The Role of Intangible Influencing Factors in Strategic Network Decision-Making

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Abstract

The strategic configuration of global production networks is shaped by a variety of influencing factors and strategic motives. In addition to cost factors, intangible factors such as employee qualification and supplier reliability in particular influence the network configuration. This paper examines the relevance of 30 influencing factors on network configuration as well as their consideration in decision-making. The study shows that intangible factors are often only included through managers' gut feelings, although they have a significant influence on network performance. However, it can be shown that with increasing perceived relevance, intangible factors are included more systematically in the decision-making process.

Keywords: Global Production Networks, Strategic Decision Making, Strategic Fit

Introduction

Both large and small companies are increasingly organizing their value creation in globally distributed production sites. The motives for internationalization are manifold. For example, many site openings can be explained by the development of markets or the use of arbitrage advantages (Lanza et al., 2019). Current network decisions are increasingly characterized by a reduction of supply or cost risks (Moser et al., 2016).

Often, several strategic motives are pursued simultaneously (Johansen et al., 2014), resulting in historically grown, closely interwoven global production networks. Formally, a global production network (GPN) is defined as a network of globally distributed production entities that are interconnected through material and information flow relationships (Lanza et al., 2019).

The configuration of GPN covering the geographical distribution of products, technologies, and capacities in the production network. The overall goal of network configuration is to create a network structure that optimally supports the strategic motives of the company. This congruence of network configuration and strategic goals is referred to as strategic fit (Friedli et al., 2014).

However, these strategic configuration decisions are affected by a multitude of influencing factors. Some are directly quantifiable factors (e.g. wages, transport times), others are less tangible (e.g. political stability, availability of qualified personnel) (Lanza et al., 2019). In addition to the multitude of factors being referred to as detail complexity (Ferdows, 2014), the quantification of intangible factors and the comparison with monetary terms pose a major challenge in decision-making (Lanza et al., 2019). Thus, intangible factors are often underrepresented in decision-making even though they significantly influence a location's competitiveness. This can lead to a strategic miss-fit between production strategy and network configuration (Lanza et al., 2019).

The aim of this paper is to analyze the relevance of influencing factors for strategic network configuration as well as their consideration in decision-making to support network decisions and to finally increase network performance. This results in the three overarching research questions:

- RQ1: How are the different tangible and intangible influencing factors considered in the network configuration?
- RQ2: What is the relevance of the different tangible and intangible influencing factors for the network configuration?
- RQ3: What is the connection between the consideration and relevance of influencing factors?

These research questions serve as guidelines for the following investigation.

Decision-making in strategic GPN configuration

The strategic configuration of a GPN involves a large number of interdependent sub-decisions. According to decision theory, the decision area of a network configuration can be divided into decision parameters, influencing factors and goals. In literature, numerous approaches exist for structuring the decision area. Thus, Hayes et al. (1988) classify the manufacturing decision area into structural and infrastructural decisions. Structural decisions thereby correspond to the network configuration. In accordance to Hayes et al., (1988), structural decisions cover decisions regarding facility, capacity, technology and vertical integration. Friedli et al. (2014), in contrast, partition configuration decisions into network structure, specialization, network resources and the internal supply chain. Subsequently, Lanza et al. (2019) name network structure, product mix allocation, resource allocation and capability building as configuration decisions. These frameworks show that the network configuration is a comprehensive and interwoven decision area.

GPN configuration decisions are subject to a multitude of influencing factors coming from an internal and external business environment. Lanza et al. (2019) structure the external business environment into market, cost, logistical, political, legal and cultural influence factors. All factors are thereby underlying to risk and dynamics. Influencing factors originating from the internal business environment are product and process characteristics (Ferdows, 2014). The influencing factors can be differentiated in terms of

their quantifiability. Thus, some of them can be evaluated directly by monetary terms (e.g. labor cost and raw material prices), while others are difficult to grasp (e.g. political stability, availability of qualified personnel). Within the scope of this paper, 30 influencing factors were identified through a systematic literature analysis which are listed in Table 1. They are split up into tangible and intangible influencing factors.

