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Airport Business Ecosystem

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Niemczyk Jerzy[1], Walków Marcin[2], Trzaska Mateusz[3], Trzaska Rafał[4]

Abstract:

Purpose: *The aim of the research, the results of which are presented in this article, is to demonstrate the usefulness of the ecosystem theory for the description and analysis of airports.*
Methodology: *The study used a critical literature review, desk research analysis, and the deduction method.*
Findings: *The result of the research is a model of an airport as an ecosystem.*
Practical implications: *Contribution to the development of management sciences is expanding knowledge on the use of the ecosystem theory to describe, research, and learn about airport organizations.*
Originality: *In the article it was formulated model of sources of the effectiveness of organization's ecosystem and model of sources of the effectiveness airport Business ecosystem*

Keywords: *Management, strategic management, ecosystem, air transportation.*

JEL Classification: *M10, L93, L20.*

Research type: *Research article.*

[1]*Department of Strategy and Management Methods, Wroclaw University of Economics & Business, Wroclaw, Poland, jerzy.niemczyk@ue.wroc.pl;*
[2]*mwalkow@gmail.com;*
[3]*Department of Strategy and Management Methods, Wroclaw University of of Economics & Business, Wroclaw, Poland, mateusz.trzaska@ue.wroc.pl;*
[4]*Department of Strategy and Management Methods, Wroclaw University of Economics & Business, Wroclaw, Poland, rafal.trzaska@ue.wroc.pl;*

1. Introduction

Management in theory and practice is constantly developing, continually discovering new research objects, constructing novel research theories, creating new ways of explaining organizational and management problems.

At the end of the 20th century, attempts to describe the organization using network theory appeared in management's theory and practice. The first attempts to explain the network phenomenon referred to relational resources as essential tools for building an advantage in The Resource-Based Approach to strategy. Subsequent studies showed the explanation of network efficiency as a means of reducing transaction costs. The reasoning based on transaction costs is still valid and, as further research is enhanced, is becoming more and more credible. According to which networks are a tool for the evolutionary adaptation of an organization to new conditions for conducting economic activities, a notable contribution to the development of research on networks is made by Nelson and Winter's evolutionary theory of economic change.

Still, other studies indicate specific properties of the network inherent only to networks. These include research referring to the network effect theory (Katz and Shapiro, 1985). Subsequent research is carried out using complexity theories to describe the network as a specific object eligible for mathematical description theories. Currently, following the logic of networks and complexity theories, networks are treated as business ecosystems. In the research, the results presented in this article assumed that ecosystems are an extension of the network theory under new operating conditions. Moreover, it was assumed that business ecosystems refer to:

- life sciences heritage interpreting the ecosystem as a unique way of adaptation;
- resource-based theory indicating that the ecosystem meets the needs of stakeholders;
- network theory in terms of value creation in the network of network values and effects;
- systems theory;
- mechanisms of complexity theories.

The choice of the airport as the research object was dictated by the premise indicating the high research potential of such an organization as a complex object, evolving from a simple formula of an airport station to an international transfer center, intertwined with a global network of logistic connections with the features of the business ecosystem. As an object that uses high-tech achievements, the airport is also the forerunner of many other innovative organizational solutions. Therefore, it is worth subjecting such an entity to the study, the aim of which will be to understand and generalize the observed regularities for this class of objects. Understanding the logic of the airport's strategy as a business ecosystem will allow us to interpret other similar objects' behavior and create practical recommendations that will enable avoiding

errors in defining strategic goals of complex institutions operating in many sectors under circumstances of globalization and exceptional susceptibility to external disturbances.

The article aims to demonstrate the usefulness of the ecosystem theory for the description and analysis of airports. The obtained results will be used to build knowledge about ecosystems, primarily in epistemology, facilitating the understanding of ecosystems and creating practical recommendations. The research will use the critical literature review, the desk research method, and the case study. The research will use data from desk research reviews of reports and documents on airport activities.

2. Literature Review

2.1 The Business Ecosystem: Selected Research Findings

In the second decade of the 21st century, the business ecosystem has become a prevalent metaphor in management sciences. Its cardinal form refers to the systems theory proposed, among others, by Bertalanffy (1967) in the mid-twentieth century – precisely the general theory of systems (or the general systems theory – GST). The central concept of the systems theory was and still is "system." The systems theory is a set of various canons of knowledge subordinated to a dozen or so deductively established system behavior rules. At its core, systems theory is a deductive theory and proposes various forms of modelling phenomena and thus looking for cause and effect explanations.

