Decision-making autonomy of production plants in global production networks – Analysis of the interplay between strategy and decisions

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Abstract

An increasing number of companies operate multiple production plants in global production networks (GPN). These production plants operate with different levels of autonomy regarding strategic, tactical and operative decision-making. So far, there is small evidence on different patterns of decision-making autonomy in GPN and their inherent strategy. We conducted a survey to close this gap and obtained data from 88 GPN operating with headquarters mainly in Europe. This research identifies two different decision-making autonomy patterns. Furthermore, the impact of strategy on decision-making autonomy patterns is analysed. To conclude, the impact of decision-making autonomy patterns on performance is elaborated.

Keywords: Global production networks, strategy, decision-making autonomy

Introduction

Both, the increasing global economic interdependence of sales and purchasing markets (Koren, 2013) as well as constant fluctuations in demand have led to intensified global competition (Abele et al., 2008). The shortening of product life cycles and the increase in product variants have thereby increased manufacturing complexity. In response, companies reduce their manufacturing depths and decentralise production geographically (Abele et al., 2008). Accordingly, large enterprises as well as small and medium enterprises organise their production in a global production network (Lanza and Moser, 2014). Production networks are complex, man-made systems that provide products and services (Lanza et al., 2019). They leverage specific resources and the capabilities of related partners to provide services for cross-enterprise relationships. Production networks open up advantages such as the production of customized and regionally differentiated products close to the market, lower production and procurement costs, and access to local knowledge, skills, and resources. (Hochdörffer et al., 2021; Greinacher et al., 2015) However, increasing multilateral dependence between partners, protectionist measures by major economic powers, and the relative decline in global trade have also

brought challenges (UNCTAD, 2018). Economists therefore consider global production networks to be the most critical form of organisation and coordination in manufacturing (Yeung and Coe, 2015). In the past, the construction and design of global production networks has been the primary interest of researchers and practitioners, but attention is now increasingly being focused on how to best operate the growing network structures (Thomas, 2015).

Further, high coordination activities characterise production networks (Schuh et al., 2014). Each production plant needs a connection to related plants or to the headquarters in order to coordinate tasks or to implement the strategic guidelines of the network (Lanza and Moser, 2012). To tackle this topic, the autonomy of production plants in global production networks can be increased (Lanza et al., 2019). Increasing autonomy with respect to strategic or operational decisions reduces the coordination effort; however, it also reduces the control of network managers over the respective autonomous production plants (Neuner, 2009). Furthermore, it becomes increasingly important to consider the strategic orientation of the manufacturing company. The strategy must be implemented congruently throughout the global manufacturing network. Similarly, the corporate strategy characterises the ideal structure of the production network, the way of efficient network management, and the degree of centralisation of the production network. Therefore, it determines the way in which decision-making autonomy should be distributed in order to align the production strategy of the production sites with the network strategy of the production network (Bhinge et al., 2015). Until now, there is no empirical research regarding the influence of strategy on decision-making patterns which describe how decision-making autonomy is distributed in the global production network.

The aim of this paper is to explore different patterns of decision-making autonomy in global production networks and their inherent strategy. Three research questions are formulated to guide this paper:

RQ1: What are different patterns of decision-making autonomy in global production networks?

RQ2: How are different patterns of decision-making autonomy related to strategy dimensions?

RQ3: How are different patterns of decision-making autonomy related to operational and financial performance?

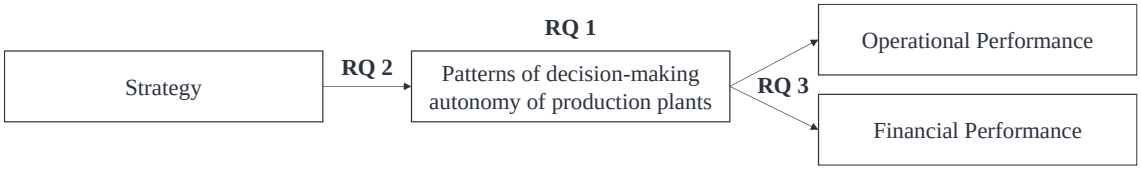

Figure 1 – Research framework and research questions

The remainder is organised as follows. At first, the theoretical background and related literature in the area of strategy and decision-making in global production networks is presented. After this, the research design and methodology in form of an empirical study are introduced which address the research questions. Then, the results of the study are reported and discussed. The paper ends with a short conclusion taking into account contributions to research and practice.

