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The Impact of Openness on Value Co-Creation in Production Networks

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Abstract

The increasing number and economic importance of production networks is one sign of the on-going paradigm shift from industrial production to value co-creation. This transformation can be described by using the notions of a value creation taxonomy, which is introduced in this paper and gives a structured overview of relevant aspects of the underlying conversion from top down to bottom up economics. In order to gain a deeper understanding of this transformation process, the specific design, characteristics and challenges of those networks will be investigated with regard to their time-dependence using a life cycle model.

The present study contributes to a fundamental understanding of the importance of openness as a key success factor of value co-creation in production networks. It gives a systematic characterization of what is meant by "openness" concerning the value creation system, the value creation process and the value creation artifact. Furthermore, an adjusted life cycle model is presented, which may support both, assessment and configuration of openness within those networks by deriving adequate and phase-specific measures.

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Keywords: openness; value co-creation; production network; cluster

1. Introduction

1.1. Bibliometric analysis

To give a first hint on the relevance of the topic, the authors performed a bibliometric analysis of scientific publications in the "Web of Science"-database (Thomson's ISI Web of Knowledge). Referring to the considered categories[1], 663.068 articles have been recorded with an average annual growth rate of 11 % between the years 1997-2013. This rate is used to standardize the following analysis of the specific topics of openness and networks. In the next step, all publications addressing openness or networks in some way were counted based on various search term combinations[2].

5.285 entries were addressing "production networks" and "clusters", 15.895 articles were containing the word "open" within the topic and 250 articles comprised both "open" and "network"-terms.

The number of annually published articles in the database grows continuously. A trend in a specific subject can only be derived when it is normalized compared to the general development. For this, all values were standardized to the respective value in 1994, which was set at 100%. Only the deviations of the development of the specific-subject matter compared to the general record development is considered in the following.

After the standardization with the overall growth an increasing use of the term "open" (194%), "network" and "cluster" (341%) within scientific publications can be observed (see Figure 1). The clearest trend can be stated regarding the development of contributions that address "openness" and "networks" and "clusters". Here the authors found an increase up to 879% within the observation period. Despite reasonable criticism of the bibliometric method and the incompleteness of the database, these figures lead to the conclusion that these issues attracted disproportionally high attention by researchers in recent years[3].

[1] "operations research management", "economics", "management", "engineering manufacturing", "business"
[2] "regional cluster", "business cluster" , "industrial cluster", "industry cluster", "production network"

[3] In comparison, other terms record a downward trend (eg "Six Sigma" with peak in 2009).

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1.2. Openness

The increasing importance of the abstract concept of "openness" can be observed in particular in the areas of innovation, R&D and technology management. The open innovation approach [1] has notably promoted this development. The scientific discussion on open innovation focuses on the effects of openness to innovation capability. Openness in terms of open innovation can be examined with respect to different levels of analysis (individual, enterprise, area etc.) [2]. Mostly, however, the enterprise-level becomes the object of analysis and in general the permeability of the corporate boundary is concerned in terms of knowledge, resources and personnel [3]. Laursen and Salter examine openness as related to the number and use of external resources [4]. Another perspective for viewing the permeability of organizational boundaries as a manifestation of openness is the inter-organizational knowledge management [5]. Lichtenthaler describes inbound and outbound transfer of knowledge [3] and the need for a dynamic management of knowledge in inter-organizational systems, without necessarily internalizing it [6].

In terms of the value creation taxonomy proposed in this paper, openness is considered not only by one of the many possible perspectives; but the concept of openness is comprehensively developed. Openness is not only used as one criterion or a single factor of innovation, knowledge management, or human psychology, it encompasses a predominant conceptual framework for identification, description, analysis and configuration of structures, processes and actor relationships in value creation systems.