The first explanations about the ecosystem indicated that the ecosystem theory was very close to the biological sciences. One of the founders of the systems theory - W. Cannon's - was a biologist, and his concept of homeostasis comes exactly from biological sciences. Biology significantly enriched the theory of systems cognitively. Another explanation of the ecosystem is to refer directly to K. Darwin and A. Wallace's evolutionary theories. For the first time, however, it was formally done by Moore (1993). According to him, the ecosystem is "an economic community supported by a foundation of interacting organizations and individuals - the organisms of the business world." A simple analogy to biology was used in 1990 by M. Rothschild when he spoke about the capitalist economy as an ecosystem. In M. Rothschild's analogy, firms serve as biological organisms and industries as species. "Like the organisms and species that make up the global ecosystem, global companies and industries have spontaneously co-evolved to create a huge living ecosystem" (Rothschild, 1990). Despite the natural sources of the theory of evolution, such perception of the ecosystem still requires deductive inference, and to some extent, also inference by analogy.

Explanations of the ecosystem can also be sought in the Resource-Based theory, which indicates that the ecosystem is oriented towards meeting stakeholders' needs (Leibold,

Probst, and Gibbert, 2005; Rong *et al.,* 2015b; Winter *et al.,* 2018). An exceptional definition is a proposal that is consistent with the dynamic capabilities' theory. Pitelis and Teece stated that the ecosystem is partly endogenous because it is co-created by entrepreneurial managers, and it is as good as the market because it enables the co-creation of social value in the process of private appropriation (Pitelis and Teece, 2010).

We can also find many analogies between the concept of an ecosystem and the network effects arising in network organizations. This context will be discussed in more detail in part 2. Ecosystem theories can also be built based on selected complexity theories. According to A. Wilczyński, "the business ecosystem has the features of a complex adaptive system, its example describes the basic phenomena occurring in complex systems, such as emergence, self-organization or coevolution" (Wilczyński, 2011). Table 1 shows many definitions of the business ecosystem, whose authors refer to the complex systems' features such as coevolution (Moore, 1996; Lewin and Regine, 1999; Peltoniemi and Vouri, 2008, Mitleton-Kelly, 2003), self-organization (Moore, 1996; Power and Jerjian, 2001; Iasiti and Levien, 2004), adaptation and emergence (Peltoniemi and Vouri, 2008, Iansiti and Levien, 2004).

The business ecosystem definitions present in the literature on the subject were created based on various theories and metaphors. They indicate sources related to the systems theory, the complexity theories, the network theories, the evolutionary theories, and many others (Table 1).

Table 1. *Selected definitions of the ecosystem*

Sciences	Author(s)	Definition
Biological ecosystem	Tansley, 1935	a system of biological organisms with a complex set of physical factors forming a network of relationships
	The New Shorter Oxford English Dictionary, 1993	a system of organisms occupying a habitat, together with those aspects of the physical environment with which they interact
	Gove, 2002	a community of living organisms with air, water and other resources
	World Resources Institute, 2001	ecosystems are not just assemblages of species; they are systems combined of organic and inorganic matter and natural forces that interact and change
Industrial ecosystem	Rothschild, 1990	a capitalist economy can best be comprehended as a living ecosystem. Key phenomena observed in nature – competition, specialization, co-operation, exploitation, learning, growth, and several others – are also central to business life.
Social ecosystem	Mitleton-Kelly, 2003	each organisation is a fully participating agent which both influences and is influenced by the social ecosystem made up of all

