Ecosystems innovation for smart connected services

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Abstract

Product-service systems (PSS) require ecosystem thinking to understand who and what is needed to keep the equipment working so that it supports the customer's or end-user's business (Kowalkowski, 2011). Often a product is designed and manufactured by one firm, packaged by another, shipped by a third, installed by another and then operated and maintained by others. Using an ecosystem approach, the actors and roles become more clearly visible, which, compared to the conventional value chain, makes it easier to manage and redesign.

In the context of the Internet of Things (IoT) the complex and important aspects that need to be characterized and understood are: customer value co-creation, risk allocation, actor dominance within the ecosystem, and the knowledge of who provides what (Adner, 2010). With the IoT, and digitalization in general, data are becoming the new enablers, allowing more effective decision-making to take place (Porter & Heppelmann, 2014; Iansity & Lakhani, 2014). However, the data are often spread out among different actors in the ecosystem, and it is important to close information loops in order to analyze data and use the information effectively. In the past, the flow was considered to be in one direction, but this is an oversimplification of the reality. It makes it more necessary for business leaders to understand and navigate their way through the ecosystem, in order to deliver and capture customer value in a complex PSS in an efficient and effective way.

This study aimed to develop and test an ecosystem innovation framework to support the development of new smart connected services for PSS. This work has been built upon the foundations of Service Design, in particular, the work of Peltoniemi & Vuori (2004). Starting from the existing product-service systems approach, through ecosystem mapping it became increasingly clear that the mapping process helps to visualizing the inter-relationships and provides a new perspective. Features or characteristics of real-world processes become experiences that create value for each actor through their activity with others and in turn create options for common and smart services. In addition, this paper adds to Lusch & Nambisan's (2015) discussion about the A2A (actor-to-actor) network and the uncertainty factors within the network. Ecosystem mapping can offer an approach to support the development of guidelines in service innovation and aligns with the perspective of S-D logic on how to reconceptualize services, resources and value creation.

Keywords: ecosystem; customer value; digitalization; servitization; service design.

Background

Product-service systems (PSS) require ecosystem thinking to understand who and what are needed to keep the equipment working so that it supports the customer's or end-user's business (Kowalkowski, 2011). Often a product is manufactured by one firm, packaged by another, shipped by a third, installed by another and operated and maintained by others. Using an ecosystem approach, the actors and roles become visible which, compared to the conventional value chain, makes it easier to manage and redesign.

In the context of the Internet of Things (IoT) the complex and important aspects that need to be characterized and understood are customer value co-creation, risk allocation, actor dominance within the ecosystem, and the knowledge of who provides what (Adner, 2010). With the IoT, and digitalization in general, data are becoming the new enablers, allowing more effective decision-making to take place (Porter & Heppelmann, 2014; Iansity & Lakhani, 2014). However, often the data are spread out among different actors in the ecosystem, and it is important to close information loops in order to analyze data and use the information effectively. In the past, the flow was considered to be one-directional, but this is an oversimplification of the reality. To make more reliable decisions, it becomes necessary for business leaders to understand and navigate their way through the ecosystem, in order to deliver and capture customer value in a complex PSS in an efficient and effective way.

Often, different suppliers/sub-suppliers are present in the ecosystem and they must interact or cooperate with the dominant equipment supplier, core company and final "end-user" via different layers of distributors, agents, service partners, installers and system integrators. Between each actor, there may be different types of transactions taking place, where the currency for the exchange can be money, goods, services, information, or risk. Transactions may be single transactions, legally governed, customs-based or relationship-driven and may be separated in time. In the context of the Internet of Things (IoT), understanding customer value (co-)creation, risk allocation, actor dominance within the ecosystem and who provides what, is a complex and important aspect that needs to be characterized. With the IoT, and digitalization in general, data are becoming the new enablers allowing more effective decision-making to take place. However, the data are often spread out between different actors in the ecosystem.