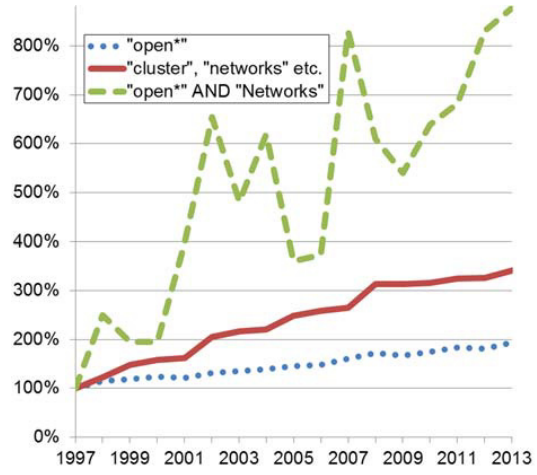

Figure 1: Bibliometric analysis in terms of openness and networks

1.3. Networks

The aim of cooperation with other companies within value co-creation systems such as production networks or clusters is the realization of larger overall revenue by realizing collective efficiency gains, synergies, coordination and emergent effects [7] that may also improve individual performance and competitive position [8]. Cooperation in networks and clusters is based on viable structures and principles that first have to be established, maintained and later also may have to be adjusted [9].

A number of scientific papers have discussed the effective design and management of production networks and network practices [10,11,12] as well as specific elements of openness such as changeability [13] and complexity [14]. A fundamental and comprehensive examination of openness from a general point of view of production networks does not occur. However, it is essential for the maintenance of the viability of a network. To provide a better understanding of the development of openness along the life cycle of networks, this contribution presents an advanced life cycle model. In the following chapter, a taxonomy is introduced which opens up the current changes in the value creation.

2. Transformation of Value creation

The basis for the following analysis is a value creation taxonomy, which includes the structures, processes and the object of value creation. These three central elements are subject to lasting changes, the cause of which can in turn be found in technological change. Key criteria are further developments and spread of information and communication technologies (I&C technologies) as well as production technology (see Figure 2).

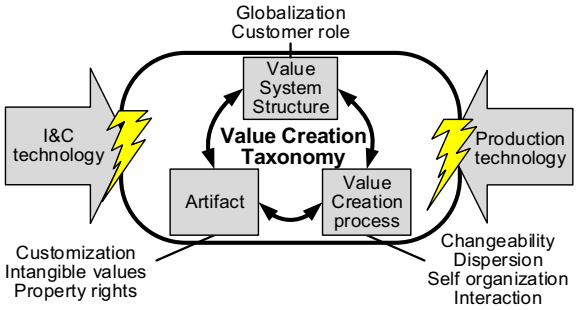

Figure 2: Value creation taxonomy

The transformation of value creation structures can firstly be attributed to globalization [15,16,17]. The spread of I&C technologies and the accompanying fall in transaction costs means that the benefits of widely dislocated value creation activities are increasing, which is followed by permanently changing relations between the worldwide operating actors. However, as the pressure of competition increases, this is also accompanied by a potential expansion of sales opportunities. Secondly, an increase in the importance of the customer's role can be detected. Since knowledge work is gaining importance as part of value creation processes, customer's power over the producer is rising due to a better access to I&C technology and networks. Therefore the value creation and production cannot longer be seen within the boundaries of a company. It is no longer possible to achieve a clear demarcation between the domains of customers and producers ('prosumer') and accordingly the role of traditional companies is changing.

The transformation of the value creation processes stems directly from the influence of the value creation structure. The need for individualized products and globalization thus calls for changeable production systems and processes. In addition, the number of actors involved in the value creation process is increasing. Coordination of these actors takes place less through hierarchical organizations: With the decreasing importance of conditions of time and space, the value creation processes are increasingly based on interaction, collaboration and self-organization [18] of the worldwide distributed actors

to cope with the increasing complexity.

Concerning the value creation artifact, three essential aspects of change can be identified. Firstly, customers are increasingly demanding individualized products and services. This involves an additional challenge for the manufacturer. Secondly, the ratio of intangible components of the product is rising in proportion to tangible components, which among other factors can be attributed to the increasing importance of software and service components. The third aspect is closely linked to the second. Here the issue concerns the property rights constellation of the value creation artifact. While the benefits of regulated exclusive property rights are accepted for physical goods, this acceptance requires a revaluation in the case of goods with an increasing intangible or informational character.

