DOI: 10.6977/IJoSI.202406_8(2).0003
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Three possible sources of inconsistency in an innovation ecosystem

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(Received 22 August 2023; Final version received 19 April 2024; Accepted 23 April 2024)

Abstract

One of the success factors of an innovation ecosystem is the willingness of its actors to cooperate, which depends on a number of factors. As usual, cooperation needs a common language among the concerned parties and opposite sides, the identification of serious differences of actors might contribute to preparing and managing a collaborative culture. In the present analysis, the authors approach the topic from an operational management perspective and examine the actors of an ecosystem through the elements of a general service management framework model. Based on this, it is possible to point out differences through various factors to determine possible conflict sources. The aim of the study is to show a method for the identification of potential points of inconsistency along the four groups of aspects as potential sources of barriers to collaboration. After literature review, the value system, the operational-business philosophy, the methods and the objectives of a research and technology center are analyzed. The presented approach can serve as a general method for identifying inconsistencies in innovation ecosystems. The current methodology is based on a two-dimension one-by-one analysis, further research can extend the approach to a multi-player inconsistency evaluation tool.
Keywords: innovation, innovation ecosystem, value creation, research centers

1. Introduction

An innovation ecosystem can be seen as a system whose participants are suppliers and customers having relations to each other and to external organizations. However, the diversity and structure dynamism of an innovation ecosystem firmly differ from the usual company environment. Therefore, the introductory parts of this paper are first started from the point of view of classic value supply models, then characterization of innovation ecosystem attributes is followed. Finally, service management perspective is taken to focus on specific features of innovation ecosystems in part 3. The main goal is to be able to identify the cooperation potential between the actors of each innovation eco-system based on the various operational aspects. Since the actors are different organizations, cooperation is not self-evident... in fact, it is difficult. This may be due to the fact that companies are afraid to share their business secrets and technological solutions with others, because they see each other as competitors. If we can reach the level where they see each other as partners, we can also increase their willingness to cooperate. All this affects the potential for cooperation.

For this consideration, a general model of producer-supplier systems can be applied to evaluate and understand the functioning of a value creation system, as a basic approach (Figure 1).

Many companies have developed a formal system to govern their operations, such as Toyota Production/Business System (TPS/TBS), Audi Production System (APS), World Class Manufacturing of Unilever (WCM), or in the services sector, the Global Delivery Framework (GDF).

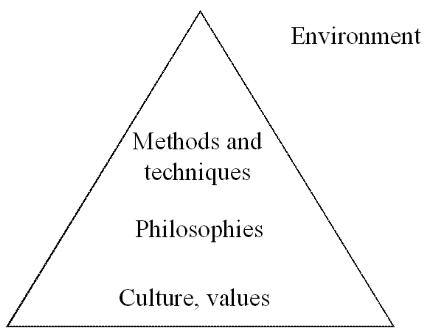

Figure 1. Components of production systems (Smith, 2017)

As production and service companies organize

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their tasks into supply chains and networks, the organizations involved in the innovation ecosystem also develop a diverse external and internal network of relationships. These relationships, especially internal ones, go beyond traditional customer-supplier relationships and include more informal elements than usual. These are the interactions that help to sustain an innovative and developing operation environment.

Figure 2 is a more detailed unfolding of Figure 1, showing the components in view of the relationship between the two organizations.

The question arises, what is the relationship between the components of the operating system within an innovation ecosystem? Is there a need for alignment and if so, to what extent, for example in terms of objectives, values, and operational philosophy? Is it even worth addressing or should it be left to develop spontaneously? In a related exploratory study, actors were looked at in a specific ecosystem with the aim of identifying what is called incongruities between the elements of the operational systems. During the analysis, pairwise comparisons were performed, as shown in Figure 2.

These elements are subsequently used to define the structural elements of a comprehensive service management framework that can be understood in an innovation ecosystem.