Theoretical background

Global production networks are man-made systems or constructs with the goal to produce products and to provide services. Global production networks operate in a highly dynamic environment cooperating with other companies in forms of suppliers and customers. The purpose of global production networks is to satisfy customer needs. (Lanza et al., 2019) In order to be called a global production network, there need to be at least two production plants in different countries (Hayes et al., 2005). Information, material and knowledge flows connect these production plants (Lanza et al., 2019).

Global production networks can be structured along their inherent tasks. These tasks are allocated to three elementary areas: strategy, footprint and management of global production networks (Thomas, 2015). The production strategy describes the strategic setting of all activities, e.g. centralisation, in the global production networks (Hayes and Wheelwright, 1984). It is measured through different competitive priorities like cost, quality or delivery (Sayem et al., 2018). The network footprint lays emphasis on the network structure, e.g. distribution of plants, product allocations. Lastly, the network management focuses on the physical or non-physical flows between the production plants. Supply management or order management are considered, but also centralisation and decision-making autonomy of production plants. (Verhaelen et al., 2021)

Centralisation and decision-making autonomy in companies and in global production networks have been hot topics for decades. Decision-making autonomy describes whether production plants are able to decide for themselves if in comparable production networks, these decisions are done by higher level authorities such as headquarters. The pendent is centralisation, which describes the construct of high level authority of a central organisation. (Brooke, 1984) Considered decisions in the topic of centralisation and decision-making autonomy stem from the production strategy content. Most scholars agree for the following decisions: supplier selection, make or buy decisions, production planning and control for the short- and long-term, technology, process, plant role and strategy, improvement programmes and organisational setup (see exemplary Maritan et al. (2004), Szwejczewski et al. (2016), Olhager and Feldmann (2018)).

Related literature

In order to review the relevant research areas, exemplary studies related to decision-making autonomy in global production networks are presented. These studies shed some light on different patterns of decision-making autonomy and factors influencing the choice of these patterns.

Young and Tavares (2004) present a literature overview of autonomy and centralisation in the area of production, marketing and product development. The authors conclude that there are no works regarding the interplay of strategy and decisions. Furthermore, they summarize that there is no procedure in how to define an optimal level of centralisation. Scherrer and Deflorin (2017) analyse the connection of plants and the production network regarding strategy fulfilment. The authors find elementary connections, but do not focus on autonomy and centralisation as elements in their research. Maritan et al. (2004) analyse the autonomy of different plant roles. As they build upon the fundamental work by Ferdows (1997), they find connections between different motives in global production, i.e. low cost, market and access to information and people. However, they do not implement different competitive priorities in their work. Olhager and Feldmann (2018) focus on the distribution of manufacturing strategy decision-making in international manufacturing networks. The authors use survey data of 107 production plants. Three different patterns of manufacturing strategy decision-making are

identified: decentralised, integrated and centralised manufacturing networks. The relationship between these patterns and the operational performance was found to be insignificant. Gammelgaard et al. (2012) analyse the relationships between autonomy and performance in corporate networks. It is found that an increase in strategic and operational autonomy of subsidiaries, taking into account network relationships, is associated with an increase in performance. McDonald et al. (2008) find that operational autonomy of manufacturing sites has a positive effect on performance, while the effect of strategic autonomy on performance is not significant.

The related literature shows that there is a variety of models and analyses regarding decision-making autonomy of production plants and centralisation in global production networks. However, the interplay between strategy in terms of competitive priorities and decisions is not analysed yet.

Research design and methodology

In order to address the above mentioned research questions, a survey was designed according to the guidelines proposed by Forza (2002). The survey was designed as part of a European benchmarking project. The main goal was to investigate the forms of decision-making autonomy and the challenges of strategy deployment in global production networks. In the first phase of the conducted study, eight large European manufacturing companies provided their points of view regarding the research areas of the survey. Researchers then set up the survey based on a literature review regarding appropriate measures and items for the relevant elements of the survey. Senior researchers as well as practitioners tested the survey in advance in order to avoid mistakes and to secure the quality and validity of the returned questionnaires in an iterative process. This feedback provided valuable insights for revising the survey. In total, we derived the items for this study from literature and discussion with industry and other researchers.