Table 1: List of Tangible and Intangible Influencing Factors

Tangible influencing factors	Intangible influencing factors
Labor costs	Availability of reliable infrastructure
Transport costs	Availability of qualified people
Energy costs	Language barrier
Raw material prices	Different mentality
Overhead costs	Employee fluctuation
Inventory costs	Political stability
Investments for machines	Trade barriers
Capital costs	Climate
State incentives	Availability of mature technologies
Local content costs	Availability of supplier
Customs fee	Proximity to market
Market size	Product structure
Market growth	Opportunity of learning in local ecosystem
Demand volatility	
Profit margin	
Productivity	
Cost for coordination (Expatriates, Qualification, product ramp up)	

After the decision area has been concretized, the decision-making process will be examined in more detail. The multitude of interdependencies and the difficulty of evaluating intangible factors make decision-making very difficult. This leads to the fact that in practice intangible factors are neglected or considered only implicitly by gut feeling and the experience of the decision makers. In addition to these implicit approaches, decision support models exist, which help to structure the decision context and provide information regarding the effects of different decision alternatives (Clark and Scott, 1995). These differ in the manner they handle influencing factors and the associated force of expression (Nguyen et al., 2018). In the easiest, influencing factors can be evaluated by scoring models. Such models impress by simplicity but underlie high subjectivity. They also do not consider interdependencies and causal interactions between influencing factors, decision parameters and goals. Case studies, in contrast, take a holistic view, but are also associated with subjectivity and high effort. Analytical models formalize interdependencies through a mathematical description offering the highest support potential (Lanza et al., 2019). Figure 1 summarizes the different approaches.

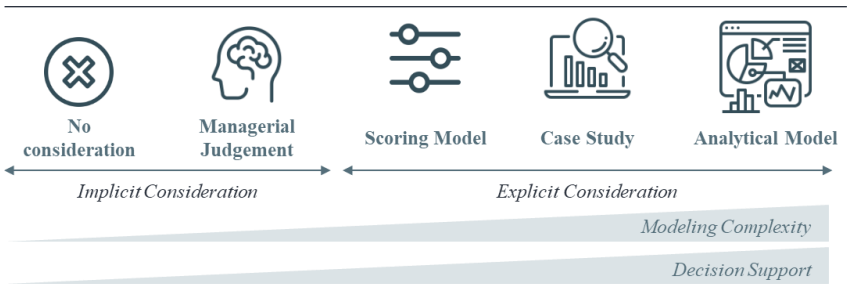

Figure 1: Consideration of influencing factors in strategic decision-making

Research Design

To answer the research questions given before, an empirical study was conducted. Figure 2 shows the research framework of the paper. The research subject is formed by the influencing factors of strategic network configuration which can be divided into the two groups of tangible and intangible influencing factors. The studies cover on the one hand the way of considering influencing factors (RQ1), and on the other hand the perceived relevance of the influencing factors (RQ2). To answer the first two research questions, the descriptive statistics of the two elements *consideration* and *relevance* of influencing factors are used. Regarding RQ1 and RQ3, the research was extended by two hypotheses, which were developed based on expert interviews and experiences from industry projects.

First, network decisions are largely evaluated based on costs, whereas intangibles are often only considered by the subjective gut feeling of managers resulting in the first hypothesis:

(H1) Intangible factors are considered less systematically than tangible factors.

Second, the imbalance between relevance and systematic consideration has not only been recognized in academic research but also in practice. It is presumed that companies that emphasize intangible factors also incorporate them more systematically in network decision-making:

(H2) The more important intangible factors are perceived, the more systematically they are considered.

To test the previously defined hypotheses, the study follows a hypothetical-deductive method. For data collection, a questionnaire was designed to evaluate the 30 influencing factors outlined in Table 1 in terms of their relevance and their consideration in decision-making. A 7-point Likert scale thereby characterizes the relevance. The consideration in decision-making is a nominal scaled metric based on the classification in Figure 1: *not at all, implicit (e.g. gut feeling), explicit in utility analysis, explicit in case study, explicit in analytical model*.

The data collection took place in the second half of 2021, with a total of 21 companies from the manufacturing sector. Most participants stem from the automotive and mechanical engineering industries. In order to ensure the highest possible data quality, managers in leading positions related to operations activities were surveyed. This includes roles such as CEO, Head of Global Production, or Head of Supply Chain. Almost three-quarters of the participants have a GPN with more than ten facilities.

