

The Whole Picture: Integrating Site and Network Dimensions in Site Roles

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Abstract In this chapter, we develop a site classification framework that combines manufacturing site advantages with manufacturing network-level targets. This framework is the first step for a company-specific site role portfolio. The framework helps to visualise site strengths and weaknesses from a capability- and knowledge-based perspective. Further, it highlights the site's contribution to the network targets and combines site- and network-level dimensions. To develop the site classification framework, we extend Ferdows' (1997) introduced dimensions of location advantages and competences with the interconnection of sites from a knowledge-based view. We use a single case study to refine the theoretically derived framework. We add to existing theory because we apply a multi-level perspective and derive methods to measure a sites contribution to the network. In addition, we provide global site managers with a helpful visualisation tool.

Keywords Site role · Manufacturing network · Site classification framework

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1 Exploiting the Network Potential

The global spread of manufacturing activities provides an international manufacturing company (IMC) with opportunities to achieve a competitive advantage. By exploiting the geographic location of its manufacturing sites, the IMC can benefit from access to local markets, low labour cost, favourable taxes or natural hedging. As additional benefit, foreign manufacturing sites are consistently recognised as a valuable source of “fresh” knowledge or skills (cf. Ferdows 1997). To maximise profit, however, the IMC must transform local advantages into global advantages. Therefore, globally dispersed sites in the network have to be coordinated (Kogut 1990) and aligned to the strategic targets of the network (Shi and Gregory 1998). Although each site contributes its specific characteristics and individual competences, fulfilment of network targets requires the concerted effort of the sites as a running network rather than the optimisation of single sites (Milteneburg 2005). To achieve maximum performance, the IMC needs to coordinate and optimise its sites from the site- and network-level perspectives. We introduce a framework that describes and classifies sites in order to optimise site advantages as well as network-level targets.

Site characteristics and competences define the site’s specific role in the network. The best known typology of site roles in operations management is the site role typology of Ferdows (Feldmann et al. 2010; Ferdows 1997). It classifies manufacturing sites along two dimensions: (1) location advantage and (2) level of competence (Ferdows 1997, 1989). Other scholars (e.g. Johansen and Riis 2005; Vereecke et al. 2006) have applied different dimensions for the classification of manufacturing sites and have derived their own typologies of site roles. Although the advantages of site role typologies are recognised, there has been some criticism. Typologies are based on different dimensions without building on each other or being connected (Kutschker and Schmid 2005). Furthermore, typologies are primarily derived from an aggregation of data from sites of various IMCs. The definition and allocation of site roles within a single network of one IMC has largely been neglected (Kutschker and Schmid 2005). To understand how a single site can optimise its contribution to network targets, we need to obtain insight from a single network of one IMC. Thus, we focus our approach on the intra-firm network, i.e. a single organisation consisting of multiple sites (Rudberg and Olhager 2003).

From a network-level perspective, four strategic targets may be goals in international manufacturing networks (Shi and Gregory 1998): (1) resource accessibility, (2) thriftiness, (3) mobility, and (4) learning. Accessibility results directly from the geographic location of the sites, but thriftiness, mobility, and learning are obtained from network coordination activities (Colotla et al. 2003). These targets define the cornerstones that compose a site role portfolio. A site role portfolio outlines which competences should be present within the network to fulfil its targets and how each site contributes to the network. Hence, we need to obtain a better understanding of how the network level has to be linked with the site-level perspective.

Our research approach addresses the described shortcomings. Although we ultimately need to construct and define a site role portfolio, which would allow deriving

an optimisation plan for each site and with this to coherently develop the network, we first need to develop a framework that classifies site competences and contributions to network targets. We first review existing literature on site role typologies in operations management and derive relevant dimensions to classify sites based on their competences and network target promotion. Second, we review manufacturing network literature and add relevant dimensions that cover site connectedness and help unlock network potential, which generates a classification framework that combines site- and network-level dimensions. Fourth, we show how this framework is applied within an IMC. We conclude with a discussion and ideas for further research.