The survey was implemented in an online survey. Potential participants were invited via email in May 2020. In this email, instructions and explanations regarding the study were given. Participants had the possibility to contact the researchers in order to clarify open points. Due to this, a better understanding of the survey questionnaire was achieved. Over 1,000 companies were contacted by means of a survey invitation. The geographical focus was set to Europe with a high density of German-speaking countries. Two reminders were sent to the potential participants. In total, 88 companies completed the questionnaire. Therefore, the response rate is below 10% which is satisfactory due to the strategic character of the survey. The sample size is acceptable for exploratory research (Isaac and Michael, 1995). Participants of the survey were management level executives, e.g. Chief Operating officer (COO), Chief Executive Officer (CEO) and supply chain or production network managers. Furthermore, production managers or business unit managers were addressed. Thus, all addressed practitioners show a high connection to the topic of the research. The practitioners all had an overall network perspective on the production or supply chain unit of the company. Furthermore, we ran random confirmatory interviews with respondents in order to verify that the validity of data is high. Missing data in the survey answers were apparent in the performance variables, probably due to sensitivity of company data. Due to limited sample size, we incorporated incomplete survey answers that only lack some questions in the questionnaire. Two respondents had to be removed due to too many missing data, resulting in 86 respondents. The main characteristics of the sample are described in Table 1.

Non-response bias was checked by analysing correlations between late and early responses for relevant items. No significant differences were found for these two groups. Furthermore, size effects were not found for the factors in this study. Harmann’s single

factor test was used for common method variance to check whether one factor would emerge from all loading items, which would lead to common method bias. Common method bias was not found in the data set, factor loadings were below 0.5 for most of the items.

Table 1 – Main characteristics of the sample

Number of employees	Distribution (%)	Number of plants	Distribution (%)	Industry	Distribution (%)
No data	4.9%	< 5	29.6%	Mechanical engineering	32.9%
< 250	8.5%	5 - 9	28.4%	Electrical equipment	13.4%
250 - 499	2.4%	10 - 14	11.1%	Automotive	11.0%
500 - 999	9.8%	15 - 19	9.9%	Metal products	9.8%
1,000 - 2,499	23.2%	20 - 24	6.2%	Computer and electronic	7.3%
2,500 - 4,999	19.5%	25 - 34	3.7%	Production of other goods	7.3%
5,000 - 9,999	12.2%	34 - 49	2.5%	Pharmaceuticals	4.9%
10,000 - 19,999	7.3%	> 50	8.6%	Other transport equipment	3.7%
20,000 - 34,999	6.1%	Total	100.0%	Rubber and plastic products	2.4%
35,000 - 49,000	2.4%			Other non-metallic mineral pr	2.4%
> 50,000	3.7%			Others	4.9%
Total	100.0%			Total	100.0%

We focused on three different areas for our constructs: strategy, decisions and performance.

Strategy is measured along competitive priorities of a production strategy (Thomas, 2015). The following items are considered: price, product quality, delivery speed, delivery reliability, production volume flexibility, production mix flexibility, innovation and service. All strategy items are handled as single items in order to grasp the multidimensional influences of strategy on different decision-making patterns. Due to this, exploratory effects of different strategies on decision-making patterns can be analysed. The survey answers range from “much worse” (=1) to “much better” (=5).

Decisions are derived from manufacturing strategy decision categories and are treated as single items in order to analyse whether some policies are centralised while others are decentralised (Olhager and Feldmann, 2018). By doing so, we are able to test whether centralisation is done for individual decisions, as proposed by Hayes et al. (2005) or if decisions follow a common pattern. We differentiate between eleven established single decisions and four novel decisions. The established decisions are site strategy and role, organisation structure of the site, capacity utilisation, establishment of additional capacities, make-or-buy, supplier selection, production process, manufacturing technology, improvement programmes, long-term planning and control, short-term planning and control (see for further details Olhager and Feldmann (2018)). We extend these decisions by the following, novel decisions: manufacturing IT (Wiech et al., 2020), product allocation (Hochdörffer et al., 2021), transfer pricing and distribution (Lanza et al., 2019). Thus, we integrate novel decisions regarding IT and digitalisation and further we lay a focus on network aspects. In total, we focus on 15 decisions in the context of global production networks. The respondents were asked to indicate where a decision is done in a global production network ranging from “fully decentralised at the plant” (=1) to “fully centralised in the headquarters” (=5).

Production network performance is measured by EBIT, market share and manufacturing costs for the financial performance. Operational performance is measured along product quality, delivery speed, delivery reliability, production volume flexibility, production mix flexibility and sustainability, see e.g. (Olhager and Feldmann, 2018; Wiech et al., 2020). All performance items are handled at a disaggregated level as single items in order to see the multidimensional construct of performance. Due to this, an exploration of the effect of different decision-making patterns on performance can be

forced. Respondents were asked to indicate how the production network performance along the different dimensions developed compared to the main competitor, using a seven-point scale. The survey answers range from "much worse" (=1) to "much better" (=7) than competitors.

