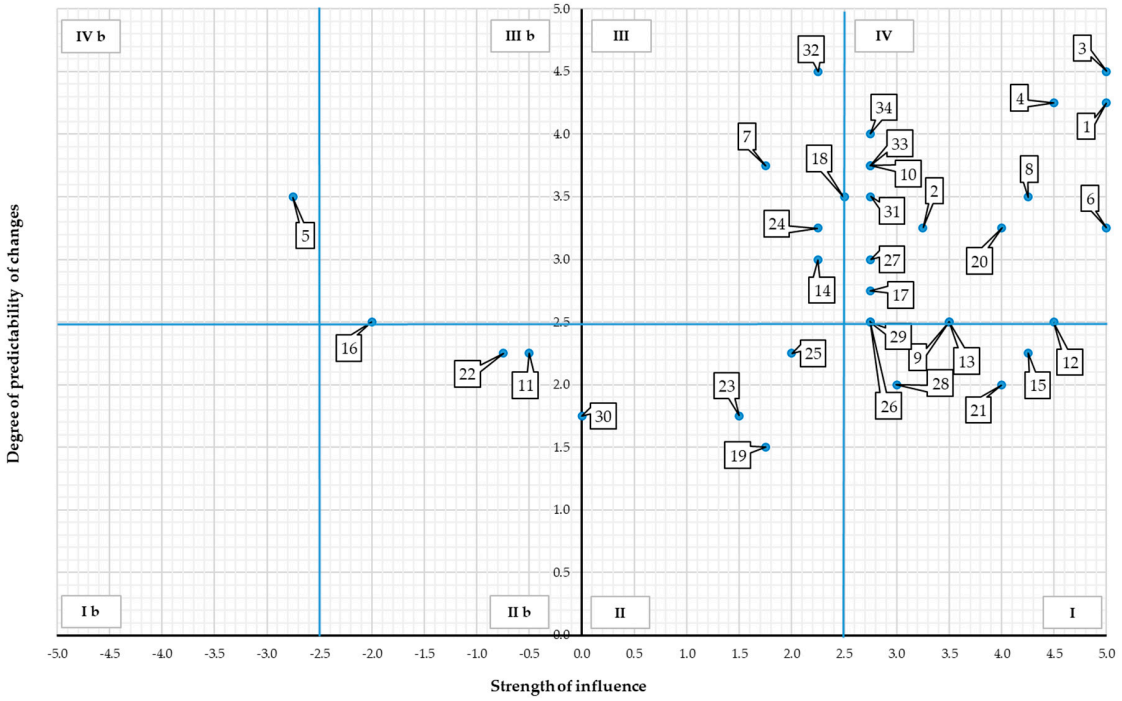

Figure 3. Stakeholder map in the business ecosystem: strength of influence—degree of predictability of change.

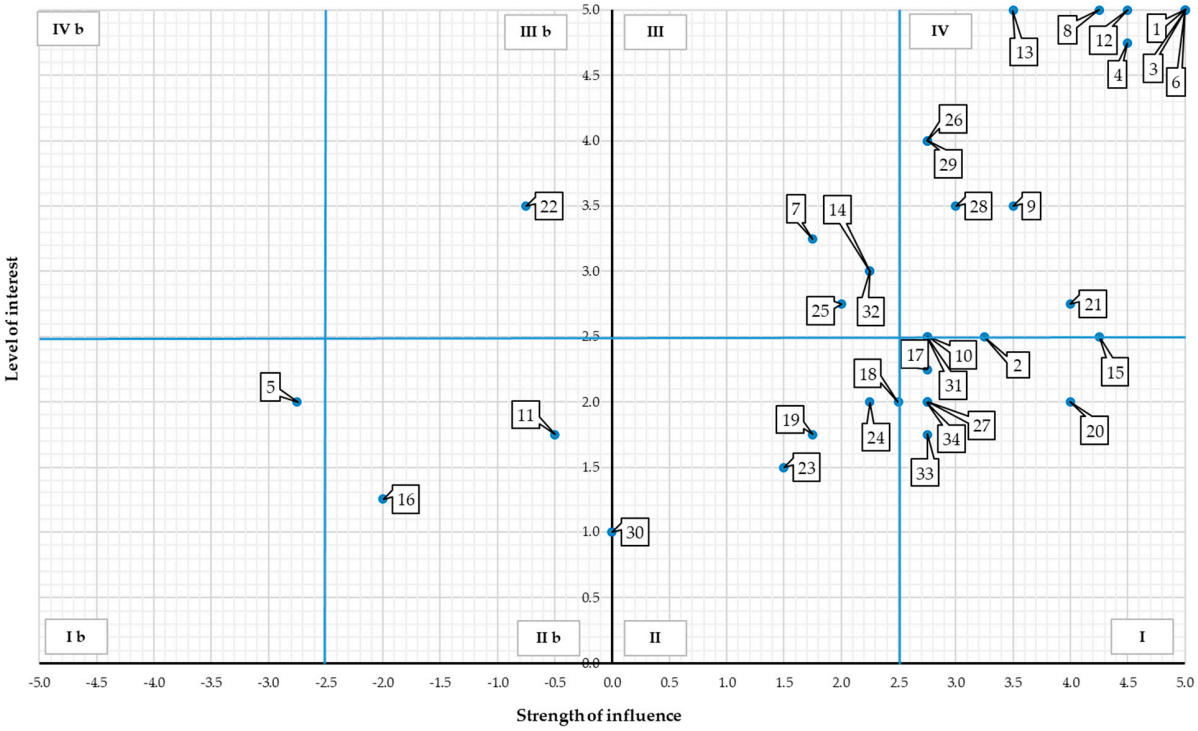

Figure 4. Stakeholder map in business ecosystem: strength of influence—level of interest.

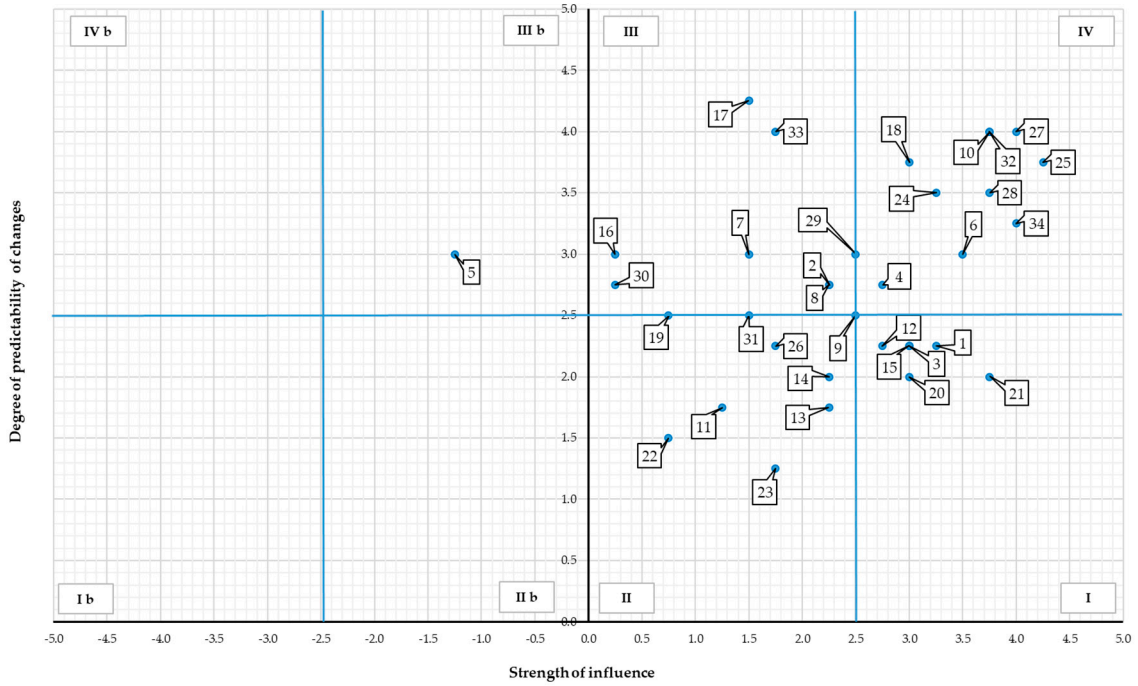

Figure 5. Stakeholder map in the innovation ecosystem: strength of influence—degree of predictability of changes.