		related businesses, consumers, and suppliers, as well as economic, cultural, and legal institutions.
Business ecosystem	Moore, 1996	an economic community supported by a foundation of interacting organizations and individuals – the organisms of the business world
	Moore, 1998	extended system of mutually supportive organizations; communities of customers, suppliers, lead producers, and other stakeholders, financing, trade associations, standard bodies, labor unions, governmental and quasi- governmental institutions, and other interested parties. These communities come together in a partially intentional, highly self-organizing, and even somewhat accidental manner
	Gossain and Kandiah, 1998	extended and refined Moore's original concept to recognize the importance of creating value for customers through the provision of additional information, goods, and services and the use of the Internet and other enabling technologies
	Iansiti and Levien, 2004	Like business networks, biological ecosystems are characterized by a large number of loosely interconnected participants who depend on each other for their mutual effectiveness and survival. And like business network participants, biological species in ecosystems share their fate with each other. If the ecosystem is healthy, individual species thrive. If the ecosystem is unhealthy, individual species suffer deeply. And as with business ecosystems, reversals in overall ecosystem health can happen very quickly
	Power and Jerjian, 2001	a system of websites occupying the world wide web, together with those aspects of the real world with which they interact. It is a physical community considered together with the non-living factors of its environment as a unit.
	Peltoniemi and Vouri, 2008	business ecosystem to be a dynamic structure which consists of an interconnected population of organizations
	Kim, Lee and Han, 2010	The ecosystem is mature networks embedded in the perspective of ecological thinking about the behavior of organisms

Source: *Own elaboration.*

This article assumes that the business ecosystem is a system of elements and relationships creating a specific whole. Its crucial purpose is to build the ecosystem's value in general and increase the value of individual elements of this whole based on the network approach's epistemology and selected components of the complexity theory's epistemology. A business ecosystem defined in this way is focused primarily on:

- implementation of the individual entities' statutory goals to the extent that given goals are achieved through belonging to the ecosystem;

- building the value of the entire entity - especially this applies to building value that is impossible to obtain in the case of acting independently, but only through action being the result of the sum of the ecosystem users activities;
- building the value of sub-ecosystems that make up the entire ecosystem;
- building the unit value of each of the ecosystem participants.

2.2 Sources of Ecosystem Efficiency

The business ecosystem defined in this work does not differ much from the network understood as a set of nodes and relations. The web is a more general concept. Therefore, an ecosystem can be understood as a specific type of network or an entity containing certain network features. In the understanding adopted in this study, an ecosystem is an entity that poses a network's characteristics. This assumption was taken because the network can only be seen as a tool for describing a specific graph without indicating the context, e.g., organizational or management. On the other hand, the business ecosystem shows clear connections with concepts such as management, organized system, synergy, and efficiency.

The business ecosystem is focused on building the value of a specific whole and its parts. Ecosystem nodes may or may not be hierarchical, may or may not seek synergies, and may or may not share stakeholders. They do so because of perceiving that the ecosystem creates the possibility of building the mentioned value based on nodes and relationships made available to everyone considering efficiency criteria. In this context, the advantage of the ecosystem over classic organizations with a hierarchical structure and inter-organizational networks comes down to calculating classic forms of effectiveness appropriate for these entities and supplementing them with new sources of efficiency (Table 2). One of the distinguishing features of contemporary organizational network analysis is the use of mathematical and graphical techniques for studying social networks to obtain a concise and structured image of the network. Social network analysis (SNA) can analyze the network of relationships and nodes within the ecosystem. The formal mathematical and graphic methods used to represent data in social networks are based on mathematical principles of graph analysis. Such an approach allows for suggesting and pointing to phenomena that researchers can look for in the collected data (Borgatti and Foster, 2003).

The ecosystem's description can also be made using selected complexity theories mentioned in Part 1. Complexity theories have their origin in the natural sciences, and the basis for their creation was research on the immune system, the nervous system, and multicellular organisms. During the era of information technology development, these theories were developed to include information systems, communication networks, artificial intelligence, and evolutionary algorithms (Brodbeck, 2002). Complexity theories make it possible to understand complex systems, the behavior of which, due to their specificity, is impossible to define or predict (Zahara and Ryan, 2007). One of the system's basic models in complexity theories is the Complex

Adaptive System (CAS) - an open and dynamic system. It can be characterized by self-organization, emergence, interdependence, co-evolution, non-linear behavior, and scalable, system-level opportunities and challenges (Adner, 2012; Moore, 1993; Priem *et al.*, 2013). CAS contains many elements (agents) that interact in different directions (Brodbeck, 2002). Some authors' research indicates that the business ecosystem has a complex adaptive system (Desai, 2010; Ritala and Gustafsson, 2018; Roundy *et al.*, 2018). Emergence, self-organization, and co-evolution are among the primary sources of the business ecosystem efficiency considering complexity theories, and value is created due to the relationships on the edge of chaos between agents.