Often, too little attention is given to exploring how digital technologies can actually enhance value co-creation. According to service dominant (S-D) logic, service innovation can be considered where the operant (i.e. supplier in a transaction) and operand (i.e. customer in a transaction) can exchange resources (i.e. knowledge, skills and capacities) and have mutually integrated resources (Nambisan, 2013). This approach then creates a human-centric approach to the application of digital technologies. Two major dimensions of S-D logic especially relevant to ecosystem innovation for smart connected services are: service ecosystem and value co-creation. A service ecosystem is composed of interacting actors characterized by a relative degree of freedom to enter and exit the system, allowing actors to continue to create and change their relationships, and, by extension, their value propositions with other participants. Flexibility (i.e. the adaptability of the ecosystem configuration), as well as structural integrity (i.e. the infrastructures that create consistency and strengthen the ties among participants) are other relevant characteristics of a service ecosystem. The service ecosystems are environments where innovation is improved through the implementation of architectures that favor the engagement of actors. Value co-creation occurs as actors' interactions involve new ways of creating value, often through the recombination of existing resources and capabilities. It emerges as essential to define key roles as well as describe the nature of the value co-created by each role. In an environment that enhances the transparency of the resource integration process, focusing on the mechanisms that facilitate interactions and adapt the processes to the different roles/actors, can contribute to a better understanding of value co-creation mechanisms.

These complexities make it ever more necessary for business leaders to understand and navigate their way through the ecosystem so that customer value is delivered and captured. This work has been built upon the foundations of Service Design rules by Stickdorn & Schneider (2011), in particular, the work of Peltoniemi & Vuori (2004), Lusch & Nambisan (2015) and a framework of West et al. (2018) (Figure 1), which was developed to support management's understanding of ecosystems.

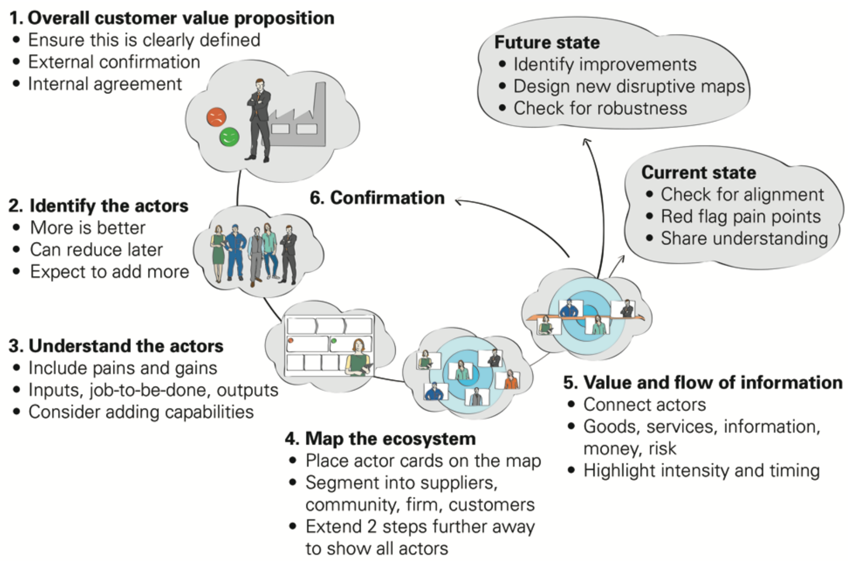

Figure 1 The ecosystem innovation framework
(West et al, 2018)

The specific research question here is: *"How to use an ecosystem innovation framework to support the development of new options in services based on S-D logic approach?"*

Methodology

There were 12 cases that followed the ecosystem approach in five steps, such as ecosystem mapping, situation analysis, service ecosystem, value creation and digital solutions or options. All cases come from different environments, and all cases have been prepared in a comparable manner on the basis of the framework proposed by West et al (2017). The first phase, ecosystem mapping, provides a specific picture that visualizes the overall situation and the relationships between the actors. The subsequent analysis helps to develop a clear problem definition on which a possible solution can be based. The problem definition will also support the idea of digital solutions to the problem. All of the cases assume the presence of IoT/Ind4.0-related technologies. Two of the cases were well documented B2B2C cases, whereas the others were all in more industrial contexts. The analysis of the cases was made based on the mapping process, the situation and the overall customer value proposition being delivered. The framework of Lusch & Nambisan (2015) was supported by the analysis of the service ecosystem and the value co-creation. Finally, the support that digital solutions provided was commented upon. The analysis was completed using observation and lessons from the mapping processes.