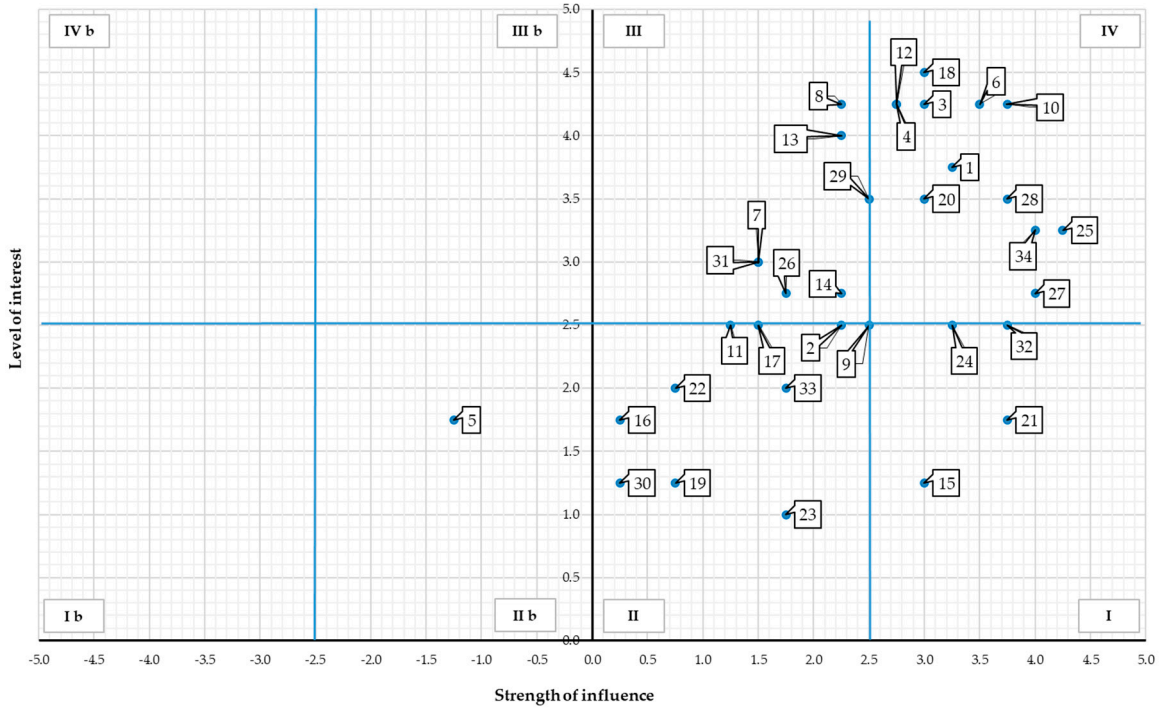

Figure 6. Stakeholder map in the innovation ecosystem: strength of influence—level of interest.

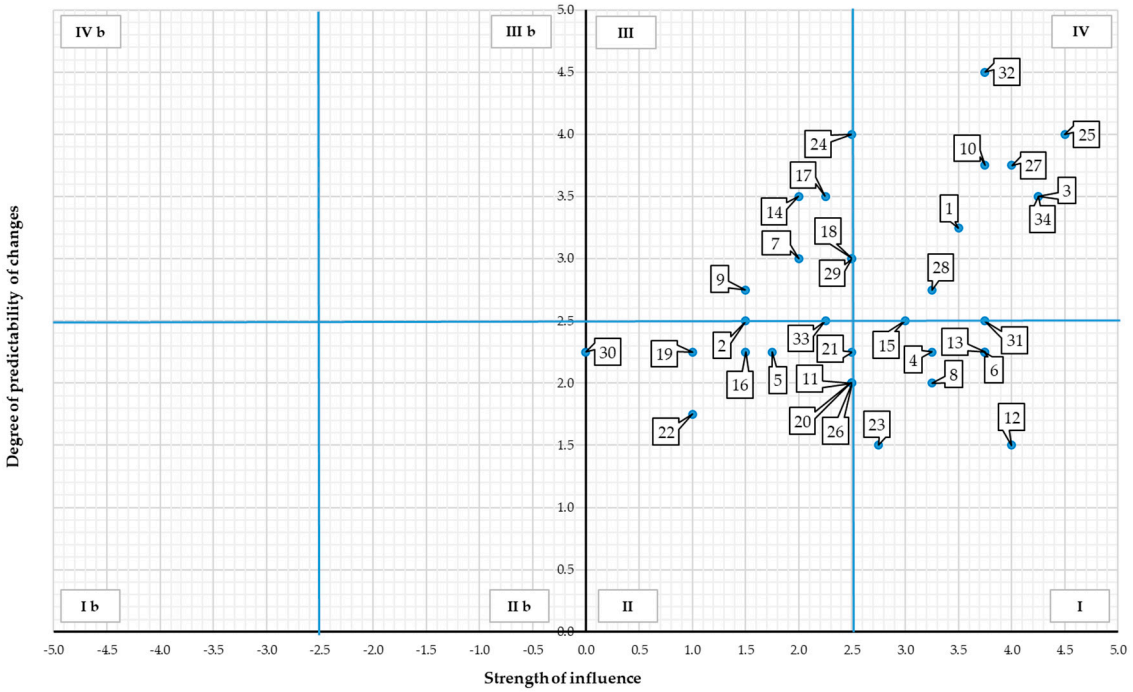

Figure 7. Stakeholder map in the knowledge ecosystem: strength of influence—degree of predictability of change.

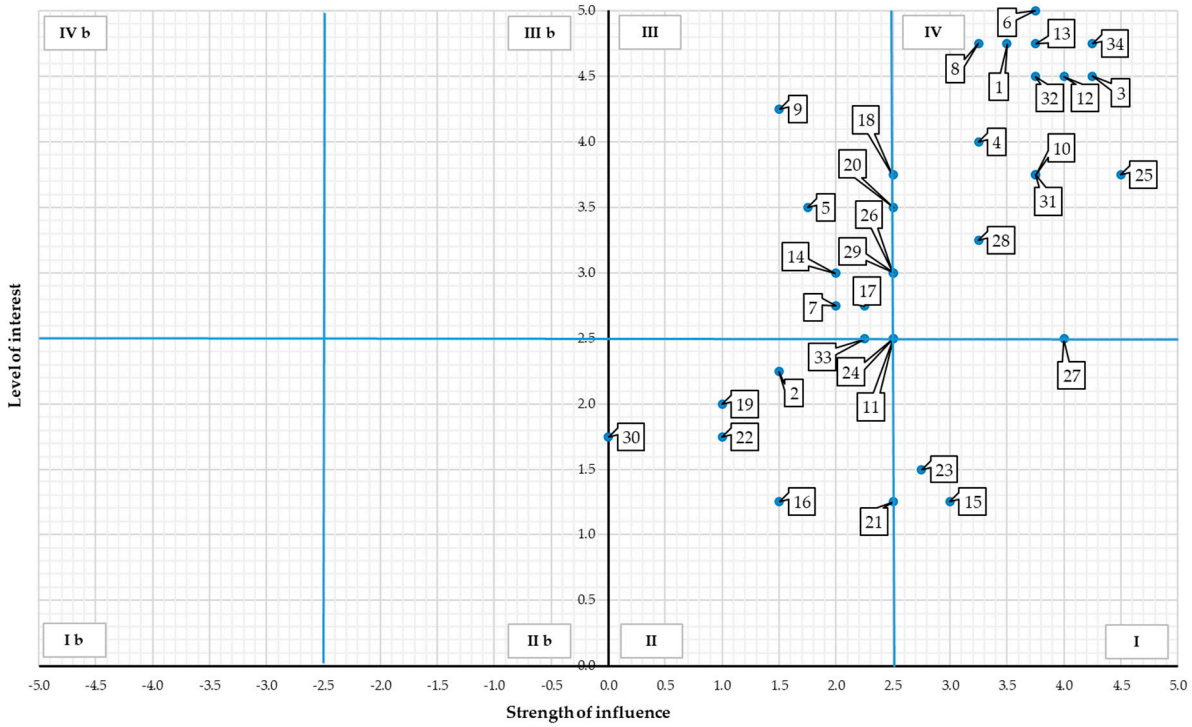

Figure 8. Stakeholder map in the knowledge ecosystem: strength of influence—level of interest.

Due to the fact that the strength of influence may have both positive and negative character, the aforementioned numbers of individual parts of the map apply to the positive influence. Similarly, as indicated above, the quarters of the map were marked for the negative impact of stakeholders, only the symbol "b" was added to the numbers of the quarters (quarter Ib, IIb, IIIb, IVb). The numbers assigned to the stakeholders (Table 4) were used for their presentation in the figures (Figures 3–8).

In the business ecosystem, four out of 34 stakeholder groups have been identified as having an inhibitory effect on the development of multimodal transport (11.8%). Among them, one group (road carriers) is included in the quarter of the fourth map, i.e., characterized with a high strength of influence and high predictability of behavior. A total of 29 groups of stakeholders (85%) positively affected the impact of multimodal transport development (one entity is recognized as not affecting the ecosystem). From among them:

- 13 groups (38.2%) are in the IV quarter of the map which means a high strength of influence and high predictability of behavior;
- Eight groups (23.5%) are in the I quarter of the map which means a high strength of influence and at the same time low predictability of behaviors. It is worth noticing that as many as five groups are located at the boundary level between the I and IV quarters of the map (predictability at level 2.5);
- Three groups (8.8%) are in the II quarter of the map which means a low strength of influence and low predictability of behavior;
- Five groups (14.7%) are in the III quarter of the map which means a low strength of influence and high predictability of behavior.