Table 2. *Sources of the effectiveness of various types of organized activities*

Sources of organizational effectiveness	**Sources of network efficiency**	**Sources of efficiency in complexity theories**	**Sources of business ecosystem efficiency**
Minimization of transaction costs through the use of hierarchy	Minimization of transaction costs by using market contracts	Emergence	Minimization of transaction costs by using market contracts
Synergy effect	Synergy effect	Self-organization. The systems independently acquire and maintain structure without external influence.	Synergy effect
Ownership of resources derived from the hierarchy	The right to use the resources of other nodes resulting from contracting	Co-evolution. Organizations (agents) coexist with each other and together create value dynamically and continuously.	Sharing effect
	Appropriation effect		Appropriation effect
	Convergence effect		Convergence effect
	Effect of dynamic knowledge diffusion		Effect of dynamic knowledge diffusion
	Value network effect		Value network effect
	Network effect		Network effect
			Effects as a consequence of complexity theories (emergence, self-organization, co-evolution)

Source: *Own elaboration based on (Plowman et al., 2007; Halley and Winkler 2008; Anderson, 1999, Niemczyk, 2013).*

The analysis of the information in Table 1 shows that the sources of the business ecosystem's effectiveness are the traditional sources of organizational effectiveness, the sources of network efficiency, and the sources specific only to business ecosystems.

2.3 Evolution of Organizational Solutions at Airports - Nodes and Ties

Airports are a type of business that evolves quickly and allows us to see, almost like in a lens, the changes occurring in the global economy. Just over 100 years of civil aviation development shows that management systems evolve to adapt to the changing needs of technics, technology, and business model of passenger and cargo aviation. Cargo and passenger traffic is growing at a geometric pace and is changing the functions of airports. There are about 2,000 airports globally, including only those operated by entities affiliated with the organization Airport Council International (ACI). They play different roles and try to meet the expectations of the business in various forms.

2.3.1 Airport as a Station

In the early days of civil aviation, planes took off and landed on grassy landing pads, accompanied by a ticket kiosk and a simple waiting area. They were surrounded by farms, fields, and green spaces. However, even then, research institutes and industrial plants were built around the landing sites. Such was the case with the Mokotów airport in Warsaw, established in 1910, or the London Heathrow airport created 15 years later. The primary function of an airport - as an airport station - is to check-in departing passengers and to receive arriving passengers. This assumption can be simplified to a model: arrive - fly away. It is accompanied by a limited infrastructure in shops and restaurants, luggage handling, mail and parcels, parking lots, and a train station. Airports serving as airport stations still exist in their modern form. These are mainly regional airports. They support direct connections (point-to-point, p2p), traditional airlines, and low-cost carriers.

London City is an example of such an airport. East London's Royal Dock's airport handles direct traffic, especially business. Due to its location in a highly urbanized part of the city, the specific approach, and departure path, certain aircraft types can only be used. Such an airport is not adapted to handle transfer traffic and does not have extensive service offers or cargo facilities.

Another example was the Berlin-Tegel airport in operation until 2020, opened in 1948, and later expanded. A characteristic feature was the lack of a traditional restricted and duty-free zone. The security control was carried out at individual gates just before boarding. This fact proves that it was not built to handle interchange traffic, so it could not adapt to the strict and more restrictive security control widespread after the terrorist attacks of September 11, 2001, leading to creating a restricted zone in the terminal.

2.3.2 Airport as a Transfer Hub

In most countries of the world, several decades ago, there was unbundling in air transport, i.e., the ownership separation of air transport from ground handling of passenger traffic. As a result, the airport ceased to be the final stage of passenger or cargo transport and became an independent entity operating based on strategic goals defined by it. After World War II, the development of civil aviation accelerated. The plane as a means of transportation became more and more popular and accessible. In the following decades, larger airplanes debuted, also powered by jet engines, which made it possible to carry more passengers over longer distances. This is how the hub-and-spoke model developed. It consists of airlines with smaller planes from smaller airports bringing passengers to a larger airport. This is where passengers from various directions on a larger plane set off on a further journey, usually transcontinental.