Results and initial analysis

Examples of the drafts of the ecosystem are shown in Figure 2 and

Figure *3*. These two figures provide insights into the different processes used to build the ecosystems. The complexities of the interrelationships and the opportunities for co-creation of value can be seen in both figures.

Table 1 provides an analysis of the twelve ecosystems that formed the core of the results for this study. The market for each case is clearly described in the table, along with the mapping process that was applied. The mapping process changed depending on the individual situation and ranged from pen/paper, over workshops, to digital tools. All of the methods provided graphical visualization during the ecosystem construction process. The situation analysis provides a clear definition of the problem or value proposition that was being investigated and of who was in the focus of the mapping process. These inputs provided clarity for those building the ecosystem. The service ecosystem results confirm that the ecosystem maps were all different, albeit some with common aspects (e.g. the need to have a clearer shared view or to better understand the actors' roles). Value co-creation ranged from low to high intensity, and appears to depend upon the clarity of the shared view and the understanding of the individual actors. Value co-creation was limited in a number of cases, due to the lack of open collaboration. Digital solutions were identified; in most cases a potential solution that could improve the degree of the collaboration within the system. Cases 11 and 12 were predicated on the basis of information sharing between actors via a digital channel.

The twelve different ecosystems were mapped using different processes, all following the general framework of West et al (2017). All of these ecosystems provide insights into how digitalization could be applied to support the solutions to improve the achievement of the overall customer value proposition. The analysis provided confirmation that the generic processes followed supported the creation of valuable insights.

Confirmation of the overall value proposition

To develop an understanding of the situation and the overall value proposition that the system should deliver, it was important to take the mapping process seriously and to approach the process correctly. The entire performance promise and its applicability are often determined more by assumptions than by facts.

Actor and role definitions

In any case, the identification of the actors requires iteration, as new actors only become visible after initial discussions. The definition of an actor could be achieved simply by the use of graphics or symbols, or could require a more detailed evaluation of the personality of each actor in a standardized way. It takes time to understand the roles of the actor and to get past the official "job titles", which are often more inward looking and do not describe their actual role. The detailed maps help with the minimum: job-to-be-done, inputs, outputs, pains and gains. Additional information provided more insights here. Actors with larger or less-known roles needed more detailed descriptions. Actors can be defined as companies, teams or individuals.

Visualization of the ecosystem

Working with pen/paper was more successful than working digitally. The active visualization created a discussion that contributed to a shared understanding of the ecosystem. The most informative ecosystem maps had around 10-12 actors. With the help of postcards for the actors, the value flows within the ecosystem could be mapped. The grouping of actors helped to clarify individual cards and reduce their complexity. Linking the streams (goods, services, money, information and risks) made the map more informative but at the same time could make the map overloaded and illegible. However, it confirmed that the linear value chain is an over-simplification of the problem and that the ecosystem offers a more realistic simplification of the problem. For goods, services and money it was clear that there was a definite 'flow', but for information (and risks) this was not so clear, since the data are often in silos (even within a single company). The visualization approach also supports finding and redefining possible actor-to-actor relationships. Specific competencies are often based on tacit information, and creating new possible capabilities based on new/alterative resource integration is part of service development (Lusch & Nambisan, 2015).

Additional comments

The duration of the mapping process varied from a few hours to several weeks. Flows that were not 'closed out' and additional other issues such as bottlenecks were identified in the ecosystems. Discussions between participants during iterations provided important insights. Isolated pockets of data, which had no apparent use by the actor who had generated or collected them, were identified (allowing new service development). It became possible to find potential new consumers of data created by the ecosystem and thereby provide new opportunities for value co-creation. Some aspects of the ecosystem were outside of the control of the core actors yet provided the framework in which the ecosystem could function.