Within the business ecosystem, considering the strength of influence parameters in relation to the level of stakeholder interest, the group No. 22 is especially worth noticing (regional society). This results from the fact that this group negatively affects the multimodal transport development (even though with low strength); however, what is more important is that it has a significant interest in the development of this type of transport. One may presume that this group is not fully aware of the road transport effects and the benefits multimodal transport may generate. The level of interest of the remaining three groups decelerating the multimodal transport development is low, as expected. In the case of stakeholders positively affecting the multimodal transport development, 15 groups have a high level of interest in its development. From among them, three important groups of stakeholders must be noticed in the case of which both these parameters gained the maximum rating. However, 14 groups are stakeholders of a low level of interest in multimodal transport development.

According to the performed stakeholders' classification concerning the innovation ecosystem, only one group (road carriers) has been identified as decelerating innovation in multimodal transport. Its behavior has been recognized as predictable with simultaneous low strength of influence. All remaining entities have been identified as positively affecting the innovations. From among them:

- 10 groups (29.4%) are in the IV quarter of the map which means a high strength of influence and high predictability of behavior;
- Six groups (17.6%) are in the quarter of the map which means a high strength of influence and at the same time low predictability of behavior;
- Nine groups (26.5%) are in the II quarter of the map which means a low strength of influence and low predictability of behavior;
- Eight groups (23.5%) are in the III quarter of the map which means a low strength of influence and high predictability of behavior.

Within the innovation ecosystem, considering the map based on the strength of influence and level of interest parameters, the group identified as negatively affecting innovation development in multimodal transport has been at the same time indicated as not having the interest in its development. In case of the remaining stakeholders (of positive impact), 19 groups (55.9%) have a high level of interest in the development of innovation. The remaining 14 groups (41.2%) are stakeholders of low level of interest. However, as many as six of them are at the boundary between low and high levels of interest.

Within the knowledge ecosystem, there are no stakeholders negatively affecting the development of knowledge in the multimodal transport. However, one entity has been identified as not affecting the mentioned knowledge. From among the remaining 33 groups of stakeholders:

- Eight groups (23.5%) are in the IV quarter of the map which means a high strength of influence and high predictability of behavior;
- Eight groups (23.5%) are in the I quarter of the map which means a high strength of influence and at the same time low predictability of behavior;
- 10 groups (29.4%) are in the II quarter of the map, which means a low strength of influence and low predictability of behavior;
- Seven groups (20.6%) are in the III quarter of the map which means a low strength of influence and high predictability of behavior.

From among all 34 analyzed stakeholders in the knowledge ecosystem, the vast majority has a high level of interest in the development of knowledge related to multimodal transport (22 stakeholders which is 64.7%). From among the remaining 12 stakeholders, four of them are at the boundary of a low and high level of interest. This shows the great importance of access to knowledge about the development and activities undertaken in multimodal transport for a large part of the stakeholders, regardless of the magnitude of their influence strength.

Using three dimensions of stakeholder evaluation: strength of influence (positive and negative), level of interest, and their predictability as well as their characteristic features, 16 roles have been proposed the stakeholders play in the ecosystem—as shown in Figure 9.

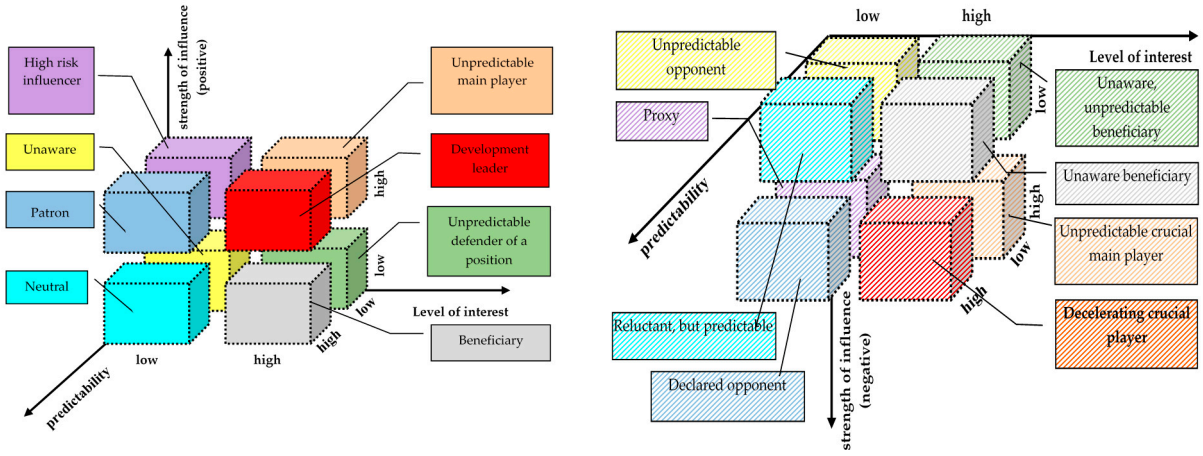

Figure 9. Role of stakeholders in the multimodal freight transport ecosystem within a cross-border area.

Characteristics of the stakeholders' role in the ecosystem were presented in Table 5. Except the name and characteristics of the role (columns 2 and 5), the stakeholder place within the identified map quarters that analyze the stakeholders has been presented (column 3: maps—Figures 3, 5 and 7, column 4: maps—Figures 4, 6 and 8).

Table 5. Characteristics of the roles of the stakeholders in the multimodal freight transport ecosystem within cross-border area.

Stakeholder	Map Quarter: Strength of Influence/Predictability	Map Quarter: Strength of Influence/Level of Interest	Characteristics
Development leader	IV	IV	High predictability, high strength of influence, and high interest in the development of multimodal transport proclaim that a given stakeholder is crucial and will strive for ecosystem development. At the same time, high strength of influence and high degree of predictability are features that proclaim that a given participant affects other stakeholders.
Unpredictable main player	I	IV	A high degree of interest and high strength of influence proclaim that a given stakeholder is crucial for multimodal transport ecosystem development. However, the unpredictability of its behavior means high risk because with such uncertainty it is more difficult to build a multimodal transport development strategy.
High risk influencer	I	I	A low degree of interest and high strength of influence of this player on the ecosystem development show its meaning supporting the multimodal transport ecosystem development. However, the unpredictability of its behavior causes that this player may affect the system with more or less power, depending on the current factors determining its interest not related to the multimodal transport system.
Patron	IV	I	A high degree of predictability of behavior and high strength of influence cause that this player will strongly support the ecosystem development despite the low level of own interest.
Beneficiary	III	III	A high level of interest and high predictability of this player with simultaneous low force of influence (however positive) means that it is a receiver of solutions. The player is interested in the effects of ecosystem development, however his/her impact on the development is low.
Unpredictable defender of a position	II	III	A high interest in the development of the ecosystem and at the same time a low strength of influence and low predictability mean that this participant will benefit from the advantages of the development, but his/her behavior is unpredictable, which means that depending on his/her current interest he/she may change its operations oriented at ecosystem development.
Unaware	II	II	A participant with a low strength of influence and low level of interest and at the same time unpredictable in its behavior does not play a significant role in the ecosystem. He/she is unpredictable, however, possible to manage.
Neutral	III	II	A high predictability and at the same time a low strength of influence and low level of interest make the participants safe and without any impact on the ecosystem.

Table 5. *Cont.*

Stakeholder	Map Quarter: Strength of Influence/Predictability	Map Quarter: Strength of Influence/Level of Interest	Characteristics
Reluctant, but predictable 	IIIb	IIb	A high predictability, low negative strength of influence, and low level of interest mean that the participant may disturb the multimodal transport ecosystem development to a small extent.
Unpredictable opponent 	IIb	IIb	A low predictability, low negative strength of influence, and low level of interest mean that the participant may disturb the multimodal ecosystem development to a small extent. The participant's low predictability makes it difficult to influence his/her behavior.
Unaware, unpredictable beneficiary 	IIb	IIIb	The unpredictable behavior of this participant and the marginally decelerating strength of influence on the ecosystem development are in opposition to the high interest of this participant. The participant is unaware of the benefits from the ecosystem development, therefore he/she is an unaware recipient of solutions who takes decelerating activities without awareness of their negative impact on the own business.
Unaware beneficiary 	IIIb	IIIb	A low decelerating strength of influence that is contrasted by a high level of interest and high predictability proclaims that the participant is not aware of the benefits from ecosystem development.
Declared opponent 	IVb	Ib	Participants strongly decelerating the development of a multimodal transport ecosystem. His/her highly predictable, negative impact on the ecosystem with a simultaneous low level of interest in ecosystem development causes that he/she represents a high threat for ecosystem development.
Proxy 	Ib	Ib	A high decelerating strength of influence, low level of interest, and low predictability mean that the participant strongly disturbs the ecosystem development, at the same time it is difficult to affect him/her due to his/her significant unpredictability.
Unpredictable crucial main player 	Ib	IVb	A high negative strength of influence, high level of interest, and low predictability are features of a participant who has problems with the adaptation of his/her business model to challenges related to ecosystem development. Such a participant has the predisposition for unawaredly disturbing other participants' activities because the remaining stakeholders are strongly dependent on him/her.
Decelerating crucial players 	IVb	IVb	A high negative strength of influence, high level of interest, and high predictability are features that identify the crucial but decelerating roles of such stakeholders in the multimodal transport ecosystem development. The participant may be unaware of high interest or has problems with the adaptation of his/her business model to the challenges put before the ecosystem participants. His/her high predictability is a chance to take actions oriented at the change of influence strength direction.