As a transfer hub, the airport serves not only passengers who get to it to travel. The leading client group of the hub is transfer passengers and traditional airlines, also known as network carriers. This model of an airport can be described as "fly-in - wait - fly away." The appearance of this specific element of longer waiting for a transfer has contributed to a significant expansion of non-aviation infrastructure - shops, restaurants, hotels, cinemas, entertainment venues, and fitness centers. Chopin Airport in Warsaw is an example of an airport that has developed from an airport station towards a transfer hub. Its central part is a restricted area, allowing direct transfer from plane to plane. At the airport, there are a coach terminal, railway station, car parks, and hotels (including those until recently belonging to the airport operator - "Polish Airports" State Enterprise). The cargo transport sphere is also expanded. These are the terminals: cargo LS Airport Services, Wellcome, DHL, and UPS. Another example of an airport that has subordinated its functioning to a transfer hub's role is Zurich-Kloten. Being the main base for Swiss airlines, it offers quick transfers (up to 45 minutes) between European and transcontinental connections. A characteristic feature of transfer nodes that have evolved from airports is severe problems with capacity, which result in limitations in the number of passengers served, take-off and landing operations, and the location relatively close to the city center.

2.3.3 Airport as the AirportCity

The further development and democratization of civil aviation based on transfer connections led to airports' "independence." The dynamically operating hubs have become transfer centers, places of doing business; they attracted business, fair and conference centers, headquarters of foreign companies' branches, and modern distribution centers. Network connections and direct connections characterize the airports operating in the AirportCity business model – often in a separate terminal adapted to low-cost carriers' needs. The infrastructure of the sphere of services and accompanying activities is extensive, spatial, and modern. The AirportCity makes it possible to meet the needs of airport customers without having to go to the city center; it can become a destination itself. A characteristic feature of the contemporary AirportCity is designing them in a broader perspective – the business ecosystem.

The flagship example of a European airport operating in the AirportCity model is Amsterdam-Schiphol airport. Although it was initially built as an airport station, it was then intentionally expanded in the spirit of the AirportCity. On the airport's websites, its description can be found, reflecting the idea of the AirportCity: "Schiphol is a city that never sleeps. For passengers, visitors, employees, and employers, there is always something to do: 24 hours a day, seven days a week, and 365 days a year. This is because we are developing Schiphol and our other airports based on the AirportCity formula, in which business, property, commercial services, and leisure facilities also play an important role alongside aviation". (www.schiphol.nl).

Another example of an airport implementing the AirportCity business model is Düsseldorf. It is the central hub of the Lufthansa Group Eurowings and the third largest airport in Germany. In 2003, the AirportCity development project began in the area of 250,000 sq m. Near the airport, a communicatively and visually coherent office and service space have been designed. Together with the nearby Messe Düsseldorf trade fair, they form an independent business center. In this article, AirportCity is the type of airport closest to the business ecosystem's idea.

2.3.4 Other Nodes at Airports

The listed characteristics of the primary node, which is the airport, and the features of the basic types of flows do not cover all potential nodes and relationships occurring in the business ecosystem. In these calculations, it is worth noting that natural nodes are also:

- airport owners,
- airlines,
- airline customers,
- partners and suppliers of airlines,
- airport partners and suppliers,
- state institutions responsible for air traffic and cross-border operations,
- institutions providing services that are not the core competencies of the airport,
- institutions providing cleaning services,
- banking and insurance institutions,
- institutions that provide services to people who are not customers of airlines and use the service, commercial, and production infrastructure of the airport,
- other institutions.

2.4 Resource Flows at Airports

2.4.1 Flows of People

In an airport, three basic types of flows can be distinguished: the flows of people (passengers), the flows of goods (loads), and other flows.

According to the Airports Council International (ACI) Europe organization, in 2019, European airports served 3.2 percent passengers more than a year earlier. "While this is just over half the growth rate registered in 2018 (+ 6.1%) and the weakest performance in 5 years, it still resulted in Europe's airports welcoming a record 2.43 billion passengers in 2019" (ACI Europe, 2019). This number increased by 32% in the last five years, i.e., an additional 595 million compared to 2014. Due to the COVID-19 pandemic and the global crisis it causes, 2020 will be unreliable in this analysis, so even the forecast data are entirely omitted here. Passengers from the perspective of airports can be divided into several primary groups:

- due to the travel purpose:
  - point-to-point (p2p) travelers, i.e., those using direct connections between airports A and B, which is the destination airport,
  - passengers in connecting traffic for whom the hub is a stopover on the way between airport A and destination C.
- due to the nature of the trip:
  - passengers traveling for business purposes - less flexible in terms of prices, often traveling only with hand luggage and returning on the same day,
  - passengers traveling for tourism or family reasons - more flexible in terms of prices, willing to plan their trips in advance.
- by the carrier type:
  - passengers of network carriers,
  - low-cost airline passengers,
  - passengers on charter flights.