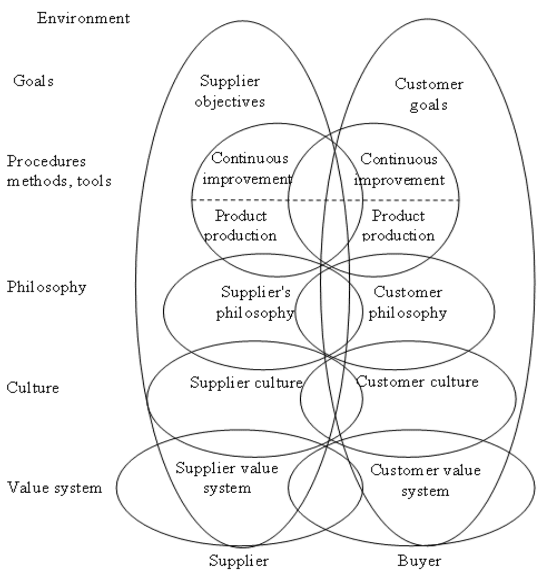

Figure 2. Relationship between the operating system components of organizations (Smith, 2019)

The figure shows that in order for value creation to start within an innovation ecosystem, the interests and needs of suppliers and customers must be taken into account. It is important to understand the actors of the ecosystem, so we arrive at the creation of value by examining the areas of goals, methods, tools, philosophy, corporate culture, and the value creation system. If we understand these characteristics, we can determine the strength and direction of customer and supplier relationships, as well as the parts that need to be improved.

2. Interpretation and general characterization of innovation ecosystems

Considering that innovation ecosystems are also based on value creation mechanisms, the paper refers to the related publications by West and Wood (2008) and Chesbrough et al. (2014), who argue that an open innovation ecosystem comprises communities of different stakeholders who create value through an open approach, linked by competitive and cooperative relationships. This definition describes well the main nature of the innovation ecosystem approach to value creation. However, it is also important to note that an innovation ecosystem is in fact a network of interconnected organizations, organized around a focal company or a platform (e.g. a technology), which includes both value creation and consumption participants, and leads to the development of new value as a result of the innovation (Autio et al., 2014).

A systematic management background usually aims at managing uncertainty or complexity (Duncan, 1972). In the present case, the study is related to a specific type of innovation ecosystem, an open research center. In such a system, both factors are present, since continuous development and technological change imply uncertainty and the need for constant adaptability. In addition, the collaborative nature of innovation ecosystems and the environmental embeddedness are themselves sources of complexity. Jucevicius and Grumadaite (2014) studied innovation ecosystems as complex adaptive systems (CAS). This concept of smart development takes into account the complex dynamic nature of the system and is based on the promotion of productive self-organization rather than imposing top-down linear solutions. A dynamic system is characterized by localized interactions between a large number and variety of actors: universities, businesses, public institutions, society, resources, etc.

The 'harmonious' and complementary cooperation between these actors is crucial to the effectiveness and efficiency of the system as a whole. The identification and analysis of sources of inconsistency within the system is, therefore, an important area of research. Responses to the environment often evolve spontaneously from bottom-up interactions without central guidance. The innovation ecosystem as a complex system cannot necessarily be explained by simple input-output processes. The spontaneous and dynamic interactions between actors in the network can make the system difficult to predict. Advanced innovation ecosystems thus balance on the 'edge of chaos', where creativity and innovativeness are at their highest levels simultaneously (Mason, 2007). Innovation ecosystems can be described as intelligent systems because of their openness, interaction with the environment, self-organization and emergence, adaptability, and flexibility (Murthy and Krishnamurthy, 2003); this should be taken into account when defining the related management methods.

Although it is intended to apply the tools and systems of operational management in understanding the value chain management of innovation ecosystems, it is important to take into account the specialties of the different corporate environments. The innovation ecosystem, as a social system, is the result of the interaction of different cultural, economic, institutional, and technological factors. Thus, the model of social self-organization presented by Fuchs (2002) can be adapted. This model emphasizes the dynamics of actors, forces, relationships, and outcomes of interactions within and between subsystems of social systems. The selection of mechanisms for the development of an innovation ecosystem therefore requires identifying the main agents, forces, relationships, and outcomes that result from interactions within and between subsystems; and then identifying the weakest parts and the forces, relationships, or outcomes that have the greatest impact on them. Consequently, the value chain management system approach needs to be understood both at the level of the ecosystem actors and at the level of the whole system.

3. Service management framework in an innovation ecosystem

One of the fundamental practices of operational management is the Toyota Production System (TPS), already mentioned, which has been the basis for many production management systems. **Figure 3** shows Liker's interpretation (Liker, 2004).

