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Global and Regional Production Networks: A theoretical and practical synthesis

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Abstract. The growth of research interest in networked production has brought up numerous important concepts aimed at production networks. Still the actual research object seems to be ambiguous, making the exact application of findings insufficient. It appears that there are two main notions of the term Production Network. The first meaning is derived by a single versus a multi-organizational perspective while the second meaning comes from a regional versus global view. Obviously indistinctness exists in this field of research and clarification of terms and concept is required. The objective of this paper is to give an overview of the existing theories in accordance with the industrial practice providing a model to bridge the academic theories to industrial practice.

Keywords: production network, literature review, case study

1 Introduction

The affects of globalization on manufacturing is indisputable. The fragmentation of production processes and the international dispersion of tasks and activities within them have led to the emergence of borderless production systems in shape of sequential chains or complex networks commonly referred to as global value chains [1]. Most middle sized and large companies are now creating an international market and have to build and/or manage an international network of operations either due to their organic growth or via M&A activities [2]. The rationale behind such action lies principally within three main categories; (1) access to low-cost production, (2) access to skills and knowledge, and (3) proximity to market [3]. Multinational companies strive to acquire, create, and use technological assets across national borders [4].

The mentioned factors and the growth of developing economies in the world have accelerated the trend of moving from stand-alone factories toward more globalized production. The management of international networks remains an under researched area [2], and networked production of multiple organizations is also moving into focus of research [5]. To improve the competitiveness of firms, not only the global production network of one enterprise but also the interplay of locally linked production of buyers and suppliers gains importance. These inter-organizational

relations are not only spotted by the discipline of Supply Chain Management which discusses global versus domestic concepts without specifying their view on very production-intrinsic challenges [6].

This paper provides an overall understanding of the *production network* concept by presenting a brief summary of the related literature along with two cases as real-life implications. The paper opens up with the introduction to the topic followed by the research methodology. Later on, some concepts are elaborated in details under reference framework section. Finally, the findings and conclusions are presented.

2 Research method

The methodology used in this study is a combination of literature review and a multiple case study. The literature review is based on searching the keywords *production, manufacturing, network, global, international* and the German equivalent words along with combination of those terms on the databases *Science Direct, Scopus, Elsevier, and SpringerLink* via different search engines. Totally about 200 articles have been analyzed in the first phase further reduced to 18 directly related to the topic of *production networks* which are referred to in Table-1. The case study approach is chosen since it allowed an in-depth study of the phenomenon in its real-world context plus conformity to answer the *how* and *why* questions [7]. Case-A is a global manufacturing company headquartered in Sweden with total number employees of approximately 1250 with eleven production sites in six different countries, four of them located in BRIC countries. The core business of the company is the production of mechanical and electromechanical solutions for commercial vehicles, construction and mining industries, and general industry. Case-B is a network of seven companies including eight plants in total located in Germany. Six of the companies are SMEs; the other is a large company. The network's focus is to produce gearboxes for energy industry. 14 semi-structured interviews have been performed in total which of 10 were conducted at Case-A and four at Case-B.

2.1 Global Production Network and Regional Production Network

Global Production Networks (GPNs) and Global Value Chains (GVCs) are two schools of Globalization studies, with their roots on Global Commodity Chains (GCCs) having some common works, as well as some differences on concepts and focus [8]. A global production network is a manufacturing network i.e. a network consisting of wholly owned factories, i.e. belonging to the same company [9] on a global scale.

A regional Production Network (RPN) is a cooperation of geographically close companies to produce a certain product. The RPN can be developed by an addressable strategic network or is formed through latent informal network structures of manufacturing enterprises [10, 11]. As long as the production cooperation is carried out, this temporary network exists. Depending on its product portfolio, an enterprise can be part of more than one RPN.

2.2 Supply Chain Management and Networked Production

Within business studies, networked value-adding processes are focused by the field of SCM which aims to establish standard measurements, functions and reference models to analyse, describe and manage networked processes. This approach is not restricted to production and manufacturing, it is also involving e.g. marketing, resellers and distributors [6]. Besides *Business Studies* discipline, there are also approaches within the *Mechanical Engineering* and *Production Management* field. One general approach describes the formation of *Production Networks* as “cross-company cooperation” and clearly differentiates between Production Networks and Supply Chains [12]. Another concept within the discipline of mechanical engineering to describe, explain and manage networked production of different enterprises is the *competence-cell-based network* approach. Among others [11] and [13] contribute to this concept mainly aiming SME networks. Furthermore an inter-organizational process model for networked production is the *Extended Aachener PPS-Model* – production planning and control model of the RWTH Aachen University [14]. Completing these ideas of inter-organizational production networks, the concept of *Strategic Production Network* is also defined as cooperation of different enterprises [15, 16].