2 Describing Site Characteristics from a Site- and Network-Level Perspective

To derive a site classification framework that combines site advantages and network level targets, we start with Ferdows' typology of site roles. Ferdows classifies sites along two dimensions; sites are distinguished by their strategic reason of location and level of competences (Ferdows 1997). The first dimension represents whether sites provide access to low-cost production, proximity to market, or access to skills and knowledge (Ferdows 1997). Site competences, ranging from manufacturing, procurement to product or process development, are described by the second dimension (Ferdows 1997). Ferdows' model is widely recognised in operations management (cf. Feldmann et al. 2009, 2010; Fusco and Spring 2003; Maritan et al. 2004; Meijboom and Voordijk 2003; Meijboom and Vos 2004; Turkulainen and Blomqvist 2010, 2011; Vereecke and Van Dierdonck 2002). However, several scholars state that the model "put a little too much emphasis on strategic role of separate factories rather than functions of the integrated or coordinated network" (Shi and Gregory 1998, p. 197). Ferdows' dimension of site competences has been extended to comprise the interaction between sites (cf. Feldmann et al. 2009, 2010; Maritan et al. 2004). In their work, Feldmann et al. (2009, 2010) and Maritan et al. (2004) highlight that the interconnection of sites in a network is a constituent element in the definition of site roles from a network perspective. This argument is supported by findings in the field of multinational company research, where various contributions to the integration of subsidiaries in the network have been made (cf. Andersson et al. 2002; Birkinshaw and Morrison 1995; Gupta and Govindarajan 1991; Jarillo and Martinez 1990; King and Sethi 1999; Prahalad and Doz 1987; Roth and Morrison 1992). Vereecke et al. (2006) have captured this idea and derived a new typology of manufacturing sites. Site integration in the knowledge network serves as the basis for classification. Roles are defined along the flow of innovations, frequency of communication, and exchange of people within the network (Vereecke et al. 2006).

For the purpose of our work, we combine the site-level perspective with the perspective of the site's integration in the network, labelled as network-level perspective. We extend the dimensions of (1) location advantages and (2) competences introduced

by Ferdows (1997) with the interconnection of sites from a knowledge-based view. This extension is termed “embeddedness” and represents the third dimension of our framework. Similar to Vereecke et al. (2006), we incorporate a fourth dimension describing a site’s position in the network as defined by its knowledge provision to and receipt from other sites in the network—the transceiver degree.

2.1 Location Advantages

Multifaceted advantages originate from the geographic location of a site (cf. Colotla et al. 2003; Feldmann et al. 2010; Ferdows 1997, 1989; Turkulainen and Blomqvist 2010, 2011; Vereecke and Van Dierdonck 2002). Vereecke and Van Dierdonck (2002) have proposed a comprehensive set of advantages, including proximity to markets, suppliers, or competition; the availability of labour, skills and know-how; and socio-political or infrastructural advantages (Vereecke and Van Dierdonck 2002). However, empirical testing validated Ferdows’ (1997) assumption that three main factors exist: (1) proximity to market, (2) access to low-cost manufacturing, and (3) access to skills and knowledge (Feldmann et al. 2010; Vereecke and Van Dierdonck 2002).

2.2 Level of Competences

Ferdows (1997) differentiates a site’s manufacturing competences, which range from manufacturing alone to serving as a global hub for product or process knowledge. He combines aspects of the bandwidth of site competences and the reach of competences. The bandwidth of site competences expresses the diversity of competences, ranging from production to the development of products or processes. To focus on the role of a site as a constituent part of the network, we assume that competences are heterogeneously distributed across sites. Sites may need the support of other sites’ competences to perform a task, which concurs with Maritan et al. (2004). The reach of competences indicates if the respective site uses its competences to perform an activity for the site alone (e.g. machine maintenance at shop floor), for a number of selected sites (e.g. the bundling of procurement orders), or for the whole network (e.g. a global hub for product and process knowledge and provision of this knowledge to the network’s sites). Accordingly, we propose to distinguish between (1) the bandwidth of competences a site incorporates and (2) the reach of its competences.

2.3 Level of Embeddedness

The interconnection of sites through flows of knowledge determines the site’s embeddedness in the network (Andersson et al. 2002; Dyer and Hatch 2006; Vereecke et al. 2006). In a case study of eight manufacturing companies,

Vereecke et al. (2006) showed that sites differ fundamentally in their degree of involvement in knowledge exchange and found that sites that are actively and frequently engaged in knowledge exchange have deeper roots in the network (Vereecke et al. 2006). In addition to the exchange of knowledge, we suggest that sites cooperate with one another to execute activities needed to produce their products. Sites with strong cooperation are assumed to have a higher degree of network integration and greater contributions to the spread of skills within the network. Thus, we distinguish between (1) the degree of knowledge exchange of a site and (2) its involvement in cooperation with other sites.

2.4 Transceiver Degree

Following the reasoning of Vereecke et al. (2006) a site's position in the network of an IMC is defined by its relationships with other sites in the network. Thereby, the relation is not always mutually balanced with respect to knowledge inflow and outflow. If knowledge outflow is higher than the amount of knowledge received by the site, the site is considered to be a sending or transmitting site. A receiving site has less knowledge outflow than inflow. The sending and receiving of knowledge is closely related to the degree of knowledge exchange. However, the degree of knowledge exchange only indicates the overall intensity of knowledge flow and therefore the level of embeddedness. It does not give any information on the main direction of knowledge flow. Thus, we add the fourth dimension, the transceiver degree, to mirror the site's dominant knowledge flow direction. The transceiver degree further represents site importance within the network as competences tend to develop around knowledge hubs (Riis et al. 2007), i.e. the more active transmitting sites.