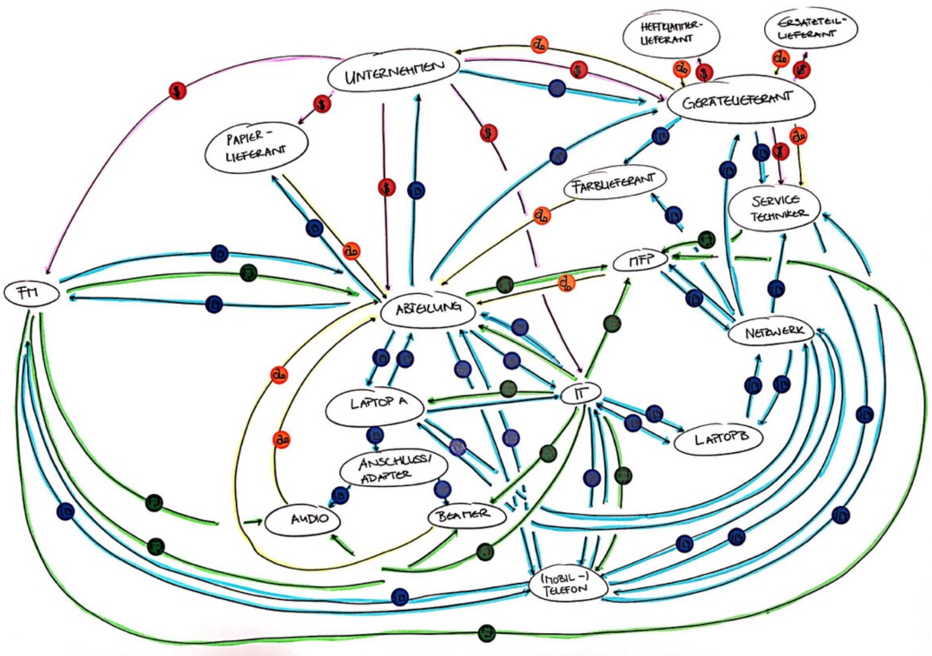

Figure 2 Example of an ecosystem created using pen and paper

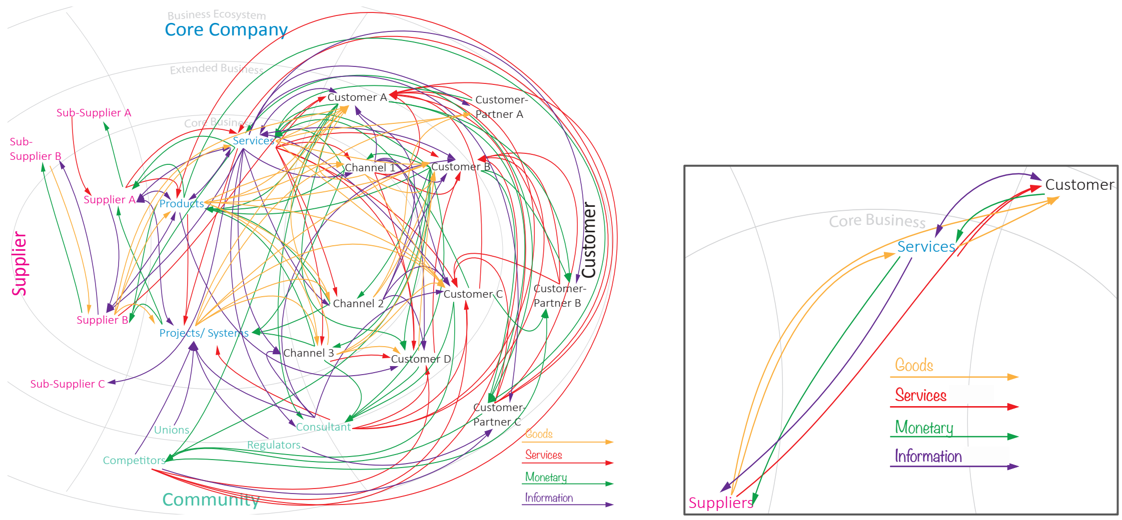

Figure 3 Example of a full ecosystem plus an extract drawn in InDesign

Table 1 Analysis of the twelve ecosystems

Case	1. Electric cars	2. Rail infrastructure	3. Motors and drives	4. Shipping
Market	B2B2C	B2B2C	B2B	B2B
Ecosystem mapping process	Workshop A1 sheet with post-its for key actors, exchanges between actors	Three-month project PowerPoint based mapping for a rail system and contracts and indirect relationships	Three-month project Product service system mapped using InDesign	Consulting project PowerPoint mapping using icons to represent the key individuals in the operational phase of ships
Situation analysis	City as focus Improving the uptake of e-mobility	Rail asset management as focus Improving the total system value	Asset owner/operator as focus Improving to information flows within the OEM to improve touch points	Ship owner as the focus Improving the service support in planned and unplanned situations
Service ecosystem	Used to create a shared view and to identify the roles of the actors	Clarification of the actor roles and the system architecture	Bottlenecks within the system became visible Areas to improve flexibility/integrity clearly described	Shared view created with the key actors identified with their individual drivers
Value co-creation	Clarification of interactions and resource integration within the ecosystem and provision of initial information on the value creation	The aspects of value co-creation and (lack) of alignment were made visible	Multi-actor value co-creation (and discretion) identified.	Decision making processes were clarified along with what was needed to help make the decisions, confirming value co-creation
Digital solutions	Digital solution integration could be seen from the data/information flows	Alignment of outcomes could be achieved here with information flows	Sharing of operational data could support product development and service teams to improve asset optimization	Provided support for the development of asset management, operations and maintenance dashboards