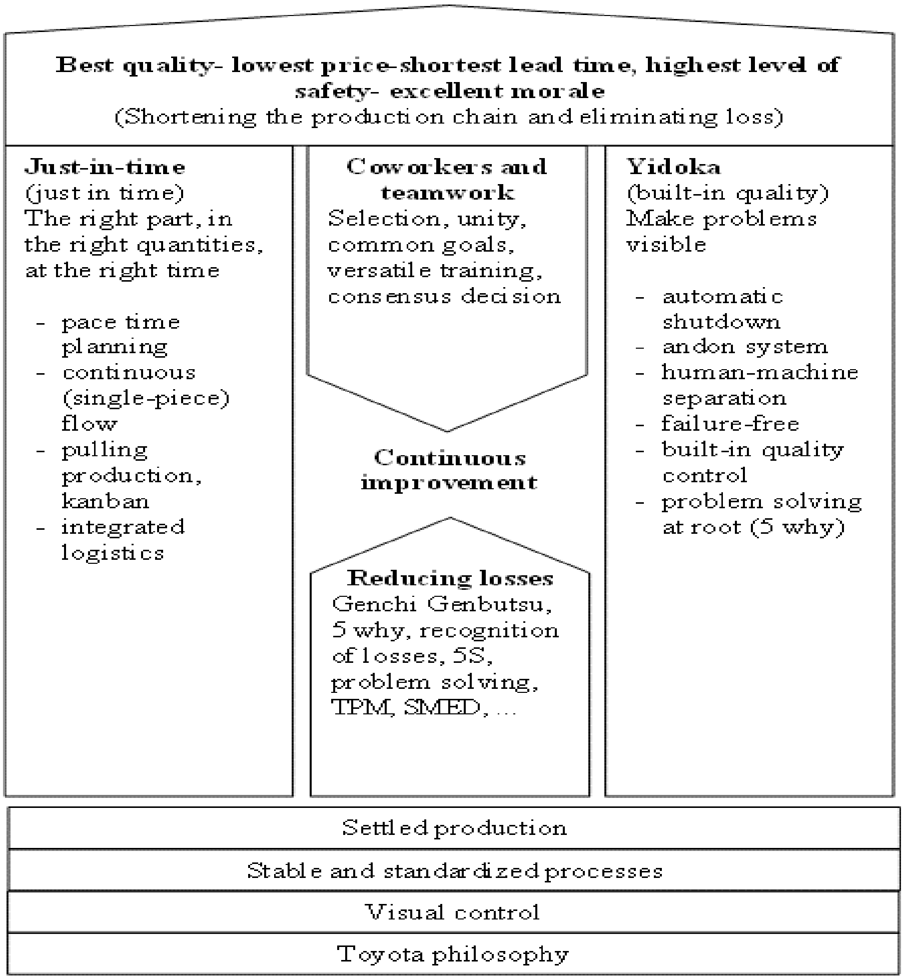

Figure 3. Toyota Production System (Liker, 2014)

It is easy to see that the objectives of the model can also be agreed for services. Quality assurance and continuous improvement are also essential components of service systems. In services, there is less material flow, less stock, and more user participation (co-creation) in the processes, more queues.

In the service domain, the number of similar models is much more limited, an example is shown in **Figure 4.**