3 Introduction of the Site Classification Framework

To classify sites in an IMC network, we integrate the above dimensions in a framework. The framework consists of four elements: (A) the competence triangle, combining the bandwidth and reach of competences, (B) the embeddedness triangle, combining the degree of cooperation and the degree of knowledge exchange of the respective site with other sites, (C) the transceiver degree, which considers the site's knowledge transmitting and receiving activities, and (D) the location advantages inherited by a site. The four elements will be introduced in more detail in the following paragraphs (see also Fig. 1).

(A) Each site inherits a variety of *competences*, some of which contribute to network targets. To classify the sites, we focus on the competences that contribute to network targets. To classify the site competence level, we first need the overall set of competences required to fulfil network targets (e.g. sales, product development, prototyping, or product testing). Each competence is displayed along two axes: (i)

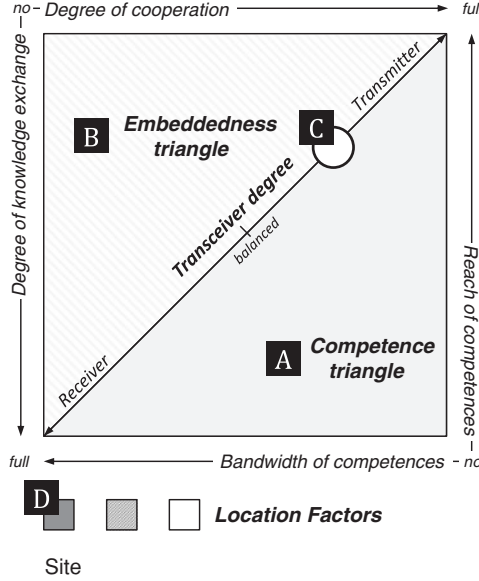


Fig. 1 Elements of the site classification framework

bandwidth of competence and (ii) reach of competence (Fig. 1, A). Site bandwidth of competences describes the actual competences of the site, whereas the reach of competences indicates for whom the site executes its competences in the network.

We use normalisation factors to evaluate the position of the bandwidth and the reach of competences of a site in the classification framework (Fig. 1) and to enable comparison of the competences of the sites in the network.

The bandwidth of a site can range from 0 to 1. A site with a bandwidth of 0 provides no useful competences for the network, and a site with a bandwidth of 1 possesses the full set of competences that contribute to network targets. Accordingly, the bandwidth of competence (b_{site}) can be understood as the sum of site competences (c_i) in relation to the total number of competences required in the network ($c_{\text{network}I}$), as shown in Eq. (1).

$$b_{\text{site}} = \frac{\sum_{i=1}^I c_i}{I} \quad (1)$$

with $I :=$ total number of competences.

A task can be executed by one site or in cooperation with another site. Tasks that can be performed independently by a site represent a full competence level in regard to a certain competence and therefore are rated with the value 1. Tasks that are executed in cooperation with a site indicate a lower level of competence. Since in practice the exact distribution of competences between the sites can hardly be determined, shared competences get the rating value of $1/\text{number of cooperating sites}$. In practice, the standard case is the collaboration of two sites and therefore the value 0.5 can be often used. We illustrate the calculation of the bandwidth

with an example. A company might need 18 different competences in a network to fulfil the targets. The site under investigation exclusively holds 10 competences. Additional, one competence is held at another site, and the respective task is achieved in cooperation. The overall bandwidth of competence of the site is:

$$b_{\text{site}} = \frac{(10 \cdot 1) + (1 \cdot 0.5)}{18} = 0.58 \quad (2)$$

Reach of competences is the second competence axis. Similar to the bandwidth of competences, the reach of competences takes a value between 0 and 1; a value of 1 symbolises that a site holds the full reach of competences needed in the network and executes activities with these competences for the entire network. To calculate the reach of competences (r_{site}), each competence (c_i) is multiplied with its reach value (r_i). The mathematically exact reach value depends on the number of sites for whom the activity with the respective competence is executed as well as the total number of requiring sites. In some previous studies we found, however, that collecting these exact numbers is at the expense of data quality. Practitioners often give diverging and inconsistent answers. Satisfying data validity can in most cases not be achieved. Taking this into account, we decided to use a more rough calculation and differentiate only between the three cases: A site can use its competences to perform an activity only for its own site, for selected sites, or for the entire manufacturing network. Assuming an evenly divided scale, the first case is represented by a reach value of $\frac{1}{3}$. A value of $\frac{2}{3}$ means that the activity is performed for selected sites and a value of $\frac{3}{3} = 1$ indicates that the activity is performed for the whole network. The formula to calculate and normalise the reach of competences is shown in Eq. (3).

$$r_{\text{site}} = \frac{\sum_{i=1}^I (c_i \cdot r_i)}{I} \quad (3)$$

with $I :=$ total number of competences.