2.1. Bottom-up economics

The transformation in the three core areas of value creation taxonomy is leading to new patterns of value creation, which can be summed up under the term ‘bottom-up economics’. It differs essentially in its structure-related and process-related character from traditional industrial production, which represents a manifestation of top-down economics.

Bottom-up economics is characterized by a fusing of production and consumption, by distributed structures and processes and by collaboration as the most intensive form of interaction between actors. In all areas of value creation, such as research and development (e.g. user innovation, open innovation), production (e.g. crowdsourcing, production networks [19], mass customization, collaborative engineering [20]) and marketing (social commerce, viral marketing, collaborative filtering), signs of this paradigm change can be found. Essential features of bottom-up economics in relation to the underlying value creation model, organization and production structures will be explained in the following subsections.

UEDA et al. describe the transformation in value creation using three value creation models [21]. While the providing value model is appropriate for describing forms of industrial production, the adaptive value model is better suited to describe the current state of production. However, an increase of the importance of the co-creative value model can be expected in the future (see Figure 3).

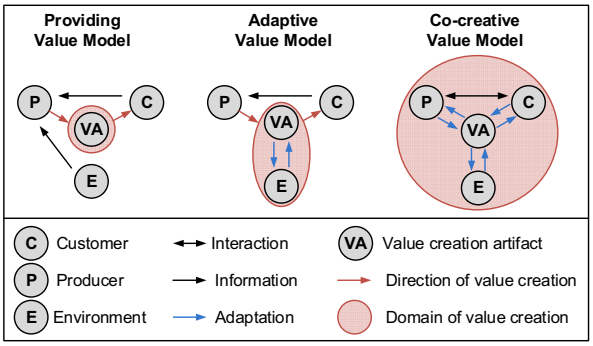

Figure 3: From providing to co-creative value model [21]

While the problems that occur in the providing value model may be regarded as optimization problems, the adaptive value type of model can be used to consider problems that may be regarded as adaptation problems. However, in the co-creative value model, the values for producer and customer cannot be determined independently from one another. Furthermore, poor predictability of the environmental behaviour and of the motivation and demands of customers is assumed. The interacting roles of producers and customers cannot be distinguished with relation to value creation. The range of value creation extends to all areas of the value creation system. A large number of the value creation patterns under observation (e.g. collaboration of producer and customer, user innovation, allowing access to product data) can be better explained by the co-creative model than by the previously described models.

Classical industrial organization is geared towards the central idea of mass production. However, mass production can only be regarded as an ideal model under certain conditions. These include uniform production independent of external influences, which in turn calls for homogeneous mass markets in the long term and a stable demand. The transition to the information age, however, has promoted the removal of these assumptions.

The concept of interactive strategy represents the starting point for the scientific discussion concerning interactive value creation, which results in a re-evaluation of the relationships between the actors involved in value creation [22]. Together with the application of modern production principles [23] it forms an integrating strategic approach for the design of future value systems that correspond to the present and future requirements. Increasing individualization and the discontinuous demand behaviour associated with it, as well as the increase in complexity of expected services represent new challenges for manufacturers. Such challenges can only be managed through structural and strategic changeability, an extension of the range of services and intensified cooperation.

The reality resulting from the transformation described can no longer be managed precisely with the existing “closed” understanding of value creation in production systems as the prerequisites of the logic of mass production have become obsolete in many cases. The consequence is the need for a redefinition of the object under consideration, namely that of production sciences, which takes the premises of a changeable, open value creation into account.