Case	5. Research	6. Pharma	7. Printers and beamers	8. Coffee
Market	B2B	B2B2C	B2B	B2B2C
Ecosystem mapping process	Part of a six-month project Pen and actor card	Workshop Pen and actor card with the head of the supply chain	Three-month project Pen/paper process based on interviews	Workshop Pen/paper process drawn on an iPad
Situation analysis	Research team as the focus Improving interactions within the network	Materials to patient supply chain focus Improving the team working between the supply chain actors	Understanding of the actual operation of the system Improving the 'user experience'	Coffee shop as the focus Improving the experience of the coffee drinking customer
Service ecosystem	Open architecture with limited control of actors No clear/shared view of the complex system	Open architecture at both ends with closed production and complex regulation No clear/shared view of the complex system	Open system with limited control of many actors Some actors unwilling to perform Limited shared views	Integrated the bean-to-cup and the machine-to-cup supply chains with all of the actors and the data producers
Value co-creation	The open innovation paradigm demands value co-creation	Value co-creation could be maximized with the supply chain collaboration	Value co-creation dependent on actors fulfilling their roles Limited accommodation of roles and resource integration	Resource integration to increase overall system value
Digital solutions	Collaboration demands sharing of digital resources yet mostly it was done via email between a closed group	Data/information sharing needed on different time horizons and with different actors	Integrated digital solutions needed to improve the customer experience and improve KPI delivery	IoT integration from different resources to improve system efficiency and effectiveness