We clarify this calculation with a continuation of the above example. We still have 18 network capabilities, and the analysed site has 10 exclusively held competences and 1 competence where corresponding activities need to be performed in cooperation with a second site. Out of the 10 exclusive competences, 6 corresponding activities are performed for the site alone, 3 are performed for selected sites and 1 is performed for the whole network. The competence held in cooperation is performed for selected sites. The corresponding normalised reach of competences is calculated as shown in Eq. (4):

$$r_{\text{site}} = \frac{\left(6 \cdot 1 \cdot \frac{1}{3}\right) + \left(3 \cdot 1 \cdot \frac{2}{3}\right) + \left(1 \cdot 1 \cdot \frac{3}{3}\right) + \left(1 \cdot 0.5 \cdot \frac{2}{3}\right)}{18} = 0.30 \quad (4)$$

(B) The execution of competences generates knowledge that is valuable for the respective site and other sites of the network often benefit from this knowledge. Hence, knowledge exchange between sites is central from a network-level perspective. A higher degree of cooperation with other sites and a higher degree of exchanged knowledge deepen the respective site's embeddedness in the network. The *embeddedness* of a site in the network is defined through two dimensions:

(i) site degree of knowledge exchange and (ii) site degree of cooperation (Fig. 1, B). The degree of knowledge exchange is measured as the knowledge inflow and outflow of the site, i.e. the knowledge the site receives from and sends to other sites in the network. The degree of cooperation is quantified by the amount of cooperative activities that the respective site accomplishes with other sites in the network.

The degree of knowledge exchange of a site can range from 0 to 1. A site that is not participating in knowledge exchange receives a value of 0. In contrast, a site that is fully engaged in knowledge exchange is assigned the maximum value of 1. The overall degree of knowledge exchange of a site (k_{site}) can be measured by its total amount of knowledge exchange and expressed as the weighted intensity of the knowledge inflow ($k_{\text{in } j}$) and outflow ($k_{\text{out } j}$), which are each measured on a 5-point Likert scale ranging from 1 = very little knowledge flow to 5 = very high knowledge flow. If there is no knowledge flow at all for a certain item, it is valued as 0. The weights ($w_{\text{in } j}$ and $w_{\text{out } j}$) represent the normalised reach of the knowledge flows. Again the ratio between number of sites that send or receive knowledge and the total number of sites that require the knowledge would depict the mathematically correct value. Experience in practice, however, shows that such an exact measurement does not result in a valid data basis. Therefore, we choose a rougher division of the scale and distinguish between knowledge that is exchanged with selected sites and knowledge that is exchanged with the whole network. The corresponding values are $\frac{1}{2} = 0.5$ for knowledge exchange with selected sites and $\frac{2}{2} = 1$ for knowledge exchange with the whole network. If knowledge is not exchanged with any other site in the network, the weight is consequently valued as 0.

To aggregate the weighted knowledge flows, the relative closeness to the maximum amount of possible knowledge exchange is calculated (Eq. 5a, Fig. 2). This closeness is defined as the Euclidian distance to the minimum value (s^-) over the sum of the Euclidian distance to the minimum value (s^- , Eq. 5b) and to the maximum value (s^+ , Eq. 5c). Due to the usage of the 5-point Likert scale and the default value 0, the minimum value is represented by 0 and the maximum value by 5. When calculating the Euclidian distance, these values represent fixed reference points, i.e. the minimum and maximum amount of knowledge exchange and must be subtracted in Eqs. 5b and 5c.

$$k_{\text{site}} = \frac{s^-}{s^- + s^+} \quad (5a)$$

$$s^- = \sqrt{\sum_{j=1}^J ((k_{\text{in } j} \cdot w_{\text{in } j} - 0)^2 + (k_{\text{out } j} \cdot w_{\text{out } j} - 0)^2)} \quad (5b)$$

with $J :=$ total number of areas to which knowledge is exchanged

$$s^+ = \sqrt{\sum_{j=1}^J ((k_{\text{in } j} \cdot w_{\text{in } j} - 5)^2 + (k_{\text{out } j} \cdot w_{\text{out } j} - 5)^2)} \quad (5c)$$

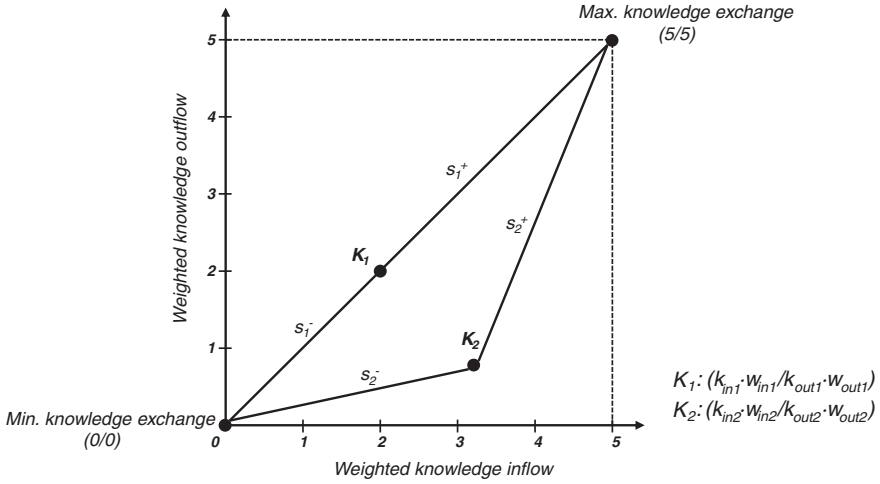


Fig. 2 Euclidian distance to the maximum and minimum knowledge exchange

with $J :=$ total number of areas to which knowledge is exchanged.