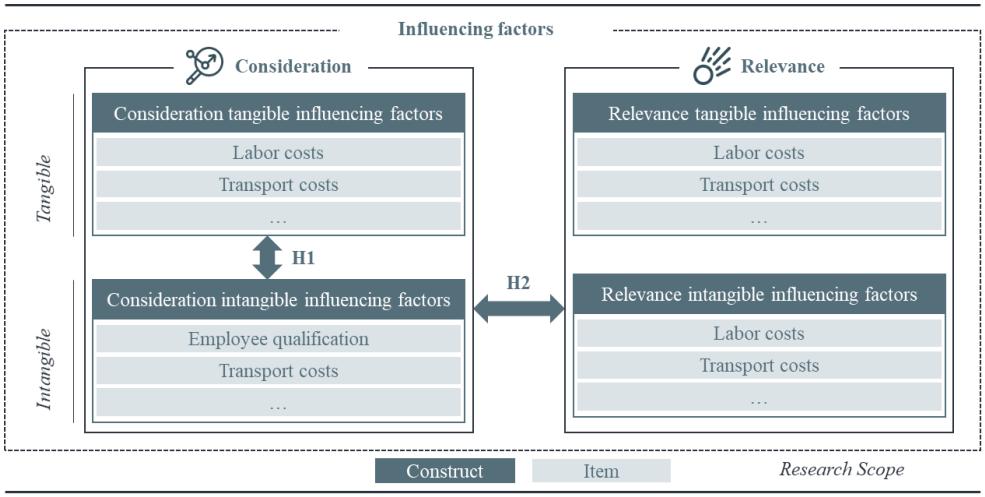

Figure 2: Research Framework and Hypotheses

Findings

With regard to the relevance of a specific influencing factor for strategic GPN configuration and their consideration in decision-making, the 30 tangible and intangible influencing factors included in the empirical study were analyzed. Through descriptive analysis and statistical tests of the individual hypotheses, important results of the study were obtained in relation to the overarching research questions which will be shown in the following.

Descriptive Analysis

Using descriptive statistics, the mean relevance and mode consideration of each factor were evaluated as shown in Figure 3. The influencing factors are combined and ranked in descending order according to their assessed relevance.

Based on the study, the most relevant tangible factors are in particular *profit margin*, *market growth* and *productivity*, followed by *material* and *labor costs*. This reflects the market and cost motive of globalization (Ferdows, 1997). The consideration of those factors in network configuration is mostly carried out explicit by business cases or case studies. However, *coordination cost*, like costs for expatriates, qualification, and product ramp up, is the only factor which is considered implicitly in the majority of responses.

Analyzing the intangible influencing factors, the most important factors are *availability* and *reliability of suppliers* and *infrastructure* and *market access*. This substantiates the statement that recently the decision-making is strongly characterized by a reduction of supply and cost risks (Moser et al., 2016). Additionally, the *availability of supplier* is not only the most important intangible factor in network configuration but the only one mostly considered using an explicit method. Even though the relevance of most intangible factors is rated high, they are considered only implicitly by gut feeling as well as managerial judgement and experience.