Case	9. Aircraft	10. Printers	11. Hotels (AirBnB)	12. Taxis (Uber)
Market	B2B2	B2B	B2B2C	B2B2C
Ecosystem mapping process	Three-month project, with interviews Service Design Tools	Twelve-month project, with interviews Service Design Tools	Part of a consulting project PowerPoint mapping using icons and customer journeys	Part of a consulting project PowerPoint mapping using icons and customer journeys
Situation analysis	Aircraft availability as the focus Integrating digital information exchange into the system	Cash improvements were the focus Reduction of waste and improving customer experience	Ease of booking rooms as the focus Improvement of customer experience	Ease of booking/riding a taxi as the focus Improvement of customer experience
Service ecosystem	There was no shared view that integrated the actors and their roles	There was a lack of clarity of the flows on the customer(s)' sides Limited understanding of actors	Defined architecture with clear actor roles and shared views Roles of regulator in segment poorly understood/defined	Defined architecture with clear actor roles and shared views Roles of regulator in segment poorly understood/defined
Value co-creation	The mapping clearly showed where and how value was co-created	The mapping clearly showed where and how value was co-created	Visibility of key customer/supplier behaviors Weak accommodation of the role of regulators	Visibility of key customer/supplier behaviors Weak accommodation of the role of regulators
Digital solutions	Ideas for digital solutions were created from simple updates to complex dashboards	The ecosystem allowed integration process (of supplier and customer processes)	Booking system based on an open platform that deals with payments between actors and provides high level of transparency	Booking system based on an open platform that deals with payments between actors and provides high level of transparency

Discussion

Manufacturers who create PSS do not often fully consider their ecosystem in their approach to their customers, supplier and partners. Consequently, they are missing the inherent value of their ecosystem and do not exploit its attributes fully since they do not understand it. This is particularly important within the realm of digitalization and Smart Services where S-D logic (Lusch & Nambisan, 2015) plays an important role in describing the value creation that can occur in such systems.

Assessment of the ecosystem framework
In this study, it was shown that the framework of West et al (2018) provides a working approach that can support the development of ecosystems within existing PSS and help to identify Smart Services potential. There was significant variance between the different approaches taken for the creation of the 12 cases, yet insights could be gained from even the most basic analysis of the ecosystem when the analysis was undertaken in a structured way. Finally, it has shown what a firm really does as contemporary fields of activities move away more and more from the production of tangible goods or tangible assets.

Workshops provide open environments where a common understanding of the ecosystem can be shared. Actor definitions can be done on an individual basis or at a team/business level and grouping of actors can help with the simplification of the mapping yet provide sufficient depth of understanding. Additionally, within the open environment, different roles and positions are almost neglected since everyone works collaboratively on one topic to better understand the extended environment of their own working area and to uncover potential for improvements.

The application of ecosystem analysis can provide insight into the operation of the systems and the roles played by each actor within the system. By using the different value streams, such as goods, services, money and information, exactly what is being exchanged becomes visible. It supports the recognition of the nature of the relationship with its dependencies and weaknesses. The actors' roles are defined by the empathy cards and supported by the visually appointed connecting lines to other actors.

The analysis of the 12 ecosystems confirmed that it is possible to:

- create new perspectives based on a current state ecosystem within three hours;
- identify the transactions and who consumes what and why;
- understand the different jobs-to-be-done for every actor;
- understand the timing and intensity/frequency of the interactions;
- visualize otherwise invisible, tacit flows of transactions and information;
- create empathy and understanding between and for the different actors;
- understand the roles and the drivers (e.g. "what's in it for me?") for every actor;
- understand the temporal separation of transactions in ecosystems;
- understand different scenarios and situations (i.e. future state).

Ecosystem innovation for smart connected services
The integration of digital channels provides new opportunities and challenges and the framework of Lusch & Nambisan (2015) provides valuable insights to the qualities of the ecosystem with respect to digital services. The major dimensions of service ecosystem and value co-creation are relevant to the understanding of existing systems and the design of new ecosystems. However, the additional dimension of the service platform becomes important for the execution of such Smart Systems. Before being able to apply the Lusch & Nambisan (2015) model to assess the degree of smartness of a Smart Service based on S-D logic it is necessary to understand the ecosystem in which the PSS exists. The digitalization of the ecosystem simply increases the speed of exchange within existing ecosystems and as such can be viewed as facilitation.