The second axis displays the degree of cooperation ($\text{coop}_{\text{site}}$) and relates the number of cooperative activities (a_k) to the number of required activities of a site ($a_{\text{site}a_{\text{req}}}$). Cooperative activities are understood as the activities that require certain interaction between sites. This interaction may either be the case for activities executed in cooperation with other sites in the network or activities provided by other sites in the network. Additionally, cooperation might be necessary if specialised resources (e.g. special manufacturing equipment) are only held at certain sites in the network. Compared to the bandwidth of competences the cooperation axis has greater sole responsibility for the activities accomplished based on aggregated competences.

$$\text{coop}_{\text{site}} = \frac{\sum_{k=1}^K a_k}{a_{\text{req}}} \quad (6)$$

with $K :=$ total number of activities that are executed in cooperation.

(C) Embeddedness shows the depth of integration of a respective site in the network. However, embeddedness does not show the direction of the exchanged knowledge. The knowledge can flow from the respective site to one or several other sites (knowledge outflow), and/or the knowledge can flow from other sites to the respective site (knowledge inflow). Both directions of knowledge flow are important. Whereas outflowing knowledge helps to develop other sites, inflowing knowledge helps to develop one's own site. We display the level of knowledge inflow and outflow as the *transceiver degree* of the site (Fig. 1, C). Depending of the amount that knowledge flows in and out of the respective site, the site is positioned on the transmitting or receiving side.

The transceiver degree is calculated as the normalised sum of knowledge out-flow intensity ($k_{\text{out } j}$) minus the corresponding knowledge inflow intensity ($k_{\text{in } j}$) (Eq. 7).

$$t_{\text{site}} = \frac{\sum_{j=1}^J (k_{\text{out } j} - k_{\text{in } j})}{J} \quad (7)$$

with $J :=$ total number of areas to which knowledge is exchanged.

(D) Site geographic locations reflect the basic network set up. With these locations, the network can achieve certain advantages. *Location advantages* (Fig. 1, D) display if the sites offer (1) access to markets, (2) access to skills and knowledge, or (3) access to low cost manufacturing. These location advantages are inherent characteristics of the respective site. Contrary to Ferdows (1997), we do not see that these location advantages are mutually exclusive. Instead, we assume that a location can provide more than one advantage, e.g. access to market and low cost manufacturing.

4 Methodology

This research seeks to make a theoretical contribution and help managers make decisions concerning their site role portfolios. We engage in middle range theory development (Merton 1968) by studying a company consisting of multiple sites with different competences and differing network integration. Middle range theory merges theory with empirical work, which we accomplish by deriving dimensions for a theoretical framework and refining the dimensions based on our case study data. Thus, we follow a grounded theory building approach (Eisenhardt 1989; Eisenhardt and Graebner 2007; Stuart et al. 2002; Voss et al. 2002; Yin 1994) to gain a better understanding of the relationships between the site- and network-level perspective and the characterisation of a site and its contribution to network targets.

4.1 Case Company

Our case describes the manufacturing network of the ELMA Electronic Group. ELMA is a global manufacturer of electronic packaging systems used as black boxes in trains or aircrafts. The company is headquartered in Switzerland. Most of ELMA's products are engineered to customer requirements. Individual constructions and batches with 1–10 pieces are not unusual. The ELMA manufacturing network consists of 12 manufacturing sites spread across the globe. Case selection was conducted in three steps with an adaptation of Miles and Huberman's (1994) sampling suggestions. First, we selected manufacturing companies with at least three manufacturing

sites and a willingness to participate in research. Based on information provided by the company, we excluded all companies without a clear manufacturing network strategy in a second step. In the last step of sample selection, we excluded companies without clear knowledge of competences, integration, and location advantages of the sites in the network. We identified five companies that would have been interesting to study and willing to provide the needed information. Due to the effort needed to conduct case studies and to meet the study purpose to develop a framework and test its applicability, we decided to conduct a single case study (Eisenhardt 1989). In this case, we considered the advantages of gaining deep insight into one company more important compared to a broad but superficial data set.

4.2 Data Collection

The purpose of our data collection was to obtain in-depth insight at two different levels, the network and the site level. At the network level, we wanted to gain insight about company network setup, manufacturing network strategy, expectations towards the contribution of each site to the network targets and site coordination. At the site level, we wanted to gain insight regarding the bandwidth and reach of competences, the type of knowledge the sites shared, the recipients of shared knowledge, and the providers of knowledge. Additionally, we wanted to identify location advantages provided by the site. Network-level information was gathered from interviews held with company management from December 2011 to April 2013. During this research period, we conducted 12 interviews with the CEO, the managers of the two major divisions, the chief financial officer, and the regional network managers.