Depending on the purpose of travel, its nature, and the type of carrier, the passenger will be more or less willing to use airport services and facilities, e.g., Fast Track, business lounges, shopping in the duty-free zone, hotel accommodation, conference rooms conference facilities, restaurant services, airport transfer, car rental, parking lot, etc.

Table 3. *Flows of passengers at the top 10 airports in the world in 2019*

The airport	Number of passengers (million)
Atlanta Hartsfield Jackson (ATL)	110,5
Beijing Capital (PEK)	100
Los Angeles (LAX)	88,1
Dubai (DXB)	86,4
Tokyo Haneda (HND)	85,4
Chicago O'Hare (ORD)	84,6
London Heathrow (LHR)	80,9
Shanghai Pudong (PVG)	76,2
Paris Charles de Gaulle (CDG)	76,2
Dallas Forth Worth (DFW)	71,5

Source: *Airports Council International: Worldwide Airport Traffic Report. Calendar Year 2019. za: 2019 Airport Traffic Report. The Port Authority of New York and New Jersey. 2020. Retrieved from: https://www.panynj.gov/content/dam/airports/statistics/statistics-general-info/annual-atr/ATR2019.pdf.*

2.4.2 Flows of Loads

Flows of loads constitute a vital part of airports and airlines' activities. Globalization, changes in the business models of industrial companies, the growing role of goods exchange platforms, and logistics companies contribute to the growth of transported goods. Moreover, the year 2020 proved that the importance of revenues obtained from cargo carriers grows in natural disasters.

Table 4. *Flows of loads at the top 10 airports in the world in 2019*

The airport	Number of loads (million tons)
Hong-Kong (HKG)	4,8
Memphis (MEM)	4,3
Shanghai Pudon (PVG)	3,6
Louisville (SDF)	2,8
Seoul-Incheon (ICN)	2,8
Anchorage (ANC)	2,7
Dubai (DXB)	2,5
Doha Hamad (DOH)	2,2
Taipei Taoyuan (TPE)	2,2
Tokyo Narita (NRT)	2,1

Source: *Airports Council International: Worldwide Airport Traffic Report. Calendar Year 2019. za: 2019 Airport Traffic Report. The Port Authority of New York and New Jersey. 2020. https://www.panynj.gov/content/dam/airports/statistics/statistics-general-info/annual-atr/ATR2019.pdf.*

2.4.3 Business Flows

Airport revenues are divided into two basic types: aviation revenues and non-aviation revenues. Aviation revenues include receipts from airlines and aircraft users for services such as landing and take-off, stop at the airport tarmac, use of the sleeve connecting the terminal to the aircraft deck, passenger and baggage check-in, fuel. Non-aviation revenues are derived primarily from passengers and other airport users.

They include income from renting commercial space (shops, restaurants, service points), sales in vending machines, access to business lounges run by the airport operator, and parking fees. The more an airport evolves towards a hub, and further - the AirportCity - the greater the share of non-aviation revenues in its revenue structure. The total value of airport revenues in the world in 2018, according to ACI, amounted to $ 178.2 billion, of which 55.9% were aviation revenues. On a per-passenger basis, that is $ 17.95. (aci.aero/news/2020/04/22/).

2.4.4 Other Sets of Nodes and Ties

The aforementioned characteristics of the flow types do not exhaust all potential nodes and ties occurring in the business ecosystem. Among other reports, it is definitely worth pointing to:

- investor relations, more broadly capital (ownership) relations,
- legal relations resulting from the consequences of state, international and local air traffic regulations and the handling of this traffic,
- media relations,
- relations with banking and insurance institutions,
- relations resulting from corporate social responsibility,
- other relationships.