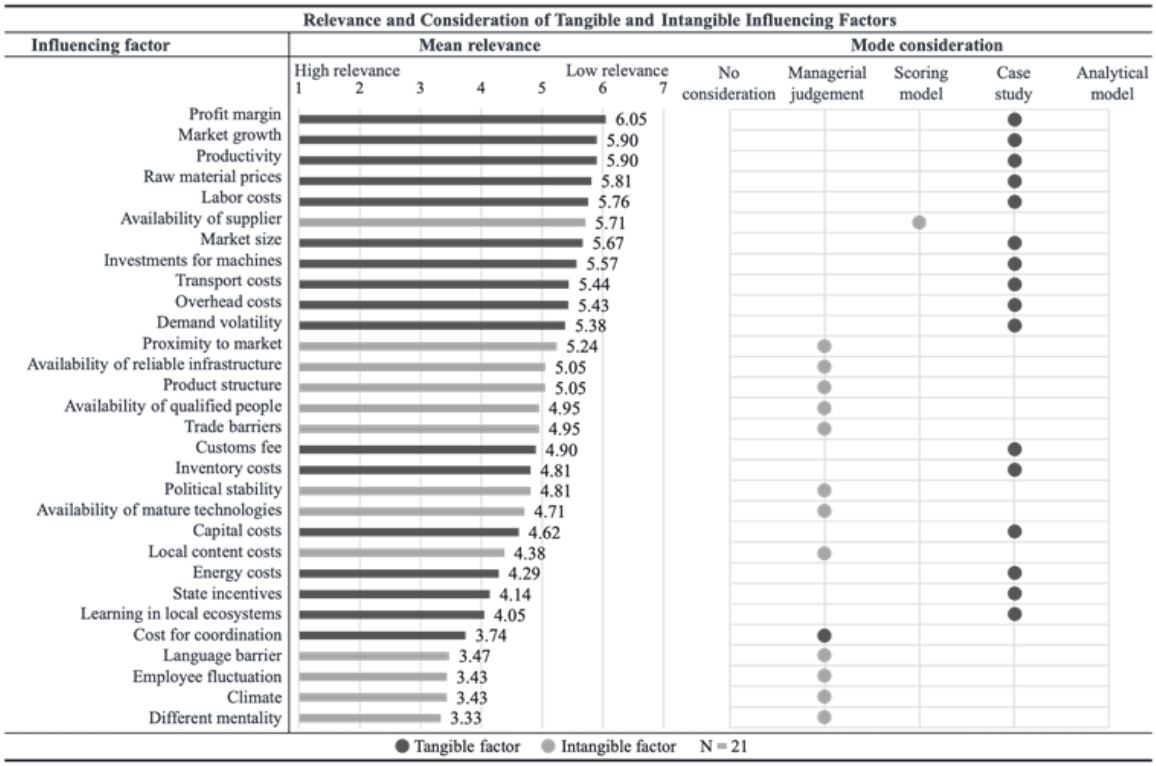

Figure 3: Relevance and Consideration of Influencing Factors

To further evaluate the interdependency of the intangible influencing factors, the correlations between the factors were analyzed. With the aim of gaining a better overall understanding, the factors are clustered into the internal and external business environment structure according to section 2. The clustering is shown in Table A1. Table 2 displays the mean relevance and standard deviation of the groups. Both, internal and external business environment outline a high relevance. On one side, the cluster *product* is of the greatest relevance followed by *political and legal* and *logistics* while, on the other side, *product* as well as *political and legal* shows the highest standard deviation.

Table 2: Descriptive Analysis of Clustered Intangible Influencing Factors

	External environment				**Internal environment**	
	Market	Logistics	Culture & people	Political & legal	Product	Process
Mean relevance	4.64	4.73	3.8	4.88	5.05	4.71
Standard deviation	1.32	1.17	1.27	1.86	1.40	1.52

To understand the interconnection between the influence clusters and to further derive implications for effects in network configuration, the Pearson correlation coefficient was investigated. The correlations between the groups can be seen in Figure 4. The highest correlation can be found between *logistics* and *culture and people* ($\rho=0.85$, $p<0.001$) followed by the correlation between *logistics* and *process* ($\rho=0.73$, $p<0.001$) and *political and legal* in correlation with *process* ($\rho=0.71$, $p<0.001$). Furthermore, all these correlations are of high significance at the 0.01 level. Comparing the mean relevance of the factors with the correlation coefficients, the study shows that although the factor *product* was rated with the greatest relevance, it, in contrast, has the weakest correlation with the other clusters.

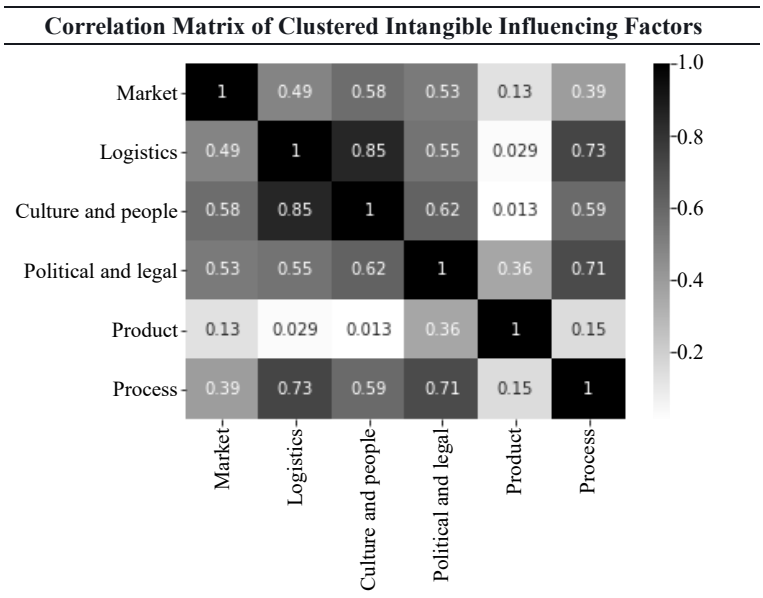

Figure 4: Correlation Matrix of Clustered Intangible Influencing Factors

Summing up the descriptive analysis, the study outlines that both, tangible and intangible influencing factors, are of high relevance in strategic network decision-making. In addition, some intangible factors are rated as more important than some tangible factors. Nevertheless, there are large differences concerning the consideration during the decision-making process since tangible factors are mostly considered explicitly while intangible factors are still mostly considered in an implicit way. Even the intangibles which are rated more relevant are considered less systematically. This finding implies the first hypothesis of this study which will be elaborated in the following.