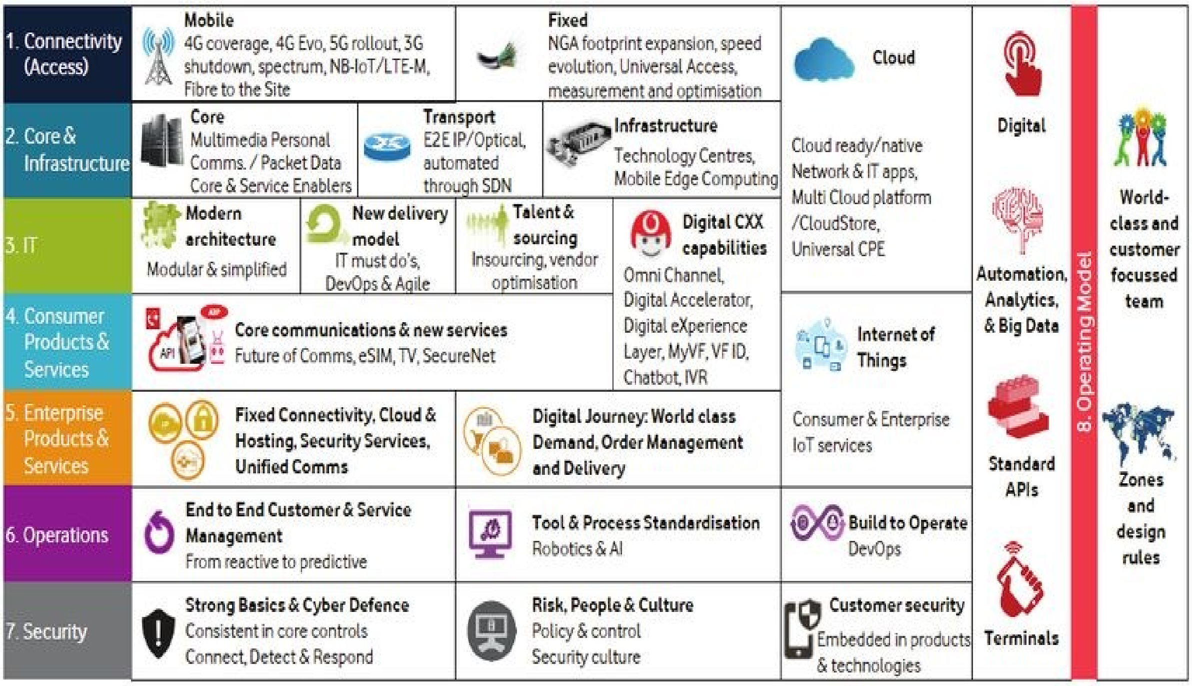

Figure 4. Service Management Model Vodafone (Kerr and Moloney, 2018)

The importance of collaboration is crucial within the innovation ecosystems. In the following, related research is referenced in view of the service management perspective.

Harmonious and complementary cooperation between actors is critical for the effectiveness and efficiency of the whole system. Identifying and investigating sources of inconsistency within the system is, therefore, an important area of research. Responses to the environment often evolve spontaneously from bottom-up interactions without central guidance. Advanced innovation ecosystems thus balance on the 'edge of chaos', where creativity and innovativeness are at their highest levels simultaneously (Mason, 2007).

What distinguishes ecosystems from purely market-based service structures is that the actors are bound together by certain interdependencies, for example, they all adhere to certain norms. In this sense, ecosystems are different from pure networks, even if the networks are formal or informal alliances between actors (Powell, 2003). In ecosystems, the customers must associate themselves with a group or platform to be able to take advantage of its specific benefits (Hagiu &Wright, 2015).

As Teece (2018) points out, to exploit opportunities for collaboration within the ecosystem, organizations should seek complementarity of purpose, but this can take several forms depending on the nature of the collaboration. Complementarity, a descriptive characteristic of the relationship between actors, can be used to clearly express the relationships between actors within an ecosystem. Hence, it is particularly important to identify and visualize the similarities or differences between the characteristics of the actors.

4. Specific case: ZalaZONE Science & Technology Park

4.1 Research problem discussed in the paper

One of the key benefits of an innovation ecosystem is the collaborative environment offered for its actors to operate in. As usual, cooperation needs a common language among the concerned parties and the opposite side, the identification of serious differences between actors might contribute to preparing and managing a collaborative culture. In the present analysis, the authors approach the topic from an operational management perspective and examine the actors of an ecosystem through the elements of a general service management framework model. Based on this, it is possible to point out differences through various factors in order to determine possible conflict sources. The aim of the study is to show a method for identification of potential points of inconsistency along the four groups of aspects as potential sources of barriers to collaboration. After literature review, the value system, the operational-business philosophy, the methods, and the objectives of a research and technology center are analyzed. The presented approach can serve as a general method for identifying inconsistencies in innovation ecosystems.

4.2 ZalaZONE Service Management System

The unique proposition of the ZalaZONE Automotive Proving Ground in Hungary is, that it not only offers the possibility to perform traditional vehicle dynamics tests, but also allows validation tests of automated, connected and autonomous (self-driving) vehicles, as well as electric vehicles. The first modules of the test track were already completed in 2019, and since then, the testing modules are available to customers. The 230 ha testing facility became completed in 2021, now it is in operational mode.

The ZalaZONE Science and Innovation Park is an innovation ecosystem around the proving ground aiming to create an environment that contributes to strengthening the translational impact of the test track. It is expected to result in the establishment of leading R&D and innovation companies, building on and collaborating with universities, research institutes and other service providers, and industrial companies that have established R&D bases locally. The ZalaZONE Research and Technology Center, as a knowledge hub and driver of the park, has been operative since 2019 and, through its tenant actors, offers in-vehicle measurements, simulation support, vehicle-level radar sensor testing, mechatronics, and engineering services.