The roles of stakeholders resulting from three estimates: predictability, strength of influence, and level of interest have been assigned to each participant in the innovation ecosystem (IE), business ecosystem (BE), and knowledge ecosystem (KE) (Table 6).

Table 6. Role of individual stakeholders.

Stake. No.	Stakeholder Name	Innovation Ecosystem	Business Ecosystem	Knowledge Ecosystem
1	Logistic centers	Unpredictable main player	Development leader	Development leader
2	Air ports	Neutral	Patron	Unaware
3	Intermodal reloading terminals	Unpredictable main player	Development leader	Development leader
4	Logistic operators	Development leader	Development leader	Unpredictable main player
5	Road carriers	Reluctant, but predictable	Declared opponent	Unpredictable defender of a position
6	Railway carriers	Development leader	Development leader	Unpredictable main player
7	Air carriers	Beneficiary	Beneficiary	Beneficiary
8	Inland navigation carriers	Beneficiary	Development leader	Unpredictable main player
9	Trade and production companies	Unaware	Unpredictable main player	Beneficiary
10	Information services suppliers	Development leader	Patron	Development leader
11	Managers and administrators in road transport	Unaware	Unpredictable opponent	Unaware
12	Managers and administrators within railway transport	Unpredictable main player	Unpredictable main player	Unpredictable main player
13	Managers and administrators in inland navigation	Unpredictable defender of a position	Unpredictable main player	Unpredictable main player
14	Warehousing developers	Unpredictable defender of a position	Beneficiary	Beneficiary
15	Human capital	High risk influencer	High risk influencer	High risk influencer
16	Road transport associations	Neutral	Unpredictable opponent	Unaware
17	Transport associations (railway, air, inland)	Neutral	Patron	Beneficiary
18	R&D institutions	Development leader	Neutral	Beneficiary
19	Ecological organizations	Unaware	Unaware	Unaware
20	Potential investors	Unpredictable main player	Patron	Unpredictable defender of a position
21	Financial institutions	High risk influencer	Unpredictable main player	Unaware
22	Regional society	Unaware	Unaware, unpredictable beneficiary	Unaware
23	Media	Unaware	Unaware	High risk influencer
24	Development agencies	Patron	Neutral	Neutral
25	Experts and specialists	Development leader	Unpredictable defender of a position	Development leader
26	Market animators and agents	Unpredictable defender of a position	Unpredictable main player	Unpredictable defender of a position
27	EU institutions	Development leader	Patron	Patron
28	Governments	Development leader	Unpredictable main player	Development leader
29	Local authorities	Beneficiary	Unpredictable main player	Beneficiary
30	Visegrad group	Neutral	Unawar	Unawar
31	Regulatory institutions (Office of Rail Transport)	Unpredictable defender of a position	Patrone	Unpredictable main player
32	Technological observatory	Patron	Beneficiary	Development leader
33	Schools and training institutions	Neutral	Patron	Unawar
34	Universities	Development leader	Patron	Development leader

A list of assigned roles is the opportunity to group the stakeholders and select these participants who take the role of a leader in more than one ecosystem (Figure 10). The numbers shown in Figure 10 define the stakeholders (in line with Table 4)

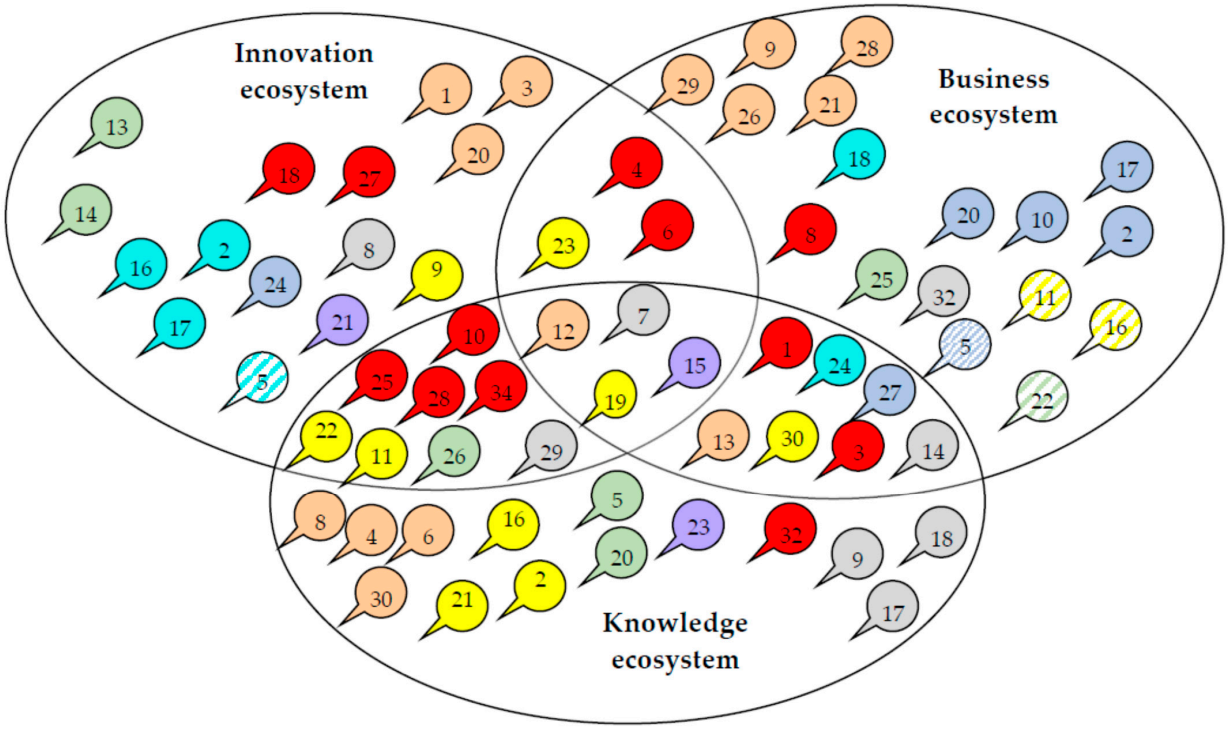

Figure 10. Stakeholders in the multimodal freight transport ecosystem.

Each of the studied types of multimodal transport ecosystem has its development leaders. In the business ecosystem, it is the logistics center, intermodal terminal, logistics operator, railway carriers, and inland navigation carrier. These organizations create added value in the multimodal transport ecosystem and at the same time are the most susceptible to fluctuations in the multimodal flows. They also have the potential to directly affect organizations within the supply chain to increase multimodal flow through incentives for manufacturers and trade organizations. Within the business ecosystem, an important role is played by crucial players who also have a significant interest in the development of this ecosystem and at the same time have a high strength of influence on its development. However, their behavior is not unequivocal and predictable like in the case of development leaders. Infrastructure managers or trade and service companies are such participants in this ecosystem. Development leaders in this ecosystem should include in their policy the crucial role of these stakeholders who must be supported in decisions oriented on multimodal transport development. Risk related to the loss of trust of such participants entails major consequences for the whole ecosystem. However, the ecosystem is supported by stakeholders' named business patrons in the multimodal transport ecosystem, and include information technology services providers, potential investors, transport associations, EU institutions, and regulatory institutions as well as schools and universities. Support for these participants is crucial for the development of the whole ecosystem.

In the innovation ecosystem, development leaders including R&D organizations, experts and specialists, railway carriers, information technology providers, logistics operators, EU institutions, governments, and universities strive to increase the level of multimodal transport innovativeness and at the same time feel significant benefits from implementing the innovations. Support for the development of innovation oriented not only on multimodal transport but also on the logistics sector in the broad sense is essential in the context of a low innovativeness index of logistics services. Such support is provided by

patrons in the multimodal transport innovation ecosystem, such as development agencies and technological observatories. Technological observatories are created for the system support of companies, universities, research and development entities, or business-related institutions. Their important element is boosting the cooperation and implementation of solutions that would level the problem of insufficient mechanisms linking the scientific research with the ability of companies to absorb new technologies, products, or innovative solutions. They can be molded as web-based monitoring tools that provide international, national, or regional decision makers and business stakeholders with quantitative and qualitative information on the implementation of key technologies. Based on the literature review [99–102], the observatories are usually responsible for developing an exhaustive set of indexes at the regional, national, and international level for the purposes of monitoring, producing and commercializing new knowledge based on specified technologies. They perform a detailed analysis related to the way individual regions/countries consider value chains related to the implementation of key technologies, starting from technology up to commercialization. In addition, they regularly analyze emerging or fast-growing technology-based products and their value chains, key actors, and constraints. Their roles may also include orders within the scope of taking specific political and legislative activities to support new initiatives.