Three operations management researchers conducted the interviews. The duration of each interview was between 2 and 4 h. The interviews were recorded and minutes were written. Researchers compared the notes and overall impressions after each interview. Following Eisenhardt (1989), detailed minutes were compiled within 24 h of each interview, including the interview data, overall impressions, and conclusions. In some cases, follow-up interviews were conducted to clarify responses or obtain additional details. The interview data were supplemented by examining other sources of information, including archival data, industry publications, manuals, and company documents.

Site-level information was gathered by sending a standardised questionnaire to each site, and the respective site manager answered the questionnaire. If questions were unclear or additional explanations were needed, one researcher was available over the phone to answer these open questions. The sites mailed the questionnaires directly to the researchers, who analysed and combined the answers with the results of the network-level interviews.

All results were discussed with the whole group of interviewees from the network-level to verify the site answers and to discuss differences in the network-level expectations and opinions as well as the site-level perspectives.

4.3 Data Analysis

We used Miles and Huberman's (1994) four-step approach for data analysis. The first step was development of a contact summary sheet to record the main themes in each interview. One researcher identified the main themes, while the other two researchers checked these themes with the interview minutes. Second, a complete theme list based on the contact summary sheet was developed. Third, all interviews were coded with selected coding (Strauss and Corbin 1990) to categorise the answers into main themes. One researcher was responsible for coding the interview minutes, while the other two researchers checked the coding. In the event of disagreement, the point was discussed until agreement was reached. If no agreement was reached, the point was referred to the interviewee for clarification. This procedure assured a high level of inter-rater reliability (Voss et al. 2002). The fourth step consisted of writing the case study, followed by a final validity check that presented the results to the interviewees.

5 The Case of ELMA: An Example for a Differentiated Network

The ELMA manufacturing network consists of 12 globally dispersed sites, which are displayed in Fig. 3. Each site in the network has a clear, specific characteristic. This characteristic visualises the site uniqueness in the network and reveals site strengths as well as current and possible future network roles. Notably, ELMA's network is divided into three regions: EMEA, Asia, and the Americas. While EMEA and the Americas are rather mature regions, Asia is in the development stage and is primarily coordinated by the Swiss site (site 1).

A clear pattern emerges in the three regions. Each mature region possesses *lighthouse sites* with rather large competences and embeddedness triangles (site 1, site 6, and site 10 have the highest values for competence as well as embeddedness triangle areas). Moreover, the mature regions stand out as knowledge transmitting sites. In particular, the Swiss site transmits much knowledge to other sites and holds an extraordinary position in the network. The Swiss site supports the new sites in the Asian region as well as newly established Romanian low cost site (site 4). All lighthouse sites in the regarded network provide access to skills and knowledge as well as proximity to markets as main location advantages.

The second group of sites consists of *support sites* (site 4, site 11) that offer low-cost advantages for the network and serve as extended workbenches for the corresponding region. The second group is characterised by a relatively high degree of cooperation and a greater amount of inflowing information and knowledge. Notably, both sites differ in the size of their competences and the embeddedness triangle. This difference may be caused by differences in site maturity stages. While the US site (site 11) is a rather mature network player with much expertise, the Romanian site