Figure 5 summarizes the service management system model for the ZalaZONE Research and Technology Center, built on the theoretical considerations presented above, especially the model of Figures 1 and 2 and key findings of Chapter 3.

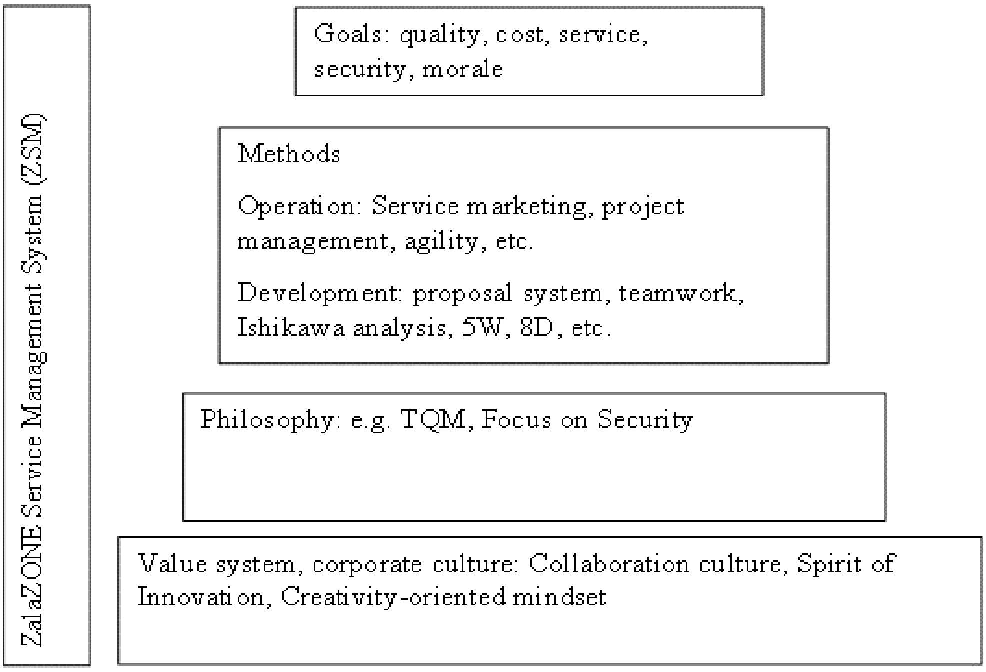

Figure 5. Service management system model for the ZalaZONE Research & Technology Center (own editing)

4.3 Structure of the ecosystem

The actors of the ZalaZONE Research and Technology Centre as an ecosystem are players from both the industry and the scientific field. The players are mentioned in an anonymous way, with identification numbers during the whole analysis.

- Univ_1: research group, whose main task is to support the research of headquarter university and its partners related to the use of proving ground and the practical validation of the specific developed concept supporting the testing methods of self-driving vehicles.
- Univ_2: a research group whose main tasks are to support the research of base university and its partners related to the use of proving ground and to develop and operate the university's industrial service site in Zalaegerszeg.
- Univ_3: is present in education in Zalaegerszeg and the region in cooperation with the ZalaZONE Research and Technology Center. The base university has been an active participant in the region's higher education activities in the field of engineering for decades.
- Serv_1: the R&D department of the ZalaZONE Automotive Proving Ground and the unit coordinating the research use of the test track.
- Serv_2: the unit coordinating the dual and trainee student base around the whole ecosystem and the student community connected to the Science and Innovation Park.
- Serv_3: contributes to the development and competitiveness of industrial enterprises, in particular mechanical engineering enterprises, by providing complex technical R&D services; provides physical solutions to complex industrial problems requiring innovative directions, broad perspectives, and often comprehensive analysis.
- Serv_4.: one of the few companies in the world to offer a contactless vehicle data reading and processing solution to customers, independent of vehicle manufacturers; their contactless sensor product is a unique method of connecting to the network of vehicles.
- Serv_5: is active in the manufacturing enterprise producing of components for production lines, the manufacturing of equipment for the transport and storage of components and finished products in factory areas, the manufacturing of components for the drive train family of agricultural machinery.
- Serv_6: provides consultancy, development, and service activities in the field of mechatronics for a wide range of industries, both domestic and foreign customers; contributes to the success of its partners through its innovation and consultancy activities.

The players make their own business or research activity for the specific target groups in line with the corporate policies. However, the environment of ZalaZONE Research & Technology Center as micro-ecosystem also offers and encourages possibilities of co-operation among these players. The nature of co-operation can be one-by-one, but can be also consortia-type, involving more organizations. The base co-operation level is the classic client-supplier relation, but in some cases partnership approach is also arising.