2.2. Theory of Openness

According to the presented study, openness is interpreted in terms of systems theory. Consequently, it concerns one of two system conditions. In contrast to a closed system, an open system is distinguished by the fact that at least one of its elements is involved in interactions with elements of another system. As organized social systems are always in interactive relationships with surrounding systems, they can be viewed as open systems as a matter of principle. For reasons of simplification companies and production systems were considered as closed systems in the past. Through changes in the environment, the requirement for openness is increasing and no longer remains negligible. Therefore, openness is not a completely new feature, but an inherent system property that is becoming increasingly relevant. In this sense, openness describes the ability for interaction with other elements and at the same time it is a prerequisite for the long-term viability of systems.

The spread of I&C technology as well as production

technology and the accompanying networking together with the increasing interaction potential demand a strategic, structural and procedural opening in form of interactive value creation. This is synonymous to the claim that "networking" and "openness" are complementary strategies. If this corresponds with reality, the result for companies is that a rational approach demands a change of the two activities at the same time and in the same direction. However, as the increased networking that delivers the growing potential for interaction is an exogenous influence, the only logical consequence for companies would be to pursue a strategy of openness more intensively.

		Indicator	Closeness → Openness		
Architecture of the value creation artifact	Structure	Granularity	Coarse		Fine
		Modularity	Low		High
	Function	Property rights	Private goods		Public goods
		Type of service	Product or service	Product-service Systems	Co-creation experience
Value creation process	Value creation activitiy	„Width" of Co-activity	Low (bilateral)		High (mass...)
		„Depth" of Co-activity	Coordination (integration)	Cooperation (participation)	Collaboration (interaction)
	Value creation strategy	Competitive strategy	Comptetition	Coopetition	Cooperation
		Competitive advantage	Unique		Hybrid
		Business model	Closed source	Partial de-commercialization	Open Source
Value system structure	Intra-organi-zational	Communication culture	Low	Participatory	Reflexive
		Organizational structure	Hierarchic		Heterarchical; Adhocratic
		Configuration	Monolithic		Modular, fractal
		Changeability	Low		High
	Inter-organi-zational	Interorgan. coordination	Hierarchic	Hybrid	Market
		Networking	Bilateral cooperation		Virtual network
		Role dynamics	Static	Flexible	Dynamic

Figure 4: Openness in value creation

2.2.1. Openness in the context of value creation

The theory of openness is derived from the observation that among the currently prevailing conditions in the business world, more open approaches to the configuration of value creation are acquiring greater importance than the more closed approaches. Here, the spheres of influence of value systems can be subdivided related to the notions of the value creation taxonomy into the categories of value creation structure, architecture of the value creation artifact and value creation process (see Figure 4) [9]. For each of these spheres we identified indicators that characterize the level of openness or closeness of a system.

2.2.1.1. Openness of the structure of the value creation system

Two aspects are considered with respect to the openness of the structure of value creation systems. Firstly, it is necessary to examine the relationship between the system and its environment, which means: defining the system's position to its surrounding systems and the permeability of the system`s boundary. Secondly, the inner structure of the system can be investigated in terms of whether they meet the requirements of openness. Consequently, the investigated driving forces are differentiated into the spheres of influence of intra-organizational and inter-organizational openness.

2.2.1.2. Openness of the architecture of the value creation artifact

In addition to the structure, the object of value creation itself, the value creation artifact, has the potential to be designed in an "open" manner. As an artificial system, an artifact differs from a natural system in a way that it has been consciously created by humans for a specific purpose. Correspondingly, a value creation artifact is the result of a value creation process. It is always a combination of tangible and intangible constituents. The architecture of such an object extends over the spheres of influence: structure and function. While the structure, which can in turn be classified as property rights constellation and physical structure, tends to be regarded as the means to an end, the function tends to be linked with the actual defining purpose. The property rights constellation assumes a key role in the design of the value creation artifact. It is decisive for the opening of the value creation process.

2.2.1.3. Openness of the value creation process

The degree of openness in the value creation process is determined by value creation strategies and activities of the actors. Open value creation strategies focus on customers` benefits by means of an individualized offer. In this context, openness aims at exploiting synergies by virtue of cooperation with other actors and at least allows partial decommercialization of traditional business areas in order to be able to achieve competitive advantages, which can be monetized in other "new" areas. Co-activity shapes the openness of the value creation process and includes all the co-actions between actors aimed at maximizing value creation.