Results and discussion

For the analysis of the study, different patterns of decision-making autonomy are analysed by cluster analyses. After this, the relationship between these patterns with respect to competitive priorities of the production strategy is tested. In the end, the impact of different patterns of decision-making autonomy on operational and financial performance is tested.

Patterns of decision-making autonomy

For research question 1, we used cluster analyses in order to unveil different patterns of decision-making autonomy of production plants in global production networks. The focus lays on the question whether some decisions followed a more centralised approach while others followed a more decentralised approach. We used a K-means cluster analysis for the different decisions. While conducting the K-means cluster analysis, one should have enough clusters to represent smaller groups and also be able to identify outliners (Hair, 2010). Two clusters were appropriate for our 88 respondents of the survey. Therefore, we are close to the suggestion of Hair (2010) to have 30-40 cases within one cluster. We also tested for three and four clusters, but we were not able to gain deeper insights. Contrary to the indications of Olhager and Feldmann (2018), we did not find significant differences between the three patterns of decision-making: centralised, integrated and decentralised. The clustering with only two clusters gave significant results for almost all considered decisions. Cluster analysis was validated by cross-validation (Hair, 2010). We split the sample in two and performed the cluster analysis again, which resulted in qualitatively identical results. This indicates the validity of the cluster analysis.

The cluster analysis in Table 2 divides the production networks regarding the similarity of their decision-making autonomy patterns. The results imply that the two clusters, coined 'central' and 'decentral', are significantly different in most of the regarded decisions. Significance was tested by conducting the Mann-Whitney-U-Test in order to compare differences in the means of the two clusters. It can be stated that there are two substantially different decision-making autonomy patterns in global production networks. Only the decisions manufacturing IT, transfer pricing and distribution are not significantly different between the two clusters.

In the 'central' cluster, most of the decisions are between 3 and 5 on a five-point scale, except for short-term planning and control. Therefore, single production plants only have limited authority for their own operations in this cluster. Decisions are taken in the headquarters or on network level.

In the 'decentral' cluster, most of the decisions are between 1 and 3 on a five-point scale. Only the above mentioned decisions manufacturing IT, transfer pricing and distribution as well as production site strategy and role and product allocations are well above the threshold of 3. Both production strategy and role and product allocations range between 3 and 4 in this cluster, but they differ significantly from the central cluster.

Manufacturing IT, transfer pricing and distribution decisions have centralised patterns in both clusters. Therefore, we can state that these more strategical decisions are allocated to local headquarters and network levels in most of the companies. All other decision areas follow the same pattern of decentralisation and centralisation. This partly supports the works by Maritan et al. (2004).

Table 2 – Cluster analysis of decision-making autonomy

Decisions	**Clusters**		**Significance**
	Decentral (n = 33)	Central (n = 53)	
Manufacturing IT decisions	3.82	4.21	not significant
Transfer pricing	4.06	4.49	not significant
Distribution decisions	3.58	4.11	not significant
Production site strategy and roles	3.61	4.42	$p < 0.05$
Product allocation decisions	3.42	4.34	$p < 0.01$
Make-or-buy-decisions	2.48	4.40	$p < 0.01$
Supplier selection	2.06	3.87	$p < 0.01$
Establishment of additional capacities	2.61	4.02	$p < 0.01$
Capacity utilization	1.73	3.60	$p < 0.01$
Production process decisions	1.79	3.66	$p < 0.01$
Manufacturing technology decisions	2.64	4.02	$p < 0.01$
Long-term planning and control principles	2.58	4.19	$p < 0.01$
Short-term planning and control principles	1.45	2.92	$p < 0.01$
Improvement programmes	2.03	3.47	$p < 0.01$
Organizational structure of sites	1.55	3.58	$p < 0.01$

Strategy and decision-making autonomy patterns

For research question 2, we tested whether the orientation of the global production network's strategy is able to predict the pattern of decision-making autonomy. Therefore, we tested the equality of means of the two clusters of decision-making autonomy regarding the single items coming from production strategy (price, product quality, delivery speed, delivery reliability, production volume flexibility, production mix flexibility, innovation and service) by means of a Mann-Whitney-U-Test.