The methodology of the study builds on the model shown in Figure 5, with the main characteristics of the actors of the research center being analyzed on the basis of its elements.

4.4 Method of the analysis

The aim of the analysis is to examine the concept of the ZalaZONE Service Management System by evaluating the characteristics of the actors of the research and technology center as a specific “micro-ecosystem”. The research approach is built on the findings summarized in literature review, especially those of Smith (2017) and Smith (2019). Method-related questions also considered research findings shown in Chapter 3, especially Toyota value approach.

In the following, the content of the research is summarized.

Value system, corporate culture:

It is assumed that the value system of a company is derived from its ownership background. The organizational culture is different for an SME, a large enterprise, a university or a public operator. The study therefore examined the ownership background of the actors in the ecosystem.

Philosophy:

To position the actors in an innovation ecosystem, it is necessary to assess the characteristics of technology-intensive versus research-intensive organizations and, on this basis, infer the business and innovation philosophy of the actor. For this purpose, the so-called KIBS/NTBF evaluation method is used (Tóth-Háry, 2021), which classifies organizations into the category of R&D service provider or Knowledge Intensive Business Service (KIBS) or New Technology-based Firms (NTBF) based on the approach of (Xiuqin et al., 2018). Based on experiences and research, the operational and business philosophy of an R&D service provider, a knowledge-intensive business service provider, a new technology-based firm is significantly different.

Methods (operations and development):

Within this aspect, a survey of the management methods used could be carried out, however, the research center currently under study includes small organizations, many of them established in the near past, and such a survey would not show the real methodological background. At the same time, it makes sense to look at the systematic management of orders/projects, the orderliness of the area, and the control of financial processes in this type of company, and therefore specific aspects were taken into account when surveying organizations:

1. Business plan, strategic approach
2. Organizational structure
3. Systematic management methods for projects/orders
4. Territorial organization
5. Cost controlling methods
6. Understanding and commitment to the ecosystem
7. Contribution to the ecosystem
8. Definition of objectives

Objectives:

All organizations operate according to defined management objectives. The highest-level indicators are usually turnover, number of employees, profit, and equity. These provide a general way of looking at the actors in an ecosystem, in particular considering the trend of the indicators.

Data collection was made in two ways: through interviews with executive leaders of actors within ZalaZONE Research and Technology Center (see method any philosophy sections), and by evaluation and processing of publicly available company and operational data of the companies (see corporate and goals sections). The research involved 9 actors, out of the total 10 inside the research center in the analysis.

5. Discussion and results

Some introductory considerations are summarized here to prepare the interpretation of the survey results.

Value system, corporate culture:

Table 1 shows the results based on an analysis of the ownership of each organization (Organization size, public or private institution and R&D background), with an assessment on three variables. It can be seen that the ownership structure is diversified, reflected by the matrix. It can be seen that the ownership structure is diversified, SMEs appear in the ownership structure in a similar proportion as large companies. State and private ownership occurred in nearly 50% of the organizations examined. In the case of university actors, it can be observed that they are university-owned, while industrial organizations tend to obtain R&D support from industry/market actors.

Table 1. Ownership background of the examined organizations

Organization	Owner Size		Owner nature		R&D background	
	SME	Large organization	State background	Private property	University player	Industrial/market player
Univ_1		X	X		X	
Univ_2		X	X		X	
Univ_3		X	X		X	
Serv_1		X	X			X
Serv_2	X			X		X
Serv_3	X			X		X
Serv_4	X			X		X
Serv_5	X			X		X
Serv_6	X			X		X

Philosophy:

The assessment was carried out on the basis of the so-called KIBS/NTBF approach and shows the given profiles in Figure 6. It can be seen that each organization is a mixture of the three categories, but dominant characteristics can be identified on this basis case-by-case. The university actors are more open to new technologies and knowledge intensity, while the organizations are less oriented towards technology intensive and look for new technological solutions related to their scientific peers.