3. Openness and production networks

3.1. Openness in networks

In this chapter, the impact factors on the design of a production network will be analyzed regarding their level of openness with the aim of maximizing the success of a production network by obtaining emergent effects. Knowing those factors is the basis to control the degree of openness within the production network; actively taking into account the objective of maximizing success. This raises the important question of what is the optimal degree of openness within a production network. To answer the question, a model was developed to describe and derive the development of the degree of openness during network life cycles.

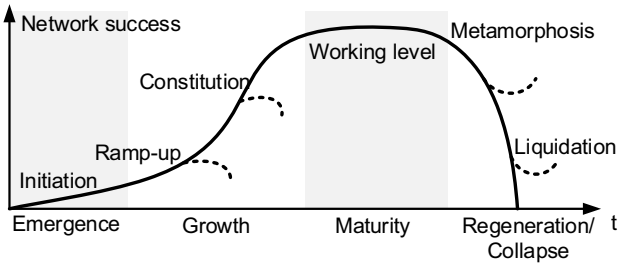

Figure 5: Modified network life cycle

For this reason the classic life cycle model of networks [24], consisting of the four stages of development (emergence, growth, maturity and collapse/regeneration) was

extended with respect to the specific steps of development of production networks (see Figure 5).

The impact factors were now assigned to the development stages of the life cycle. We further analyzed, what kind of impact openness reveals regarding the success of the production networks. The results were summarized in a life cycle model extended by the factor of openness, which reflects the degree of openness to be pursued over the time course (see **Fehler! Verweisquelle konnte nicht gefunden werden.**).

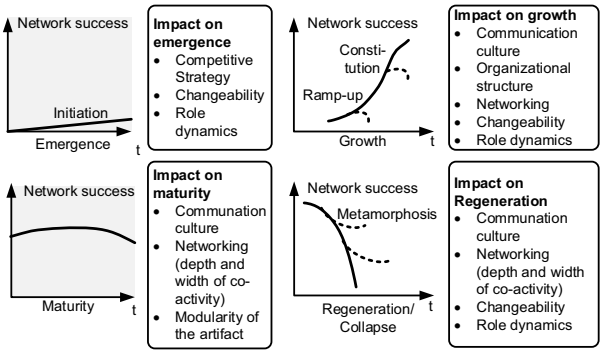

Figure 6: Impact factors on network life cycle openness

3.2. The specific stages of development

The *stage of emergence* is essentially characterized by the openness of its promoters. Their motivation, agility and willingness to assume operational and coordinative tasks in the production network provide the basis for success of the network structure. Concurrently, the dynamic of the roles of the actors contributes to a lasting competence of changeability within the network. A high degree of openness in terms of flexibility and changeability of individual production systems and actors is desirable in this stage. The competition strategy pursued by the players can be referred to as coopetition. It is characterized by the parallel occurrence of complementary and competitive relationship between the players.

During the *stage of growth,* it is important to establish an open communication structure, which forms the basis for trust. Here, openness is also characterized by the motivation of all players to contribute to value creation with their individual experience and expertise. An open design of the organizational structure (through informal communication structures, symmetrical distribution of information and situational concentration of power and competencies in form of "heterarchic" structures) is deliberately chosen to prevent a hierarchical structure considering the pursuit of a high level of flexibility. The design of successful cooperation relations in the production network therefore needs to be implemented in this stage by promoting a culture of openness.

Objective of the *maturity stage* is to maintain the network identity and motivation of individual network actors and a participatory culture of communication within the network, which does not compromise the flexibility. An additional success factor is the effective networking in the sense of the depth and width of the co-activities. Studies regarding the optimal width of co-activity revealed that a pronounced openness does not necessarily lead to an increase in success, but rather to an increase in complexity within the network, which limits the flexibility of the network [25]. This complexity requires a common solution for active coordination of network activities through network-internal controls in order not to jeopardize the competitiveness of the network [26]. In addition, too high degrees of modularity of the value creation artifact threaten the effectiveness of the value creation process.