However, within the knowledge ecosystem, information technology services providers, experts and specialists, governments, and universities are the leaders. These participants build a system of knowledge management related to multimodal transport in the region. The system is not integrated so far. Attempts to integrate the system and the gaps present in it have been shown by experts responsible for the implementation of the TRANS TRITIA project. During the project implementation, players critical to the whole knowledge management system have emerged, who are not willing to share the knowledge. The key role of development leaders will therefore be to make these players aware of the benefits of the knowledge ecosystem, which will also be fed into their databases. Knowledge patrons such as EU institutions are the support of the ecosystem development. The array of stakeholder profiles is disturbing for this ecosystem, especially the sole player identified so far as a knowledge patron. At the same time, a significant number of players specified as beneficiaries can be noticed in the ecosystem.

Table 7 includes the main challenges put before leaders in relation to individual (identified in the research) stakeholder groups selected according to the assigned roles.

The main problem representing the basic challenge in the cross-border freight transport network is the missing coordination of flows. Actors identified within individual regions creating the TRITIA cross-border area cooperate with each other to a medium or low degree, and do not take common initiatives. Definitely, a low level of cooperation can be noticed between the stakeholders of different countries. Thus, building the structure and mechanisms of coordination in the cross-border freight transport network in the TRITIA cross-border area is a fundamental challenge in the development of cross-border freight transport. This challenge is related to the problem of information flow and knowledge sharing between individual internal stakeholders. The reluctance of network actors to share knowledge and experience makes it difficult to undertake such initiatives that enable the sustainable development of the freight transport system in cross-border areas. Therefore, the second challenge in the area of stakeholders of cross-border freight transport is to build a system for collecting, processing, and sharing knowledge. It is necessary for the effective coordination of flows in the cross-border freight transport network.

According to the theoretical basis of ecosystems, leaders are the players responsible for coordination. Looking holistically at the multimodal transport ecosystem in a cross-border area, thus taking into account the combined ecosystem of business, knowledge and innovation, leaders are expected to link these three ecosystems through the ability to coordinate them. The conducted research shows that currently there is no entity that is a development leader in all three ecosystems. On the other hand, leaders were identified at the junction of the two ecosystems in all combinations resulting from the holistic approach.

Table 7. Guidelines for the development leader.

Stakeholder	Guidelines for the Development Leader
Unpredictable main player	• focusing attention on them: care and protect • monitoring their needs and behaviors • maintaining a high level of satisfaction • cooperation and orientation of operations on ecosystem development direction • coordination of operations and support for patrons
High risk influencer	• consideration of his/her opinions • monitoring his/her operations oriented on multimodal transport support • coordination of support with the needs of other stakeholders • maintaining the satisfaction level
Patron	• relationships oriented to listening opinions and accepting support • coordination of support with the needs of other stakeholders
Beneficiary	• identification of needs • information about new solutions • raising satisfaction
Unpredictable defender of a position	• monitoring • showing new benefits • informing about new solutions and support options
Unaware	• passing information to raise the predictability of behavior • minimum effort oriented on these entities
Neutral	• monitoring • minimum effort oriented on these entities
Reluctant, but predictable	• identified benefits • minimum effort oriented on these entities
Unpredictable opponent	• monitoring • identified benefits • minimum effort oriented on these entities
Unaware beneficiary	• monitoring behaviors • activity promoting solutions, informing about benefits
Declared opponent	• monitoring behavior of these participants • developing variants of reactions to unfavourable actions of the player

At the interface of the innovation and knowledge ecosystems, these are universities, EU institutions, experts, and specialists, and IT service providers. At the junction of the innovation and business ecosystems, these are railway carriers and logistics operators. On the other hand, at the junction of the knowledge ecosystem and the business ecosystem, these are logistics centers and reloading terminals.

5. Discussion

The role of development leaders integrating and coordinating two ecosystems is essential. However, the noticeable lack of a leader who has the predisposition to coordinate and integrate all three ecosystems is a factor that threatens the sustainable development of the multimodal transport ecosystem in the TRITIA cross-border area. Therefore, the concept of participants who will ensure the integration, coordination, and monitoring at the junction of the three ecosystems was presented. These participants are the Multimodal Transport Coordinator in the TRITIA cross-border area and the Multimodal Transport Observatory in the TRANS TRITIA cross-border area.

In the role of the coordinator in the network, the strength of influence on the other participants is important. Therefore, in the holistic approach to the multimodal transport

ecosystem, it was assumed that the coordinator must be a development leader in all three ecosystems. The network coordination theory presents an effective approach to streamlining business processes within the networks of cooperating organizations, including supply networks [103]. In the literature, the coordinator is indicated, inter alia, as a key link in the marketing communication system of organizations cooperating in the region and country [104], an entity connecting the activities of cluster participants [105], as well as a network orchestrator [106], i.e., an entity combining the competences of various organizations for the implementation of network tasks, creating added value and generating innovative solutions. The coordinating function is also assigned to the flagship companies of the network [107]. In this sense, the coordinator is often assigned the role of the synchronization (also at the operational level of scheduling) of processes in the network.

The increasing importance of the coordinator is also noticed in complex transport systems. The indicated scope of coordination in such systems varies, but usually concerns a precisely defined area. In particular, the importance of coordination in the implementation of infrastructure projects in various modes of transport is indicated [108]. Another area, currently strongly developed in the research, is the coordination of transport routes for many participants of the road transport network [109]. This issue is particularly important and topical due to the strong development of e-commerce and with it the increased and fragmented cargo flows by road transport. The TRANS TRITIA project proposed more comprehensive solutions for the coordination of multimodal freight transport networks. Kramarz et al. [3] in an earlier publication indicated that the coordinator is a solution necessary to implement the assumptions of both the proactive scenario and the reactive development of multimodal transport in the TRITIA region. In this concept, the coordinator is understood as an organizational unit anchored at the TRITIA association, whose task is to:

- process knowledge about material flows carried out in the TRITIA area in various modes of transport, as well as share this knowledge with stakeholders;
- stimulate solutions and projects within the development of multimodal transport that support innovation and sustainable development;
- initiate projects to reduce transport time with the use of non-road modes of transport, as well as reduce delays and improve the flexibility of material flow through these modes of transport;
- model material flows in the cross-border area based on knowledge resources and develop new development scenarios in line with changes in the environment of the multimodal freight transport network in the TRITIA area;
- support and strengthen the cooperation of organizations implementing goods flow;
- communicate the participants of the multimodal transport system to the closer and further environment.

Among the detailed projects proposed as part of the TRANS TRITIA project results, which are important for the development of multimodal transport in the TRITIA area, the following were indicated:

1. Modelling of logistics center networks and multimodal terminals;
2. Multimodal transport innovation centers;
3. Multimodal transport system simulation model.

However, when analyzing the challenges faced by the coordinator integrating the three ecosystems, these challenges must include building a knowledge management system and the development of a platform similar to a freight exchange dedicated to participants in multimodal transport.

The coordinator's model cannot function properly without a developed knowledge management concept in a multimodal transport network. The overall concept of the coordinator's functioning requires systematic monitoring of the network and the collection of information and data obtained by a logistics observatory.

The role to be played by the logistic observatory in the multimodal transport ecosystem mainly concerns the observation of technological and market trends in the development of multimodal transport in the TRANS TRITIA cross-border zone. The observatory is to respond to the specific needs of stakeholders operating in the multimodal transport ecosystem in the Śląskie Voivodeship, Opolskie Voivodeship, the self-government of the Žilina region and the Moravian–Silesian region in terms of supporting and tracking the development of multimodal transport, positioning key technological areas and assessing the effectiveness of development activities.

The activities of the observatory will include the collection and processing of specialist knowledge on technological and infrastructure areas, monitoring the implementation of multimodal transport development strategies, identifying technological trends and infrastructure development, as well as assessing the potential of the endogenous TRANS TRITIA region in terms of multimodal transport development. The basic tasks of the observatory will include:

- mapping the multimodal transport system in the territory of TRANS TRITIA;
- mapping the relationships within the multimodal transport network in the territory of TRANS TRITIA;
- the assessment of transport and logistics potential;
- cooperation for the development of transport and logistics in the territory of TRANS TRITIA;
- monitoring the development of the TEN-T network as well as line and point infrastructure (roads, railways, inland waterway networks, multimodal terminals);
- lobbying for the creation of an intergovernmental organization guaranteeing freedom of navigation and equal treatment of all flags on the Oder;
- the comparison of the use of external elements in freight transport, including charges for the use of transport infrastructure; development of maps of pilot projects before and after full implementation of external elements (in the area of TRANS TRITIA).

Among the projects that have been proposed as necessary for implementation as part of the implementation of the multimodal transport development strategy in the TRANS TRITIA area, the following can be distinguished:

- The establishment of the Oder Commission;
- The concept of determining the external costs of freight transport;
- Analysis of disruptions in freight transport resulting from shared infrastructure;
- A freight transport monitoring and data collection system.

In addition to the above-mentioned projects, within the indicated gaps, the necessity to implement a new project concerning the creation of a communication system for the multimodal transport ecosystem was proposed.

The planned evolution of the multimodal transport ecosystem requires the implementation of the indicated projects. At the same time, this assumption is the main limitation of the adopted concept. Difficulties in obtaining funds for the implementation of the indicated projects may disrupt the coherent development of all three types of ecosystems.