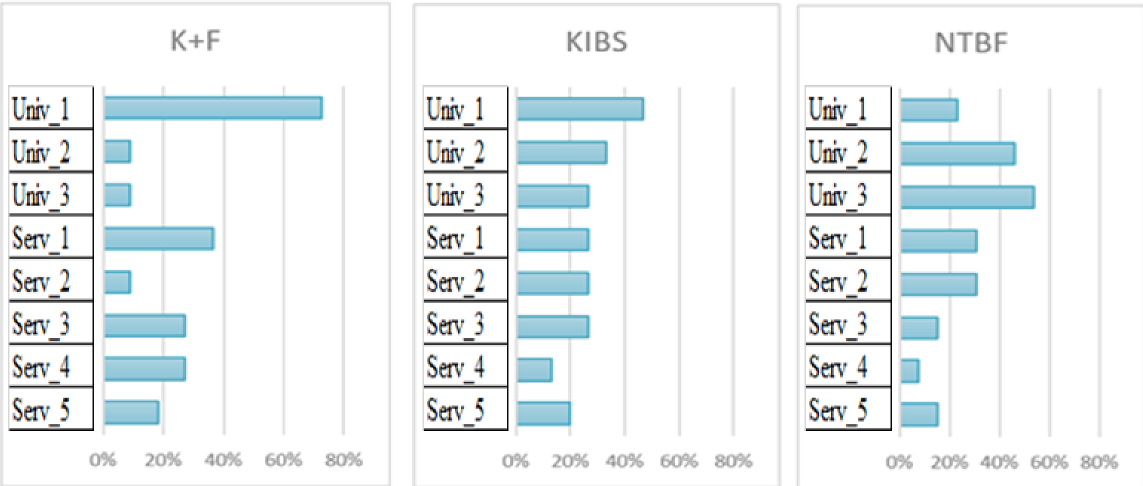

Fig 6. Nature of the examined organizations

Methods (operation and development):

Looking at each organization based on the seven criteria, the assessment in Table 2 was given on a scale of 1 to 4 (where: 1 uncharacteristic, 4 very typical). The results are scattered, with a dominant value 4 in many cases, which is a positive reflection of systematic operations. The seven criteria reflect the operational model approach of organizations (strategy, organization, methods, goals, etc.). The results show that all of the 7 criteria are considered very typical (4) by the respondents.

Table 2. Evaluation of the methods of the examined organizations

Players	Business plan, strategic approach	Organizational structure	Systematic management of projects/order	Area order	Cost controlling methods	How well he understands and how committed he is to the ecosystem	Contributing to the ecosystem	Set goals
Univ_1	1	3	4	3	3	3	3	4
Univ_2	4	4	4	4	3	4	4	4
Univ_3	1	1	1	1	1	2	2	2
Serv_1	2	3	4	3	3	3	4	4
Serv_2	3	4	3	2	2	4	4	4
Serv_3	4	4	4	3	3	4	3	4
Serv_4	1	2	2	2	2	2	2	2
Serv_5	2	3	4	3	3	4	3	4
Serv_6	2	2	3	3	3	3	3	4

Goals:

With regard to the main business and operational indicators, the absolute values in thousand HUF and trend direction (+/o/-) have also been taken into account, the results are shown in Table 3. Some of the actor is in growing or start-up phase, while others belong to a more mature mother organization or headquarters.

Table 3. Evaluation of **the** main management metrics of the examined organizations

Players	Number	Turnover	Result	Equity
Univ_1	10	80 000 000	0+	40 000 000
	o	+	o	+
Univ_2	20	105 000 000	0+	15 000 000
	+	+	o	+
Univ_3	2	3 000 000	0+	1 000 000
	o	o	o	o
Serv_1	5	30 000 000	1 000 000	1 000 000
	o	+	o	o
Serv_2	7	45 000 000	0+	60 000 000
	+	+	+	+
Serv_3	15	110 000 000	5 000 000	50 000 000
	o	+	+	o
Serv_4	3	455 932 000	20 857 000	210 792 000
	o	+	+	o
Serv_5	3	105 582 000	25 440 000	83 122 000
	o	o	+	+
Serv_6	2	5 120 000	19 000	3 676 000
	o	+	+	+

In order to identify potential points of inconsistency between the actors in the innovation ecosystem, the actors were examined pairwise, looking for significant points of differences in terms of values, philosophy, methods, and goals. Table 4 shows the basic theoretical approach of the study. It is assumed that the inconsistency, as a possible point of inhibition of cooperation, stems from the significant differences between the actors.