3. Model of the Airport Ecosystem

What is characteristic of the evolution of the airport operating model is continuous, reactive adaptation to new operating ways. The indicated examples mainly concerned the transformation of already existing ports. In the case of airports designed as greenfield institutions, we are dealing with a project mature enough to consider the current and planned functions of the airport. In many cases, there is space for the so-called options. Most often, it is about not using a particular area to respond to new challenges in the future. Unfortunately, in new airports, we rarely deal with creating new solutions that could determine the emergence of new, non-existent airport functions. Therefore, it takes the form of a controlled ecosystem construction and not activities to create conditions for forming a spontaneous ecosystem. It is influenced by the legally regulated nature of the entire sector, dependence on airlines' business models, high level of capital expenditures and long construction cycles, and the sector's susceptibility to natural and technological disasters.

The network ecosystem model mainly includes a set of nodes and a set of ties described on these nodes. However, such a model would be used if the airport was treated as a network. The ecosystem is something more. The synergy effect of sharing with the share economy and emergence, self-organization, and co-evolution effects form complexity theories (Table 2).

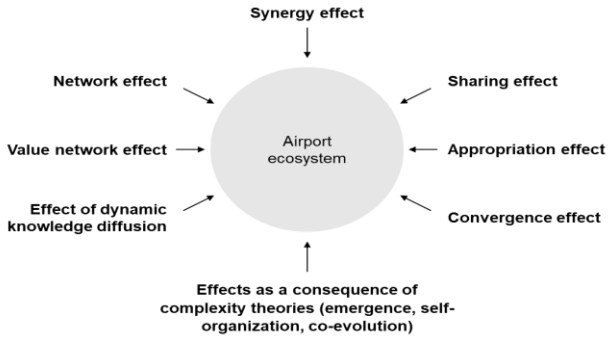
Therefore, in the strategic analysis of an airport understood as an ecosystem, the following should be used, transaction cost analysis, experience curve analysis, structural analysis, network analysis (such as knowledge diffusion, value network analysis, network analysis, appropriation analysis, social network analysis, PARTS analysis, synthetic meter for orchestrators of business networks, model of competitive forces of the network field, the mechanism of shaping the company's competitive advantage, network model for assessing flows between sectors, strategic balance, scenario methods) and the analysis of the complex adaptive system that identifies the features complexity theory. The use of these methods will allow us to understand the

logic of ecosystems from the effectiveness perspective. It will allow indicating an adequate airport as an ecosystem development strategy.

To increase the depth and insights derived from the analysis, it is worth using graphic models. The authors suggest several graphical presentation methods when analyzing airports as an ecosystem.

The first proposal is a graphic illustration of the sources of ecosystem efficiency from Table 2. These nine effects can co-occur. It will then be an exceptionally mature ecosystem that draws strength from all its components. This representation does not involve agents and relationships between them. It is unknown which node or partner of the ecosystem is essential to the core or ties between them.

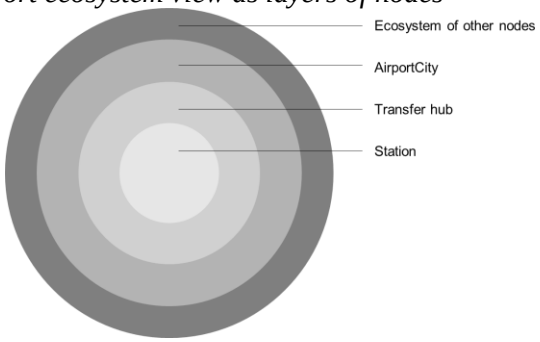
Figure 1. *Airport ecosystem viewed as sources of business ecosystem efficiencies*



Source: *Own elaboration.*

The second proposal is a system of overlapping circles, in which each successive wheel is a group of nodes classified from the position of the following added groups of customers and manufacturers. The farther from the center of such a circle, the greater the risk associated with the acquired node. This view shows the relationships between different layers of the ecosystem and the depth of ties, but one cannot analyze the direct relationship with the core.