Table 3 shows that we found significant differences between the two clusters. The centralised pattern is associated with significantly higher emphasis on the competitive priorities: quality, delivery reliability and production volume flexibility. All other items are not significantly different between the two clusters. The results support the indications by Hayes et al. (2005) where different patterns of decision-making autonomy are related with different aims of production.

Table 3 – Relationship between strategy and decision-making autonomy patterns

Competitive Priorities	**Clusters**		**Significance**
	Decentral (n = 33)	Central (n = 53)	
Price	4.03	4.02	not significant
Quality	4.30	4.66	$p < 0.05$
Delivery speed	3.67	3.98	$p < 0.1$
Delivery reliability	3.97	4.45	$p < 0.01$
Variant flexibility	3.48	3.75	not significant
Volume flexibility	3.12	3.62	$p < 0.05$
Innovation	3.55	3.79	not significant
Service	3.85	4.00	not significant

Dealing with the competitive priorities in detail, a focus on quality may lead to the need for better alignment between plants in the improvement of production processes. Therefore, the centralisation of decisions may lead to superior achievement of this aim. A focus on delivery reliability may also need centralisation in order to be able to deliver from other production plants if one plant has some disturbances. Furthermore,

interactions with customers may be handled on a central level in order to achieve quicker response times and a more reliable delivery. Production volume flexibility may be achieved by central shifting of production volumes between production plants and the quick setup of new capacity by central organs.

Decision-making autonomy patterns and performance

For research question 3, we analysed the impact of decision-making autonomy patterns on financial and operational performance. We also tested the equality of means between the two clusters using the Mann-Whitney-U-Test (see Table 4). We found a significant difference in the operational performance for production volume flexibility and production mix flexibility. Financial performance was not significantly different for the two clusters.

Table 4 – Impact of decision-making autonomy patterns on performance

Performance criteria	**Clusters**		**Significance**
	Decentral (n = 33)	Central (n = 53)	
EBIT {financial}	4.50	4.45	not significant
Market share {financial}	4.54	5.00	not significant
Manufacturing costs {financial}	4.57	4.82	not significant
Product quality {operational}	4.75	5.20	not significant
Delivery speed {operational}	4.76	4.72	not significant
Delivery reliability {operational}	4.59	4.96	$p < 0.05$
Production volume flexibility {operational}	4.50	5.09	$p < 0.01$
Production mix flexibility {operational}	4.61	5.12	$p < 0.05$
Sustainability {operational}	4.86	4.95	not significant

The first finding is that all performance criteria are relatively high in both clusters. Most of the criteria are well above 4 on a seven-point Likert scale. Thus, all companies are considered to perform well in comparison to competitors. These results support the findings by Olhager and Feldmann (2018).

Second, there is a difference in the strategic setting of the two decision-making autonomy patterns that are significantly different in production volume flexibility (see RQ 2). The significant difference in production mix flexibility is novel and not indicated by a significant difference in the competitive priorities (see RQ 2). These results are also found by Olhager and Feldmann (2018), but without being significant. This indicates that following specific competitive priorities leads to higher performance.

Third, the results show that the decision-making autonomy patterns were selected properly according to the competitive priorities of the respective production network since the performance is high for all criteria and clusters.

Conclusion

This research contributes to the topic of centralisation and decentralisation of decision-making autonomy in global production networks by analysing the interplay between strategy, decisions and performance.

We find support for the presence of centralised and decentralised decision-making autonomy patterns. Only decisions regarding manufacturing IT, transfer pricing and distribution show a tendency to only centralised decision-making. All other decision areas can be clustered homogenously in the two dichotomous extremes.

Furthermore, centralised patterns are associated with a higher strategic emphasis on quality, delivery reliability and production volume flexibility. This supports managers in

finding the appropriate decision-making autonomy pattern for different competitive priorities of the global production network.

In addition, we find significant difference in the production volume and mix flexibility performance between the two clusters. Centralised decision-making autonomy leads to significantly higher performances in these two criteria. Nevertheless, all other performance criteria are not significantly different. This indicates the good fit of the decision-making autonomy pattern with different boundary conditions.

Further research may analyse the effect of network aims and capabilities, e.g. mobility of resources or internal and external learning, on the choice of decision-making autonomy patterns. In addition, different aspects of the production environment like internal and external complexity of the global production network may be implemented in the centralisation analyses. This may extend the works by Olhager and Feldmann (2018) with a focus on other factors like the influence of supplier reliability, customer demand flexibility or technology complexity on centralisation.

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