3 Findings

3.1 Literature Findings

To identify certain concepts and clarify their attributes, two main characteristics were ascertained based on literature study. The first characteristic is *ownership* of a network i.e. having one or multiple owners. The second characteristic is called *geographical reach*, which describes the range of the concept from regional to global scale. The summary of the findings are shown in table 1.

Table 1: classification of the literature review summary

Literature	Ownership	Geographical reach
[11], [13], [16], [17], [18], [19]	multiple-owner	regional/local
[12], [14], [15]	multiple-owner	regional/global
[3], [20], [21], [22], [23], [24]	single owner	global
[25]	N/A	regional/national/global
[26], [27]	N/A	global

Based on the literature study, two major streams and interpretations of the term *production network* appear. One stream leans toward to the concept of GPN owned by one organisation and being led globally. The other stream refers to the RPN concept consisting of different companies with different ownership managed in a mutual manner on the basis of certain regional closeness and production dependency.

3.2 Reflections from the case studies

Networks on a global level

Global production networks are supposed as fully owned factories branding the mother company which are able to supply the customers with locally-produced products but to a global standard of quality. They provide some advantages beside the challenges mainly due to the global environment summarized in table 2. One example of such networks is demonstrated in figure-1 along with one global customer in order to depict the structure of such networks.

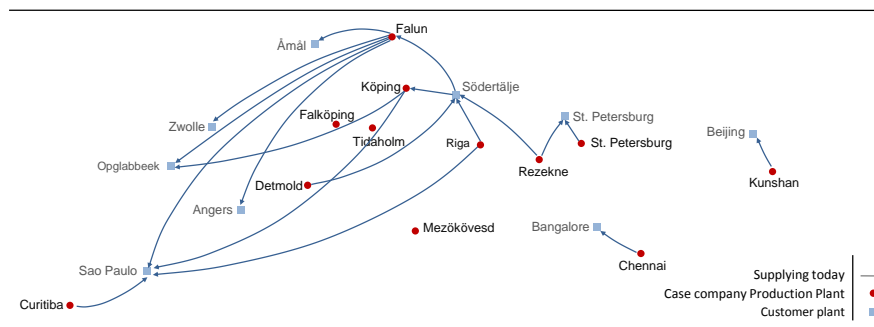


Figure 1- GPN of the case-A along with a major global customer's plants

Foreign-exchange rate variations affect the development of costs and consequently the global production network. From the global profitability prospective, companies have to make sure that over time, the investments pay off otherwise they might be urged to move the business to other locations.

Local cost of capital interest rates in one hand is the value of the local currency; on the other hand is the inflation and interest rate cost. This must be considered as it could affect the production costs in the respective country.

Understanding the global customers' strategy: by knowing about the end-customers' demands, production companies (especially contract manufacturers) could see the trend and the increase/decrease in the volume.

Culture: despite having a global standard to run production, the local culture will be a part of the "total". So, it must be initially defined how much of the core values of the mother company could be implemented locally. Apparently, there would always be a sort of local variants due to the local culture. Thus, it would be useful to have resources, people in specific, to carry the core values of the mother company.

Local legislations and regulations such as import/export regulations or the salary system in certain countries have great impacts on GPNs.

Custom duties This is also affecting as the duties could affect the network especially when it comes to importing equipments and machinery to the host country.

Global managers who travel around the system are required to make sure that the plants continue over time to maintain the core values of the mother company and not inventing their customized system.

Networks on regional level

RPNs which are comprised of SMEs, continuously struggle with their production costs due to not having the potential to decrease it through mass production. Furthermore, relevant production steps on the network are distributed among diverse partners, thus, planning, controlling and coordinating the processes becomes intricate. Beside, SMEs involved in RPNs strongly depend on network partners' quality and delivery performance. They also face too much logistic processes and the challenge of integrating IT solutions to all network partners for managing the information flow.