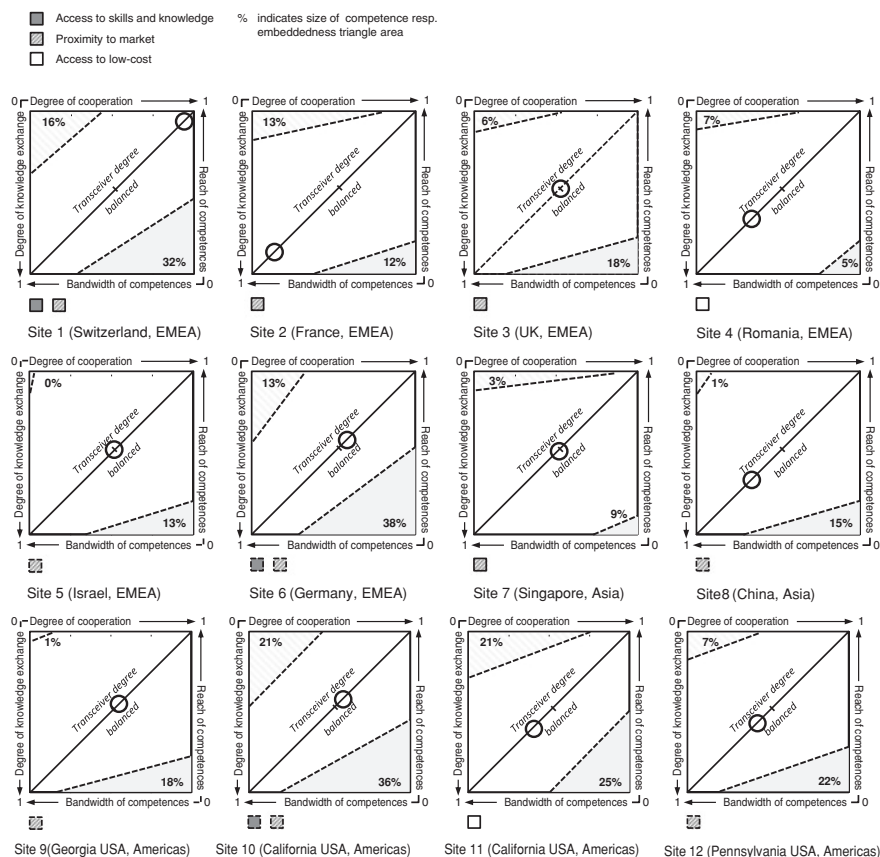


Fig. 3 ELMA network

(site 4), founded several years ago, remains very dependent on the Swiss lighthouse site (site 1). With increasing maturity, the Romanian site is likely to obtain a set of competences and a degree of embeddedness similar to that of the US site.

The third group that can be identified in the sample is the *market producers* (site 2, site 3, site 5, site 8, site 9, and site 12). Its sites are similar in their degrees of location factor proximity to markets and their competence triangle sizes. Three sites (site 2, 3, and 12) possess a medium degree of embeddedness whereas the other three sites (site 5, 8, and 9) are rather isolated in the network. This isolation is primarily caused by site history, state of maturity, legal restrictions due to the product's market requirements, and site product portfolio. The transceiver degree of the isolated market producers tends to be balanced. The Chinese site (site 8) seems to be an exception, which potentially results from the fact that the Asian sites remain in the development stage and receive knowledge from the Swiss Site.

The remaining site is located in Singapore (site 7). The site primarily acts as a sales and trade partner within the network, but the site will be developed into a

full manufacturing site, which is mirrored in the rather small competence triangle. In contrast, the degree of cooperation is rather high because the site is new and dependent on the Swiss site.

6 Discussion and Conclusion

The site classification framework helps global site managers to characterise plants. First, the framework helps to visualise the site's capability and knowledge base and its embeddedness in the manufacturing network. Next, the framework shows from which location advantages the network can benefit from. Furthermore, the framework highlights site contributions to the network. Overall, the framework builds the first step for a company specific site role portfolio.

ELMA's site classification shows that different groups can be identified. We assume that similar groups can be found within each company's site classification framework. This site characterisation reveals measures to coordinate the network. To maximise the benefit from the support sites, a site needs continual monitoring and actions should be taken to improve efficiency, if necessary. Additionally, a lighthouse site is a knowledge provider for the network. Closing such a site could negatively influence the performance of the entire network. The specific competences and knowledge of a lighthouse site cannot be easily transferred to another site. Some sites may not belong to a specific group (e.g. Singapore). Such a site raises the complexity level within a network because this site may need different coordination mechanisms. As in the case of the Singapore site, complexity reduction from a network-level perspective may require investment in the plant to improve competences and/or cooperation and knowledge exchange.

The case study exemplifies that all sites in the network need not fully cover the maximum values. In fact, the appropriate combination of sites with different characteristics leads to an effective and efficient manufacturing network. Hence, the framework helps to decide plant development by competency or knowledge.

To unlock the network's potential, global network managers need to combine site specific advantages and network level targets. The classification framework developed in this paper highlights site capabilities and contributions to the network. Furthermore, the framework helps unlock network potential and considers site connections. Additionally, we demonstrate site importance from a knowledge-based view and present the transceiver degree. Visualisation of site location advantages further highlights potential site improvements.

We add to existing theory because we combine the capability perspective introduced by Ferdows (1997) with the network-level perspective mirrored by site embeddedness and transceiver degree. This combined approach permits site classification and supports managers who aim to unlock the network's potential. In addition, this approach is a first step towards a site role portfolio, which defines the required network site characteristics to optimise network level performance. Combining this framework with network targets (access to markets or thriftiness)

helps global managers define site role portfolios. A comparison of an optimised site role portfolio with the actual situation allows measure identification. Based on a company's contingency factors, however, optimal site role portfolios differ.

We further add to theory by providing an operationalization which allows comparing the level of competences as well as the degree of embeddedness of sites belonging to **one** manufacturing network.

We labelled identical groups to illustrate the site characteristics found in the case study. However, groups may differ by site specific characteristics and network goal. From our perspective, the defined names for the roles are not as important as the clear definitions of site contributions to the network and its further development path.

From a practitioner view, the classification framework is a visualisation tool that allows continual revision and improvement of the site competences and contribution to the network. The framework helps clarify a site's network position and explains the measures needed from a network perspective. Further research should combine network targets with the classification framework to derive an optimised site role portfolio. A survey would allow the investigation of patterns within the classification framework and among the network targets.