The need to measure the innovation and therefore smartness of the service is based on the flexibility/integrity, a shared view, the actors and their roles, and the architecture of the ecosystem. The innovation should increase the degree of value creation between actors, support diverse actors, accommodate roles, and integrate the resource to increase system-level value co-creation. Finally, they suggest that rules of exchange should be clearly defined (critical for smooth operation) and that the system should be modular in structure. Many of these characteristics can only be learnt from having a clear understanding of the current (or proposed future) ecosystem. For this reason, the authors consider the ability to visualize and analyze the ecosystem critical to the development of Smart Services. The ecosystem model of West et al (2018) should therefore be supportive to the development of Smart Services. The visualization supports the reflection on a broader perspective as cognitive distance (Lusch & Nambisan, 2015) and this is one key element in organizational learning issuing innovative solutions.

Extension to include ecosystem services

The whole ecosystem cannot be drawn, and in fact would likely provide an overload of information that cannot be processed by managers. The analysis suggests that around 10-12 is the optimal number of actors that can be clearly visualized. The detailed analysis of the ecosystem occurs with this number and it is possible to identify key actors and critical bottlenecks. Additionally, it has been seen that data may be produced by one actor yet the real value comes when another actor is able to translate that data into information and act upon it. There were other instances where the functioning of the ecosystem in question was dependent upon another system from Fu, et al. (2013). The complex interrelationships of unrelated actors in a business ecosystem is an analogue of natural world ecosystems. Ecosystems in the natural world (Ainscough et al. 2018) provide a model with richer understanding of the function of business ecosystems and the behaviors of actors within it, as well as help to organize it in a more efficient way. A natural ecosystem's structure and cycles supports the idea of business ecosystems and provide insights into the sustainability of the relationships and transaction between actors. This is because business ecosystems can be thought of as communities of associated populations that share the same physical environment and constraints. A natural ecosystem is built up of:

- ecosystem services (e.g. food production, microclimates, nutrient recycling)
- biological communities and their environment (e.g. light, temperature, hydrology, physical disturbances in terrestrial and aquatic communities);
- communities of associated biological populations (e.g. plants, animals, microbes);
- a population is comprised of individuals of one species.

For service innovation with Smart Services within complex PPS environments, a more detailed assessment of ecosystem services from the natural world ecosystem could provide valuable insights into its operation.

Conclusion

The cross-case analysis of the 12 ecosystems allowed the development of a framework for ecosystem innovation. The framework was tested, and within three hours new insights into the businesses could be gained. To support the applicability of the model the framework was validated in 10 B2B systems. The approach confirmed the importance of individual actors, their roles and the transactions between individual actors and organizational units. The integration of information flows within the ecosystem allowed data producers and information consumers to be identified, allowing participants to understand the business opportunities better. In some cases, new (possibly disruptive) innovative digital solutions may be developed – in all cases improvements to the current system could be found.

Recommendations

People need to start using ecosystem mapping in the long term in their professional environment to gain more insights (i.e. relationships, transactions of goods/services, value/risk exchanges, identification of information providers, identification of identification consumers) and evaluate the framework in detail. Because ecosystem mapping allows you to zoom in and out of a system and its relationships, in doing so each actor can develop a better sense of their own dependency.

Ecosystem mapping is an easier way to understand ecosystems in existing complex PPS and digital environments and offer an alternative to already existing ecosystem approaches. By integrating this approach into industry 4.0 environments, stakeholders are an important part of the environment and help to develop services based on S-D logic. A checklist for IOT integration should be developed and linked to a framework for the development of intelligent services.

Further research

Ecosystem mapping visualizes actual streams between actors, including tacit information. Since informal settings and practical approaches in already disrupted ecosystems are subject to formal settings, these interventions can lead to unavoidable changes in the environment of all actors. Against the background of data congestion and disrupted markets, research should focus on a detailed analysis of the wicked problems within ecosystems. The hidden and tacit knowledge of all actors must be respected, as they provide information on the type of stream exchanged and at the same time on the type of information available. The change from analog to digital also triggers a change in the streams themselves, how and in what form they are exchanged. The use of further tools and an analysis of natural ecosystems can provide a better insight into the nature of informal processes to support the identification and classification of information and potential services as well as other needs or opportunities.

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