DOI: 10.6977/IJoSI.202406_8(2).0003
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Table 4. Identification of potential inconsistencies between the examined organizations

Players	Univ_1	Univ_2	Univ_3	Serv_1	Serv_2	Serv_3	Serv_4	Serv_5	Serv_6
Univ_1									
Univ_2	ΔC_1								
	ΔM_1								
	ΔF_1								
	ΔY_1								
Univ_3	ΔC_2	ΔC_3							
	ΔM_2	ΔM_3							
	ΔF_2	ΔF_3							
	ΔY_2	$\Delta É_3$							
Serv_1	ΔC_4	..	..						
	ΔM_4								
	ΔF_4								
	ΔY_4								
Serv_2	..	..	..	..					
Serv_3	..	..	..	..	..				
Serv_4	..	..	..	..	..	..			
Serv_5	..	..	..	..	..	..	..		
Serv_6	..	..	..	..	..	..	..	..	

When examining pairs, it is sufficient to analyze one side of the diagonal of the matrix as this way all combinations between actors in the innovation ecosystem could be considered.

In **Figure 7**, there is an illustration of the method along selected pairs as a concrete example, which, on this basis, is suitable for highlighting significant differences between any two actors in the innovation ecosystem.

Element	Characteristic	Univ_2	Serv_3	Variance	Comment
Values, culture: POINT OF INCONSISTENCY!	SME		1	x	Significant differences in ownership and the resulting value system!
	large organization	1		x	
	State background	1		x	
	Private property		1	x	
	University player	1		x	
	Industrial/market player		1	x	
Philosophy	R&D	1	3	x	Part of a difference in philosophy.
	KIBS	2	2		
	NTBF	3	1	x	
Methods	Business plan, strategic approach	4	4		Slight variance, no critical difference.
	Organizational structure	4	4		
	Systematic management of projects/orders	4	4		
	Area order	4	3	x	
	Cost controlling methods	4	3	x	
	How well he understands and how committed he is to the ecosystem	4	4		
	Contributing to the ecosystem	4	3	x	
	Objectives defined	4	4		
Goals	Number	1	1		There is a partial difference in goals, this is due to the organization.

Figure 7. Example - Identification of possible inconsistencies between two actors based on different characteristics

6. Conclusions and summary

The basic general conclusion of the research was that the methodology which had been developed based on the review of several related research findings is suitable for identification of apparent differences of characteristics of innovation ecosystem actors. This way, using the theoretical method presented and demonstrated in this paper is suitable for potential hampering factors in cooperation of actors as critical to the development of innovation ecosystems. In the following, the main findings derived from using the analysis method is summarized.

What we have examined?

In this research, the relationships between actors were examined in an innovation ecosystem from four perspectives: values and culture, philosophy, goals, and methods. The relationship of each actor in the ecosystem with each other actor was assessed along the four aspects, using data or rating scales or ratings for the given aspect.

What we found?

As a result of a survey of the actors in the ecosystem concerned, pairs of actors have been identified with extreme differences, like significant variation in the assessment of a particular aspect. The study showed that the pair with the most significant differences in each of the characteristics was a large university actor with a public background and a small market-based R&D company.

The novelty of the study is that it allows to systematically detect differences between actors in an innovation ecosystem along a relevant management aspect. Significant divergence between actors can lead to cooperation difficulties and is, therefore, a source of inconsistency between actors in terms of cooperation potential.

Theoretical relevance

The theoretical significance of the study presented in this article is that it offers a method for assessing the cooperation potential within an innovation ecosystem. The method presented in this paper illustrated the evaluation of a system of relationships between only two actors and four sets of criteria. With further research, the method could be further developed into a multi-stakeholder evaluation method or an evaluation method along additional criteria.

Practical relevance

Practical experience has shown that one of the sources of difficulties in cooperation is that actors do not find common ground, are too different, think significantly differently, and use different management approaches. The practical role of the method presented here is to point out possible sources of inconsistency that can make cooperation between actors difficult. It allows to visualization of critical aspects of cooperation, which provides a good basis for identifying and then avoiding or minimizing potential conflict situations.

Limitations of the study

The presented study was based on one selected case of an innovation ecosystem, with a limited number of actors. This limits the findings relevant to the type and nature of players from the point of view of cooperation behavior in an innovation ecosystem. Nevertheless, the method presented is suitable for the analysis of further cases, without any limitation.

Possibilities for further investigation

The method discussed in this paper has been developed for the analysis of pairs of actors in an innovation ecosystem. Further research can extend the methodology of evaluation into more-dimension comparisons, involving not only pairs but more actors into the comparison.

The scale and aspects of analysis can be also subject for further research, resulting in a more precise base and method for the comparison.

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