6. Conclusions

The multimodal transport ecosystem is a construct that is only slightly recognized theoretically and empirically. The conducted research indicates the existence of three types of ecosystems within the multimodal transport ecosystem, which include the business ecosystem, knowledge ecosystem and innovation ecosystem. In each of the above-mentioned types of ecosystems, stakeholders are a key component. Preliminary studies allowed for the development of a set of stakeholders in the multimodal transport system in the cross-border area. The indicated stakeholder groups have been evaluated by experts from different (investigated) countries. The limitation of this approach is the lack of analyses of specific stakeholders who may influence the multimodal transport ecosystem in different ways (depending on the country in which they operate). At the stage of the work, it was not yet possible. However, future research concerning individual roles may be based

on individual cases. Moreover, the assumption of averaging the assessment of impact, interest and predictability has been adopted. This allowed for an overall view and image of stakeholders in the shaped multimodal transport ecosystem.

The stakeholder analysis showed their differentiated impact on individual ecosystem types and, consequently, on their diverse roles. Based on the conducted research, on the basis of three criteria (strength of influence, and level of interest, level of predictability), 16 stakeholder roles were distinguished, of which 12 were identified in the multimodal transport ecosystem in the TRITIA cross-border area. According to the theory of ecosystems, leaders play a key role in the coordination of ecosystems. At the junction of the two types of ecosystems, leaders were identified, while at the same time identifying a coordination gap at the level of all three types of ecosystems. From this point of view, it becomes necessary to indicate or appoint an entity/organization that will have the ability to coordinate all three types of ecosystems. The presented concept of the multimodal transport ecosystem in the cross-border area provides the basis for further in-depth research in the field of factors stimulating and inhibiting the evolution of this system. One of the currently important areas of further research is the analysis of the impact of the pandemic situation on the development of the multimodal transport ecosystem. Moreover, it should be emphasized that the willingness to cooperate with and between stakeholders is the main determinant of the development of the studied ecosystem, which will also be the subject of further research by the authors.

Author Contributions: Conceptualization, M.K., L.K., E.P. and K.D.; methodology, M.K., L.K., E.P. and K.D.; software, M.K., L.K., E.P. and K.D.; validation, M.K., L.K., E.P. and K.D.; formal analysis, M.K., L.K., E.P. and K.D.; investigation, M.K., L.K., E.P. and K.D.; resources, M.K., L.K., E.P. and K.D.; data curation, M.K., L.K., E.P. and K.D.; writing—original draft preparation, M.K., L.K., E.P. and K.D.; writing—review and editing, M.K., L.K., E.P. and K.D.; visualization, M.K., L.K., E.P. and K.D. All authors have read and agreed to the published version of the manuscript.

Funding: The research presented in the paper was supported by the statutory work 13/040/BK/21/0095 carried out at the Faculty of Organization and Management, Silesian University of Technology.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Research and Markets. *Global Multimodal Freight Transportation Market (2020–2025)*; Research and Markets: Dublin, Ireland, 2020.
2. European Commission. Roadmap to a Single European Transport Area-Towards a Competitive and Resource Efficient Transport System. Available online: https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0144:FIN:EN:PDF (accessed on 14 April 2021).
3. Kramarz, M.; Dohn, K.; Przybylska, E.; Knop, L. Scenarios for the development of multimodal transport in the TRITIA cross-border area. *Sustainability* **2020**, *12*, 7021. [CrossRef]
4. European Commission. A Strategy for Smart, Sustainable and Inclusive Growth. 2020. Available online: https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:2020:FIN:EN:PDF (accessed on 14 April 2021).
5. European Commission. *Towards a Sustainable Europe by 2030*; European Commission: Brussels, Belgium, 2019.
6. Dohn, K.; Knop, L.; Kramarz, M.; Przybylska, E.; Żebrucki, Z. (Eds.) Concept of the development of multimodal freight transport in the Trans Tritia area. In *Strategy and Action Plans for the Polish-Czech-Slovak Cross-Border Area*; Dom Organizatora: Gliwice, Poland, 2020.
7. Williamson, P.J.; de Meyer, A. Ecosystem Advantage: How to Successfully Harness the Power of Partners. *Calif Manag. Rev.* **2012**, *55*, 24–46. [CrossRef]
8. McGrath, R.G. *The End of Competitive Advantage: How to Keep Your Strategy Moving as Fast as Your Business*; Harvard Business Review Press: Boston, MA, USA, 2013.
9. Weill, P.D.; Woerner, S. Thriving in an Increasingly Digital Ecosystem. *Mit Sloan Manag. Rev.* **2015**, *56*, 27–34.
10. Porter, M.E.; Heppelmann, J.E. How Smart, Connected Products Are Transforming Companies. *Harv. Bus.* **2015**, *93*, 97–114.
11. Leminen, S.; Westerlund, M.; Rajahonka, M. Innovating with Service Robots in Health and Welfare Living Labs. *Int. J. Innov. Manag.* **2017**, *21*, 1740013. [CrossRef]

12. Valkokari, K. Business, innovation, and knowledge ecosystems: How they differ and how to survive and thrive within them. *Technol. Innov.* **2015**, *8*, 17–24. [CrossRef]
13. Tansley, A.G. The use and abuse of vegetational concepts and terms. *Ecology* **1935**, *16*, 284–307. [CrossRef]
14. Oxford University Press. *The New Shorter Oxford English Dictionary*; Oxford University Press: Oxford, UK, 1993.
15. Coventry, D. World Resources 2000–2001: People and Ecosystems: The Fraying Web of Life: United Nations Development Programme, United Nations Environment Programme, World Bank, World Resources Institute, Elsevier Science, 2000, Casebound Edition, 389p., US$ 49, ISBN 0080437818. *Agric. Ecosyst. Environ.* **2001**, *86*, 109–110.
16. O'Neill, R.V. Is it time to bury the ecosystem concept? (With full military honors, of course!). *Ecology* **2001**, *82*, 3275–3284.
17. Teece, D.J. Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance. *Strat. Manag. J.* **2007**, *28*, 1319–1350. [CrossRef]
18. Battistella, C.; Colucci, K.; De Toni, A.F.; Nonino, F. Methodology of business ecosystems network analysis: A case study in Telecom Italia Future Centre. *Technol. Soc. Chang.* **2012**, *80*, 1194–1210. [CrossRef]
19. Despeisse, M.; Ball, P.D.; Evans, S.; Levers, A. Industrial Ecology at factory level—A conceptual model. *J. Clean. Prod.* **2012**, *31*, 30–39. [CrossRef]
20. Nielsen, S.N. What has modern ecosystem theory to offer to cleaner production, industrial ecology and society? The views of an ecologist. *J. Clean. Prod.* **2007**, *15*, 1639–1653. [CrossRef]
21. Moore, J.F. Predators and prey: A new ecology of competition. *Harv. Bus.* **1993**, *71*, 75–86.
22. Knop, L.; Odlanicka-Poczobutt, M. The typology and components of ecosystems in business. In *Business and Non-Profit Organizations Facing Increased Competition and Growing Customers' Demands, Proceedings of the 17th Conference of Scientists and Business People, Tomaszowice, Poland, 18–19 June 2018*; Nalepka, A., Ujwary-Gil, A., Eds.; Foundation for the Dissemination of Knowledge and Science "Cognitione": Nowy Targ, Poland, 2018; pp. 402–422.
23. Adner, R. Ecosystem as structure: An actionable construct for strategy. *J. Manag.* **2017**, *43*, 39–58. [CrossRef]
24. Tsujimoto, M.; Kajikawa, Y.; Tomita, J.; Matsumoto, Y. A review of the ecosystem concept-Towards coherent ecosystem design. *Technol. Soc. Chang.* **2018**, *136*, 49–58. [CrossRef]
25. Liguori, E.; Bendickson, J.; Solomon, S.; McDowell, W.C. Development of a multi-dimensional measure for assessing entrepreneurial ecosystems. *Entrep. Reg. Dev.* **2019**, *31*, 7–21. [CrossRef]
26. Adner, R.; KAPOOR, R. Value Creation in Innovation Ecosystems: How the Structure of Technological Interdependence Affects Firm Performance in New Technology Generations. *Strat. Manag. J.* **2010**, *31*, 306–333. [CrossRef]
27. Moore, J.F. *The Death of Competition: Leadership & Strategy in the Age of Business Ecosystems*; Harper Business: New York, NY, USA, 1996.
28. Gueguen, G.; Torrès, O. Fondements et dynamiques concurrentielles ecosystems d'affaires: l'exemple de Linux contre Microsoft. *Rev. Française Gest.* **2004**, *30*, 227–248. [CrossRef]
29. Cygler, J. Ekosystem biznesu jako platforma relacji kooperacyjnych przedsiębiorstw. *Pr. Nauk. Uniw. Ekon. We Wrocławiu* **2008**, *20*, 47–57.
30. Isenberg, D.J. *The Entrepreneurship Ecosystem Strategy as a New Paradigm for Economic Policy: Principles for Cultivating Entrepreneurship*; Institute of International European Affairs: Dublin, Ireland, 2011.
31. Iansiti, M.; Levien, R. Strategy as ecology. *Harv. Bus.* **2004**, *82*, 68–78.
32. Peltoniemi, M. Preliminary theoretical framework for the study of business eco-systems. *Emerg. Mahwah Lawrence Er Baum* **2006**, *8*, 10.
33. Kastalli, I.V.; Neely, A. *Collaborate to Innovate, How Business Ecosystems Unleash Business Value*; University of Cambridge: Cambridge, UK, 2015.
34. Nambisan, S.; Baron, R.A. Entrepreneurship in Innovation Ecosystems: Entrepreneurs' Self–Regulatory Processes and Their Implications for New Venture Success. *EtP* **2013**, *37*, 1071–1097. [CrossRef]
35. Li, Y.R. The technological roadmap of Cisco's business ecosystem. *Technovation* **2009**, *29*, 379–386. [CrossRef]
36. Basole, R.C. Visualization of interfirm relations in a converging mobile ecosystem. *J. Inf. Technol.* **2009**, *24*, 144–159. [CrossRef]
37. Clarysse, B.; Wright, M.; Bruneel, J.; Mahajan, A. Creating value in ecosystems: Crossing the chasm between knowledge and business ecosystems. *Res. Policy* **2014**, *43*, 1164–1176. [CrossRef]
38. Peltoniemi, M.; Vuori, E. Business ecosystem as the new approach to complex adaptive business environments. *Empower. Organ.* **2004**, *2*, 267–281.
39. Sako, M. Business Ecosystems: How Do They Matter for Innovation? *Commun. Acm* **2018**, *61*, 20–22. [CrossRef]
40. Jackson, D.J. *What Is an Innovation Ecosystem?* National Science Foundation: Arlington, VA, USA, 2011.
41. Jütting, M. Exploring Mission-Oriented Innovation Ecosystems for Sustainability: Towards a Literature-Based Typology. *Sustainability* **2020**, *12*, 6677. [CrossRef]
42. Gulati, R.; Puranam, P.; Tushman, M.L. Meta-Organization Design: Rethinking Design in Interorganizational and Community Contexts. *Strat. Manag. J.* **2012**, *33*, 571–586. [CrossRef]
43. Korhonen, J.; Snäkin, J.-P. Analysing the Evolution of Industrial Ecosystems: Concepts and Application. *Ecol. Econ.* **2005**, *52*, 169–186. [CrossRef]
44. Post, D.; Doyle, M.; Sabo, J.; Finlay, J. The Problem of Boundaries in Defining Ecosystems: A Potential Landmine for Uniting Geomorphology and Ecology. *Geomorphology* **2007**, *89*, 111–126. [CrossRef]