Statistical Findings of the First Hypothesis

For statistical proof that intangible factors are considered less systematically than tangible factors, a contingency analysis was conducted. Crosstabulation and contingency analyses are used to identify and examine correlation between nominally scaled variables (Backhaus et al., 2016). In this case, the independent variable is the allocation of the influencing factors into tangible and intangible factors while the dependent variable is the approach used for consideration in decision-making. No correlation is assumed for the null hypothesis. The columns of the crosstabulation in Table 3 contain the five different methods of consideration (from section 2), while the rows divide tangible and intangible influencing factors. It indicates the interrelation between group and consideration by highlighting that the way of consideration varies between tangible and intangible influencing factors. Based on the small sample size of the study with only 21 independent data sets, the Fisher-Exact-Test was conducted during the contingency analysis to test the statistical independence with the aim of rejecting the null hypothesis. Table 3 additionally includes the result of this test. Based on the approximate significance with a p-value < 0.001, a significant dependency between relevance and consideration of influencing factors can be identified using a significance level of 5%. Further, the null hypothesis can be rejected and a correlation between the allocation of the influencing factors and the method of consideration can be identified. Thus, the hypothesis that intangible factors are considered less systematically than tangible factors can be verified based on the results of the crosstabulation and Fisher-Exact-Test.

Table 3: Crosstabulation and Result of Fisher-Exact-Test

Group*Consideration Crosstabulation						
	Implicit consideration		Explicit consideration			
	No consideration	Managerial judgement	Scoring model	Case study	Analytical model	Total
Intangible factor	2	12	3	4	0	21
Tangible factor	3	1	2	14	1	21
Total	5	13	5	18	1	42
Fisher-Freeman-Halton Exact Test						
Value	Exact significance (2-sided)				N of valid cases	
16.888	<.001				42	

Statistical Findings of the Second Hypothesis

Furthermore, the study also shows that with increasing importance of intangible factors, a more systematic consideration in decision-making is sought. This second hypothesis was validated by a two-sided t-test for equality of means and a discriminant analysis. The t-test is used to test whether the means of two groups are the same or different from each other. Due to the wide variability of relevance values and methods of consideration within a company, all relevance and consideration combinations were used as a test basis. This

means out of the 21 data sets from different companies which contain the ratings for the strength of relevance and the way in which the 13 intangible influencing factors were considered in decision-making, each relevance-consideration-combination was contrasted, resulting in 273 combinations being used for further investigation. Within the statistical tests, the five different methods of consideration are divided into the group *implicit* and *explicit*. The classification is integrated in Table 3. The group statistics in Table 4 displays the different mean relevance between implicit and explicit consideration. The mean relevance of the group explicit is greater than the relevance which was replied when using an implicit method in the decision-making process. Nevertheless, a specific influencing factor is considered implicit twice more often than explicit. With a p-value < 0.001, the t-test rejects the null hypothesis that both groups have the same value using a significance level of 5%. Thus, it can be shown that a specific influencing factor is taking more systematic into account during strategic network configuration when the factor is associated with a higher relevance.

Table 4: T-Test for Equality of Means

Group Statistics					
	Consideration	N	Mean	Std. deviation	Std. error mean
Relevance	Implicit	183	3,97	1,80	0,13
	Explicit	90	5,50	1,15	0,12

T-Test for Equality of Means			
One-sided p	Two-sided p	Mean difference	Std. error difference
<0,001	<0,001	-1,53	0,21

For further statistical testing of the hypothesis a discriminant analysis is conducted with the aim of predicting the group affiliation of subjects or objects based on their expressions of two or more metric characteristics (Backhaus et al., 2016). Thus, the independent variable is the relevance of intangible influencing factors while the dependent variable is defined by their consideration divided into the two groups of implicit or explicit consideration. The null hypothesis assumes that there is no difference between the two groups, implicit and explicit consideration. With a value of $p < 0.001$, a significant correlation can be attested at a significance level of 5% between the strength of the relevance and the group affiliation regarding the difference of implicit or explicit consideration. As shown in Table 5, with a probability of 71.8%, the correct group of consideration can be assigned based on the degree of relevance. Hence, the hypothesis that the more important intangible factors are perceived, the more systematically they are considered can be supported within the data of the empirical study.