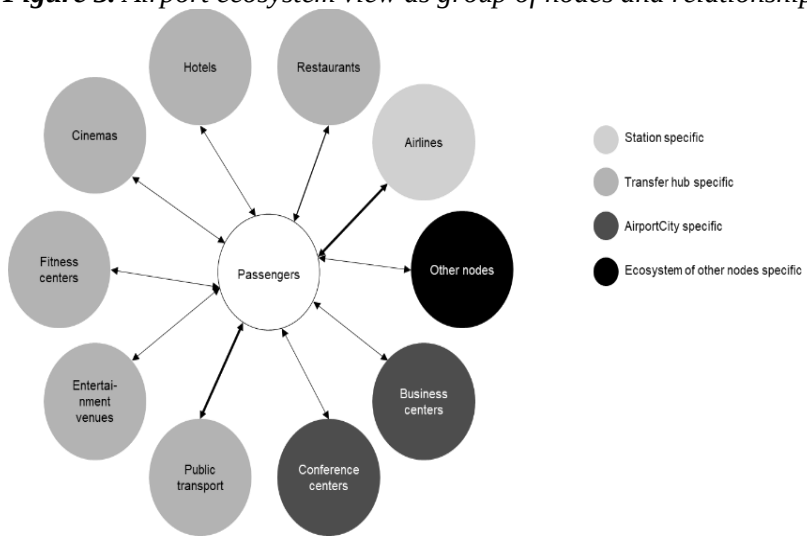
Figure 2. *Airport ecosystem view as layers of nodes*



Source: *Own elaboration.*

The third proposal takes into account the classic picture of the network of nodes and relationships. Emphasizes the size of the nodes as measured by the area of the circle assigned to the node. The vectors and their width show the scale of the triggered flows. This model shows the relationship between agents and how they are essential to the core, passengers.

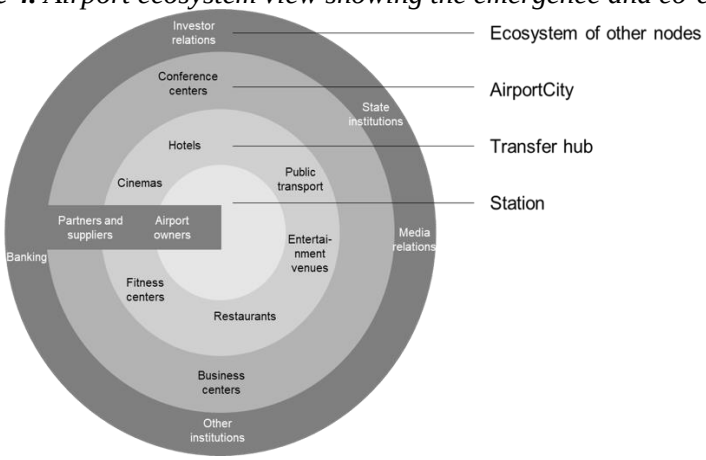
Figure 3. *Airport ecosystem view as group of nodes and relationships*



Source: *Own elaboration.*

The fourth proposal includes the network effect. The distance of the circle representing the node from the center of the scheme indicates the degree of participation of a given node in the unconditional offer of ecosystem nodes. This shows to some extent, the emergence effect and co-evolution effect.

Figure 4. *Airport ecosystem view showing the emergence and co-evolution effect*



Source: *Own elaboration.*

The presented proposals are based on analysis and graphic presentation of selected ecosystem effects present in the literature. At the same time, the authors' proposals of these studies try to indicate the relationship of all these effects within the ecosystem.

5. Conclusions

The aim of the research, the results of which are presented in this article, was to demonstrate the usefulness of the ecosystem theory for the description and analysis of airports.

The conducted analyzes, supported by literature review and the deduction process, indicate the usefulness of the ecosystem concept for the description and analysis of airports. Literature research has shown that an airport has been treated like any organization so far as a collection of people, resources, and relationships. Management research (apart from logistics), in which it would be the subject of strategic analyzes, was relatively less frequent. In this context, the modern one, mainly anchored in: network theory and complexity theories - ecosystem theory, offers excellent opportunities to show the flows (people, cargo, finance) between numerous airport nodes. A feature of the ecosystem is that all its nodes are treated as producers and customers. This allows increasing the airport's revenue calculated per customer served constantly. The ecosystem allows you to show it all.

In 2020, the covid-19 pandemic began. Airlines and airports were the companies most adversely affected by the pandemic. Hence, the studies deliberately ignored this temporary decline. It does not appear that the pandemic will also change the role of the airport. It will undoubtedly increase the cost of their construction and operation by increasing the safety of people in the face of disasters.

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