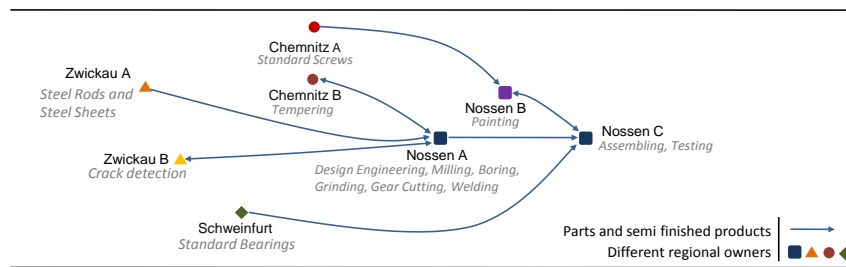


Figure 2- RPN of case-B contained of different plants and owners

Beside the mentioned difficulties, there are advantages of SMEs within RPNs such as the capability to co-develop with the customers in a one-to-one manner because of the regional closeness and manageable number. This leads to sophisticated products, with exact fulfillment of functions and quality. Furthermore, an individual project management from the design stage to service can be realized. Additionally the production processes become flexible by adjusting the production system by means of changing the cooperating partners (Figure-2). The challenges and opportunities of the two types of production networks are summarized in table-2 resulted from the interviews performed in both case companies.

Table 2: The challenges and opportunities concerning RPN and GPN

	Challenges	Opportunities
Global Production Network (Single-owner)	Foreign-exchange rates (Currencies)	Using the global redundancy for achieving volume flexibility
	Local cost of capital interest rates	Competence transfer reduces R&D costs on development and minimize risk
	Understanding the global customers' strategy	Global sourcing perspective achieved by global footprint
	Culture	Economy of scale due to the global presence
	Local legislations and regulations	One production system within the whole network
	Custom duties (toll)	Local presence gives easier logistics for local market
	Global managers (people)	

Regional Production Network (Multiple-owner)	Higher production costs	Sophisticated product development with possibility to generate individual product functions and variations due to closeness to customers
	Intricate coordination of required production steps within supply chain / production network	Exact quality accordance to customers' requirements and individual project management due to a lower amount of customers compared to larger companies
	Dependency on network partners quality and delivery reliability	Flexible adjustment of production to market needs due to changeability of cooperation partners
	High amount of logistic processes	
	Difficult to apply inter-organizational IT standards for cooperation partners	

4 Conclusion

The article presents two main streams of interpretation out of the term Production Network which are found in literature and also represented by two cases. Figure 3 sums up both concepts in one theoretical model linking global and regional production networks with our given definitions.

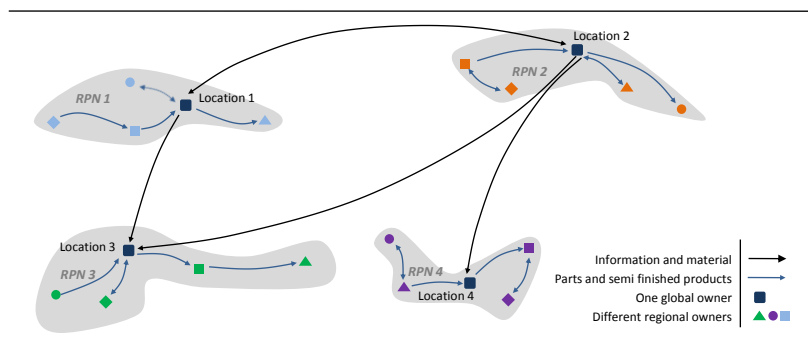


Figure 3- proposed model synthesizing GPN and RPN concepts

Regarding this model a scenario could be supposed; an enterprise in one location and an existing regional network decides to start a new production site in another country. Starting the business in a new location triggers the formation of a new regional production network to produce the desired product. Therefore, concerning the terms regional and global, two questions arise; (1) how large a “region” could be? And (2) how small “global” could be?

There should be no difference in the concept of RPN even if some suppliers are not located within a certain geographical region. Also if new locations of one company spread only over one continent, the concept of GPN would still apply. Therefore, the naming of those two concepts can be misleading and can cause confusion as well. However, the naming of those concepts which points out their actual structure will facilitate further research within this discipline. For future work the dependence of those concepts on geographical location should be reconsidered.

Defining the boundaries for the usage of the term “region” and “global” can affect the definition of those concepts. Thus, we suggest keeping the boundaries of the

region and global open and not limited it to the geographical borders whether a country or a continent, but still having a directing definition:

RPNs are comprised of multiple production plants in a specific geographical area with certain closeness shaped by different owners with a common product. GPNs are entirely owned production plants spread over a certain reach of distance to capture foreign markets.

Enterprises should be aware of the usage of those concepts to apply research findings concerning their own interests and objectives. Besides, there are a lot of potentials in linking the concepts of RPN and GPN. This can support enterprises with their important decision making processes, for instance when starting a new production facility during an expansion phase to be able to start an effective production cooperation network. Also, what instruments could be applied, not only to control and compare the performance of the production sites within a GPN, but also monitor and manage the involving RPNs within GPN.

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