Table 5: Discriminant Analysis and Classification

Summary of Canonical Discriminant Functions			
Wilks' Lambda	Chi-square	df	Sig.
0.835	48.70	1	<0.001

Classification			
Observed	Predicted		
	Implicit	Explicit	Percent correct
Implicit	157	26	85.8%
Explicit	51	39	43.3%
Overall percentage	76.2%	23.8%	71.8%

Discussion

The descriptive evaluation shows that both tangible and intangible factors play a role in the strategic GPN configuration. This reflects the different strategic motives pursued in the network configuration as well as the complexity of the decision area. In particular, with regard to intangible factors, availability and reliability of suppliers and infrastructure as well as market access were rated as especially important. This supports the statement that, in recent times, decision-making is increasingly influenced and shaped by a reduction of supply and cost risks motivated by events related to the COVID-19 pandemic, the chip crisis, and the Suez Canal blockade.

Furthermore, the study shows that tangible factors are usually considered explicitly, while intangible factors are mainly considered through management judgment and the subjective gut feeling of decision-maker. The reason for this lies in the difficulty of quantification and the corresponding effort. Thus, the additional effort required to find auxiliary metrics may not justify the additional improvement in decision quality gained.

Also, coordination cost, such as expatriate, qualification, and product ramp-up costs, is the only tangible factor implicitly considered in the majority of the study. In terms of coordination and support effort, it is generally observed that the increasing globalization and complexity of GPN leads to the need of operating in larger market contexts, resulting in increased coordination effort for firms (Abele et al., 2008). But many of the coordination costs, such as expenses for training employees and compensating for initial underutilization during the production ramp-up, are difficult to quantify in the course of setting up a foreign location and are therefore not adequately included by companies in their calculations. This also shows that tangible factors like coordination costs are influenced by many intangible factors such as process complexity, employee qualifications and culture. This finding in turn motivates a stronger focus on intangible factors to justify the validity of monetary assumptions.

In this study, GPN were considered in aggregate. However, since production sites have different strategic roles according to Ferdows´ site roles (Ferdows, 1997), a detailed analysis of the influencing factors per site would be useful. Based on the results by Mediavilla et al. (2015), it is to be expected that the site role *Lead* in particular focus on access to know-how and qualified personnel. *Offshore* sites, in contrast, are usually focused purely on cost advantages.

Conclusion

The configuration of global production networks is a highly complex management task and has been the subject of research and practice for decades. The goal is to create a network configuration that optimally supports production strategy. However, the sheer number and ambiguity of influencing factors complicate the evaluation of a strategic fit. Ferdows (2014) and Lanza et al. (2019) conclude that there is a need for research on approaches fostering harmonization of production strategy and network configuration.

Therefore, the aim of this study was to analyze the relevance of influencing factors on the one hand and their consideration in the decision-making process on the other hand. For this purpose, an empirical study was conducted with executives from operations strategy in multinational companies. The descriptive analysis of the results shows that, currently, the factors profit margin, market growth, productivity, availability of supplier, labor, and raw material costs are perceived as particularly relevant. Furthermore, with the help of a contingency analysis with a significance level of 5%, it could be shown that intangible factors are considered less systematically than tangible factors. However, the way of consideration of intangible factors in decision-making increases with perceived relevance. This was confirmed by a discriminant analysis with a 5% significance level.

Two central implications can thus be derived from the results. First, aside from profit and cost, supplier availability and productivity have particular relevance for strategic network configuration. Future research should therefore focus on these factors. Second, there is a large gap between the relevance and consideration of intangible factors. However, in order to put decision-relevant intangibles on a comparable basis with cost factors as well, further research is needed. Scholars should therefore develop decision support models that simultaneously consider tangible and intangible factors to ultimately increase strategic fit in network configuration. Furthermore, practitioners can also draw important insights from the paper for decision-making in their own companies. Thus, the results can initiate a re-evaluation and optimization of the decision-making process.

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Appendix

Table A1: Clustering of Intangible Influencing Factors

External business environment	
Market	Proximity to market
	Opportunity of learning in local ecosystem
Logistics	Availability of reliable infrastructure
	Availability of supplier
	Climate
Culture and people	Availability of qualified people
	Employee fluctuation
	Language barrier
	Different mentality
Political and legal	Political stability
	Trade barriers
Internal business environment	
Product	Product structure
Process	Availability of mature technologies