During this work stage, enterprise structure and standards are emerging. They help to control the complexity of the network and to increase efficiency. At the same time, they often restrict openness and the changeability of the production network. Established structures and standards should be continually scrutinized. The goal of this stage is to establish a production network-specific maximum of openness with respect to a long-term successful network.

The openness in the *final stage of the network* progressively decreases due to the establishment of standards, strengthening of structures and expansion of access barriers. In this stage – from a system's point of view - a collapse can only be prevented by maintaining customized communication structures, persistent agility and changeability within the network structure and dynamic roles in the composition of the network. Thus, the complexity of the network can be controlled without the constraint of giving up the flexibility.

Summing up, the development of openness in production networks can be depicted as follows (cf. Figure 7):

• Emergence: Openness increases starting from a moderate base level

• Growth: Established trust; internal communication culture and a culture of openness lead to a strong increase in openness

• Maturity: Openness rises until maximum because of increased networking and expanded communication between the players; risk of premature collapse (due to standards, solid structures and the danger of limited openness between parties caused by the growing importance of competition) should be prevented by achieving a balance between openness that preserves the flexibility and viability of the network and closeness that reduces the complexity of inter-organizational coordination

• Regeneration/Collapse: Setback of openness caused by competition, limited flexibility, trust abuse and exit of players

The pure pursuit of maximizing openness does not lead to a successful maximum of a production network. Rather, it is necessary to obtain the correct linking between closed and open design patterns and to establish coordination mechanisms that generate a high level of long-term success by concurrently reducing complexity in the respective production network.

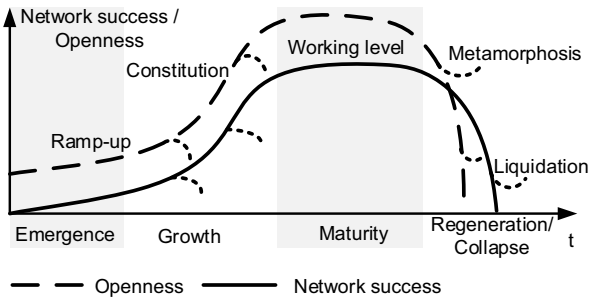

Figure 7: characteristics of openness and network success

4. Conclusion

Manufacturers face the prospective challenge of designing their own value creation through suitable developments in product, process and structure. In doing so, they primarily tend to exclusively concentrate on classical parameters such as time, costs and quality. Globalization and the spread of I&C technologies are thus leading to completely new patterns of value creation, which can be summed up under the term ‘bottom-up economics’. This phenomenon essentially differs in its structure-related and process-related character from industrial production, by following logics based on openness. As the classical models for designing and explaining value creation configuration are predominantly based on top-down approaches, they are less suitable for modelling value creation.

Despite the increase of literature on openness as a general phenomenon within networks and clusters and despite some euphoria concerning the latest procedures based on information technology, such as open source, open innovation and crowdsourcing etc., research on ‘openness’ as a characteristic of value creation taxonomy is a largely neglected area in academic terms. In spite of the acknowledged potential of the underlying principles, a broad-based academic examination is lacking – not to mention systematic implementation in companies’ organizational culture. The main reason for this is the absence of suitable procedures and framework concepts capable of supporting companies in the configuration of value creation.

In view of this problem, the presented contribution underlies the understanding of a necessarily more open design and management of production networks. It has been shown that it is necessary to actively promote openness for tapping the potential of value co-creation. The proposed method is a life cycle model for production networks extended by the factor of openness, which may be used for practical management decisions. Fields of activity for management can be derived from this model as well as from the theory of openness which includes a large number of practice-related options for the design of value systems and offers orientation aids for the design of production structures.

In addition to the unsolved problem of quantitative measurability, further need for research exists in terms of finding a suitable or sufficient measure of openness. Factors specific to product, sector, market and - above all - to the company play a role here and will require closer examination in the future.

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