45. Pilinkiene, V.; Maciulis, P. Comparison of different ecosystem analogies: The main economic determinants and levels of impact. *Procedia Soc. Behav. Sci.* **2014**, *156*, 365–370. [CrossRef]
46. Scaringellaa, L.; Radziwon, A. Innovation, entrepreneurial knowledge, and business ecosystems: Old wine in new bottles? *Technol. Soc. Chang.* **2018**, *136*, 59–87. [CrossRef]
47. Aarikka-Stenroos, L.; Ritala, P. Network management in the era of ecosystems: Systematic review and management framework. *Ind. Mark. Manag.* **2017**, *67*, 23–36. [CrossRef]
48. Xu, G.; Wu, Y.; Minshall, T.; Zhou, Y. Exploring innovation ecosystems across science, technology, and business: A case of 3D printing in China. *Technol. Soc. Chang.* **2018**, *136*, 208–221. [CrossRef]
49. Hileman, J.; Kallstenius, I.; Häyhä, T.; Palm, C.; Cornell, S. Keystone actors do not act alone: A business ecosystem perspective on sustainability in the global clothing industry. *PLoS ONE* **2020**, *15*, e0241453. [CrossRef]
50. Iansiti, M.; Levien, R. *The Keystone Advantage: What the New Dynamics of Business Ecosystems Mean for Strategy, Innovation and Sustainability*; Harvard Business School Press: Boston, MA, USA, 2004; p. 255.
51. Gómez-Uranga, M.; Miguel, J.C.; Zabala-Iturriagagoitia, J.M. Epigenetic economic dynamics: The evolution of big internet business ecosystems, evidence for patents. *Technovation* **2014**, *34*, 177–189. [CrossRef]
52. Håkansson, H.; Ford, D. How Should Companies Interact in Business Networks. *J. Bus. Res.* **2002**, *55*, 133–139. [CrossRef]
53. Basole, R.C.; Srinivasan, A.; Park, H.; Patel, S. Ecoxight: Discovery, exploration, and analysis of business ecosystems using interactive visualization. *ACM Trans. Inf. Syst.* **2018**, 9. [CrossRef]
54. Ramezani, J.; Camarinha-Matos, L.M. Novel Approaches to Handle Disruptions in Business Ecosystems. In *Technological Innovation for Industry and Service Systems. DoCEIS 2019. IFIP Advances in Information and Communication Technology*; Springer: Cham, Switzerland, 2019; Volume 553, pp. 43–57.
55. Ritala, P.; Agouridas, V.; Assimakopoulos, D.; Gies, O. Value creation and capture mechanisms in innovation ecosystems. *Int. J. Technol.* **2013**, *63*, 244–267.
56. Chesbrough, H. *Open Innovation: The New Imperative for Creating and Profiting from Technology*; Harvard Business School Press: Boston, MA, USA, 2003.
57. Wessner, C.W. *Innovation Policies for the 21st Century. Report of a Symposium*; The National Academies Press: Washington, DC, USA, 2007.
58. Russell, M.G.; Still, K.; Huhtamäki, J.; Yu, C.; Rubens, N. Transforming Innovation Ecosystems through Shared Vision and Network Orchestration. In Proceedings of the Triple Helix IX International Conference, Silicon Valley: Global Model or Unique Anomaly? Stanford, CA, USA, 11–14 July 2011. Paper 81.00.
59. Knop, L. Competence centre for clusters in the regional innovation ecosystem: The case of the Silesian Voivodeship in Poland. In *Global Perspectives on Sustainable Regional Development*; Gorges, I., Ed.; Kovac: Hamburg, Germany, 2015; pp. 79–95.
60. Katz, B.J.; Wagner, J. The Rise of Urban Innovation Districts. *Harv. Bus. Rev.* Available online: https://hbr.org/2014/11/the-rise-of-urban-innovation-districts (accessed on 1 September 2017).
61. Klimas, P.; Czakon, W. Species in the wild: A typology of innovation ecosystems. *Rev. Manag. Sci.* **2021**. [CrossRef]
62. Oh, D.S.; Phillips, F.; Park, S.; Lee, E. Innovation ecosystems: A critical examination. *Technovation* **2016**, *54*, 1–6. [CrossRef]
63. Granstrand, O.; Holgersson, M. Innovation ecosystems: A conceptual review and a new definition. *Technovation* **2020**, *90*, 102098. [CrossRef]
64. Klimas, C.; Williams, A.; Hoff, M.; Lawrence, B.; Thompson, J.; Montgomery, J. Valuing Ecosystem Services and Disservices across Heterogeneous Green Spaces. *Sustainability* **2016**, *8*, 853. [CrossRef]
65. Quinn, J.B.; Anderson, P.; Finkelstein, S. New Forms of Organizing. In *Readings in the Strategic Process*; Mintzberg, H., Quinn, J.B., Eds.; Prentice Hall: Upper Saddle River, NJ, USA, 1998; pp. 362–374.
66. Koening, G. Business Ecosystems Revisited. *Management* **2012**, *15*, 208–224.
67. Szmal, A.; Kowal, D. Knowledge Commercialization Ecosystem-the Case of the AGH University of Science and Technology. In Proceedings of the 5th International Multidisciplinary Scientific Conference on Social Sciences and Arts (SGEM 2018), Albena, Bulgaria, 26 August–1 September 2018; Modern Science. Iss. 1.5, Business and Management. STEF92 Technology: Sofia, Bulgaria, 2018; Volume 5, pp. 601–609.
68. van der Borgh, M.; Cloodt, M.; Romme, A.G.L. Value creation by knowledge-based ecosystems: Evidence from a field study. *RD Manag.* **2012**, *42*, 150–169.
69. Järvi, K.; Almpanopoulou, A.; Ritala, P. Organization of knowledge ecosystems: Prefigurative and partial forms. *Res. Policy* **2018**, *47*, 1523–1537. [CrossRef]
70. Pucci, T.; Runfola, A.; Guercini, S.; Zanni, L. The role of actors in interactions between "innovation ecosystems": Drivers and implications. *IMP J.* **2018**, *12*, 333–345. [CrossRef]
71. Freeman, R.E. *Strategic Management: A Stakeholder Approach*; Pitman: Boston, MA, USA, 1984.
72. Parmar, B.L.; Freeman, R.E.; Harrison, J.S.; Wicks, A.C.; Purnell, L.; de Colle, S. Stakeholder Theory: The State of the Art. *Acad. Manag. Ann.* **2010**, *4*, 403–445. [CrossRef]
73. Ison, S.; Wall, S. Market—and non-market—Based approaches to traffic-related pollution: The perception of key stakeholders. *Int. J. Transp. Manag.* **2003**, *1*, 133–143. [CrossRef]
74. Bosch-Sijtsema, P.M.; Bosch, J. Plays nice with others? Multiple ecosystems, various roles and divergent engagement models. *Technol. Anal. Strat. Manag.* **2015**, *27*, 960–974. [CrossRef]

75. Dedehayir, O.; Mäkinen, S.J.; Ortt, J.R. Roles during innovation ecosystem genesis: A literature review. *Technol. Soc. Chang.* **2018**, *136*, 18–29. [CrossRef]
76. Spitzeck, H.; Hansen, E.G. Stakeholder governance: How stakeholders influence corporate decision making. *Corp. Gov.* **2010**, *10*, 378–391. [CrossRef]
77. Lu, C.; Rong, K.; You, J.; Shi, Y. Business Ecosystem and Stakeholders' Role Transformation: Evidence from Chinese Emerging Electric Vehicle Industry. *Expert Syst. Appl.* **2014**, *41*, 4579–4595. [CrossRef]
78. Kaufmann, V. Modal Practices: On the Rationales behind Car and Public Transport Use of Coherent Transport Policies. *WTPP* **2000**, *6*, 9–18.
79. Schippl, J.; Arnold, A. Stakeholders' Views on Multimodal Urban Mobility Futures: A Matter of Policy Interventions or Just the Logical Result of Digitalization? *Energies* **2020**, *13*, 1788. [CrossRef]
80. World Trade Report 2019. *The Future of Service Trade*; World Trade Organization: Genève, Switzerland, 2019.
81. Wang, L.; Xue, X.; Zhao, Z.; Wang, Z. The Impacts of Transportation Infrastructure on Sustainable, Development: Emerging Trends and Challenges. *Int. J. Environ. Res. Public Health* **2018**, *15*, 1172. [CrossRef] [PubMed]
82. Badassa, B.B.; Sun, B.; Qiao, L. Sustainable Transport Infrastructure and Economic Returns: A Bibliometric and Visualization Analysis. *Sustainability* **2020**, *12*, 2033. [CrossRef]
83. Zhang, S.; Witlox, F. Analyzing the Impact of Different Transport Governance Strategies on Climate Change. *Sustainability* **2020**, *12*, 200. [CrossRef]
84. Final Act and Convention on International Multimodal Transport of Goods. In Proceedings of the Convention on International Multimodal Transport of Goods, Geneva, Switzerland, 24 May 1980.
85. Russo, F.; Comi, A. Measures for Sustainable Freight Transportation at Urban Scale: Expected Goals and Tested Results in Europe. *J. Urban Plan D Asce.* **2011**, *137*, 142–152. [CrossRef]
86. Guerrero-Ibáñez, J.; Zeadally, S.; Contreras-Castillo, J. Sensor Technologies for Intelligent Transportation Systems. *Sensors* **2018**, *18*, 1212. [CrossRef] [PubMed]
87. Załoga, E.; Wojan, W. Przesłanki i, uwarunkowania rozwoju ekosystemów mobilności w, oparciu o inteligentne systemy transportowe. *Probl. Transp. I Logistyki* **2017**, *3*, 87–94.
88. Leviakangas, P.; Oorni, R. From business models to value networks and business ecosystems—What does it mean for the economics and governance of the transport system? *Util. Policy* **2020**, *64*, 101046. [CrossRef]
89. Rea, B.; Stachura, S.; Wallace, L.; Pankratz, D.M. Making the Future of Mobility Work: How the New Transportation Ecosystem Could Reshape Jobs and Employment. *Deloitte Rev.* **2017**, *21*, 183–197.
90. Thatcher, J. Defining Digital Supply Chains and Digital Ecosystems. *ASCM Built Upon Apics Glob. Stand. Think. Supply Chain Top.* **2016**. Available online: https://www.apics.org/tes/apics-blog/think-supply-chain-landing-page/thinking-supply-chain/2016/09/15/defining-digital-supply-chains-and-digital-ecosystems (accessed on 1 September 2017).
91. Urciuoli, L.; Hintsa, J. Can digital ecosystems mitigate risks in sea transport operations? Estimating benefits for supply chain stakeholders. *Marit. Econ. Logist.* **2020**, 1–31. [CrossRef]
92. Lagorio, A.; Pinto, R.; Golini, R. Research in urban logistics: A systematic literature review. *Int. J. Phys. Distrib. Logist. Manag.* **2017**, *46*, 908–931. [CrossRef]
93. Knop, L.; Kramarz, M. Attractiveness of the region in connection with intermodal transport development. In *Sustainable Logistics and Production in Industry 4.0. New Opportunities and Challenges*; Grzybowska, K., Awasthi, A., Sawhney, R., Eds.; Springer: Berlin/Heidelberg, Germany, 2020; pp. 197–217.
94. Przybylska, E.; Dohn, K.; Knop, L.; Kramarz, M. Implementation model of the multimodal freight transport development strategy in the TRITIA cross-border area. In *Sustainable Economic Development and Advancing Education Excellence in the Era of Global Pandemic, Proceedings of the 36th International Business Information Management Association Conference (IBIMA), Granada, Spain, 4–5 November 2020*; Soliman, K.S., Ed.; International Business Information Management Association: Granada, Spain, 2020; pp. 13702–13713.
95. Mitchell, R.K.; Agle, B.R.; Wood, D.J. Toward a theory of stakeholder identification and salience: Defining the principle of who and what really counts. *Acad. Manage Rev.* **1997**, *22*, 853–886. [CrossRef]
96. McElroy, B.; Mills, C. Managing Stakeholders. In *People in Project Management*; Turner, R.J., Ed.; Gower: Aldershott, UK, 2003; pp. 99–118.
97. Taschner, S.; Fiedler, M. Stakeholder Involvement Handbook. 2009. Available online: https://www.eltis.org/sites/default/files/trainingmaterials/aeneas_stakeholderinvolvementhandbook_0.pdf (accessed on 14 April 2021).
98. Przybylska, E.; Dohn, K. Analysis of Intermodal Freight Transport Stakeholders in a Selected Crossborder Area. In *Challenges and Modern Solution in Transportation [Online]*; Stajniak, M., Szuster, M., Kopeć, M., Toboła, A., Eds.; Instytut Naukowo-Wydaw Spatium: Radom, Poland, 2019; pp. 48–62.
99. Salazar, H.J. Towards a new observatory for science and technology in Colombia. *Res. Eval.* **1996**, *6*, 201–204. [CrossRef]
100. Bonnafous, A. Permanent Observatories as Tools for Ex-Post Assessment: The French case study. *Int. Transp. Forum Discuss. Pap.* **2014**, *10*, 14–30.
101. Roggeri, P.; Belward, A.; Mayaux, P.; Eva, H.; Brink, A.; Dubois, G.; Peedell, S.; Leo, O. Sustainable development in developing countries: The African, Caribbean and pacific observatory. *Technol. Econ. Dev. Econ.* **2010**, *16*, 736–752. [CrossRef]

102. Olko, S. Regional Observatory of technology-theoretical framings and practical implementation: Case study. In Proceedings of the 21st European Conference on Knowledge Management, ECKM 2020, Coventry, UK, 2–4 December 2020; Alexeis, G.-P., Simkin, L., Eds.; Coventry University, Academic Conferences International Limited: Coventry, UK, 2020; pp. 895–903.
103. Mahdavi, I.; Mohebbi, S.; Zandakbari, M.; Cho, N.; Mahdavi-Amiri, N. Agent-based web service for the design of a dynamic coordination mechanism in supply networks. *J. Intell. Manuf.* **2009**, *20*, 727–749. [CrossRef]
104. Margarisova, K.; Vokacova, L.; Kuralova, K. Marketing support for local producers' agrarian perspectives XXVIII: Business scale in relation to economics. In Proceedings of the International Scientific Conference, Prague, Czech Republic, 18–19 September 2019; pp. 152–158.
105. Frankowska, M. The role of third party cluster managers in strengthening cooperation of cluster companies. In Proceedings of the 15th European Conference on Management, Leadership and Governance ECMLG 2019, Porto, Portugal, 14–15 November 2019; Academic Conferences and Publishing International Limited: Reading, UK, 2019; pp. 141–149.
106. Enger, S.G.; Gulbrandsen, M. Orchestrating collaborative projects: Inside ICT networks in Horizon 2020. *Sci. Public Policy* **2019**, *47*, 396–409. [CrossRef]
107. D'Cruz, J.R.; Rugan, A.M. *Multinationals as Flagship Firms: Regional Business Networks*; Oxford University Press: Oxford, UK, 2000.
108. Rey, D.; Bar-Gera, H.; Dixit, V.; Waller, T. A Branch-and-Price Algorithm for the Bilevel Network Maintenance Scheduling Problem. *Transp. Sci.* **2019**, *53*, 1455–1478. [CrossRef]
109. Papadopoulos, A.A.; Kordonis, I.; Dessouky, M.; Ioannou, P. Coordinated Freight Routing with Individual Incentives for Participation. *IEEE Trans. Intell. Transp. Syst.* **2019**, *20*, 3397–3408. [CrossRef]