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References

- Andersson U, Forsgren M, Holm U (2002) The strategic impact of external networks: subsidiary performance and competence development in the multinational corporation. *Strateg Manage J* 23(11):979–996
- Birkinshaw JM, Morrison AJ (1995) Configurations of strategy and structure in subsidiaries of multinational corporations. *J Int Bus Stud* 26:729–754
- Colotla I, Shi Y, Gregory MJ (2003) Operation and performance of international manufacturing networks. *Int J Oper Prod Manage* 23(10):1184–1206
- Dyer JH, Hatch NW (2006) Relation-specific capabilities and barriers to knowledge transfers: creating advantage through network relationships. *Strateg Manage J* 27(8):701–719
- Eisenhardt KM (1989) Building theories from case study research. *Acad Manage Rev* 14(4):532–550
- Eisenhardt KM, Graebner ME (2007) Theory building from cases: opportunities and challenges. *Acad Manage J* 50(1):25–32
- Feldmann A, Olhager J, Fleet D, Shi Y (2010) Linking networks and plant roles: the impact of changing a plant role. 17th international annual EurOMA conference, Porto, Portugal
- Feldmann A, Olhager J, Persson F (2009) Designing and managing manufacturing networks—a survey of Swedish plants. *Prod Plann Control* 20(2):101–112
- Ferdows K (1989) Mapping international factory networks. In: Ferdows K (ed) *Managing international manufacturing*. Elsevier Science Publishers, Amsterdam, Netherlands
- Ferdows K (1997) Making the most of foreign factories. *Harvard Bus Rev* 75(2):73–88
- Fusco JP, Spring M (2003) Flexibility versus robust networks: the case of the Brazilian automotive sector. *Integr Manuf Syst* 14(1):26–35
- Gupta AK, Govindarajan V (1991) Knowledge flows and the structure of control within multinational corporations. *Acad Manage Rev* 16(4):768–792

- Jarillo JC, Martinez JI (1990) Different roles for subsidiaries: the case of multinational corporations in Spain. *Strateg Manage J* 11(7):501–512
- Johansen J, Riis JO (2005) The interactive firm—towards a new paradigm: a framework for the strategic positioning of the industrial company of the future. *Int J Oper Prod Manage* 25(2):202–216
- King WR, Sethi V (1999) An empirical assessment of the organization of transnational information systems. *J Manage Inf Syst* 15(4):7–28
- Kogut B (1990) International sequential advantages and network flexibility. In: Bartlett CA, Doz Y, Hedlund G (eds) *Managing the global firm*. Routledge, London, pp 47–68
- Kutschker M, Schmid S (2005) *Internationales management*. Oldenbourg, München, Wien
- Maritan CA, Brush TH, Karnani AG (2004) Plant roles and decision autonomy in multinational plant networks. *J Oper Manage* 22(5):489–503
- Meijboom B, Voordijk H (2003) International operations and location decisions: a firm level approach. *Tijdschrift voor Economische en Sociale Geografie* 94(4):463–476
- Meijboom B, Vos B (2004) Site competence dynamics in international manufacturing networks: instrument development and a test in Eastern European factories. *J Purchasing Supply Manage* 10(3):127–136
- Merton RK (1968) *Social theory and social structure*. Free Press, New York
- Miles MB, Huberman MA (1994) *Qualitative data analysis*. Sage, Thousand Oaks, CA
- Miltenburg J (2005) *Manufacturing strategy: how to formulate and implement a winning plan*. Productivity Press, Portland
- Prahalad CK, Doz YL (1987) *The multinational mission: balancing local demands and global vision*. Free Press, New York
- Riis JO, Johansen J, Waehrens BV, Englyst L (2007) Strategic roles of manufacturing. *J Manuf Technol Manage* 18(8):933–948
- Roth K, Morrison AJ (1992) Implementing global strategy: characteristics of global subsidiary mandates. *J Int Bus Stud* 23(4):715–735
- Rudberg M, Olhager J (2003) Manufacturing networks and supply chains: an operations strategy perspective. *Omega* 31(1):29–39
- Shi Y, Gregory M (1998) International manufacturing networks—to develop global competitive capabilities. *J Oper Manage* 16(2, 3):195–214
- Strauss A, Corbin J (1990) *Basics of qualitative research: grounded theory procedures and techniques*. Sage Publications, Newbury Park, CA
- Stuart I, Mccutcheon D, Handfield R, Mclachlin R, Samson D (2002) Effective case research in operations management: a process perspective. *J Oper Manage* 20(5):419–433
- Turkulainen V, Blomqvist M (2010) What is the future of manufacturing in western countries? Analysis of plant roles. 15th Cambridge international manufacturing symposium Cambridge, UK
- Turkulainen V, Blomqvist M (2011) Plant roles in high cost countries. A survey analysis of manufacturing networks in the northern Europe. 18th international annual EurOMA conference, Cambridge, UK
- Vereecke A, Van Dierdonck R (2002) The strategic role of the plant: testing Ferdows' model. *Int J Oper Prod Manage* 22(5):492–514
- Vereecke A, Van Dierdonck R, De Meyer A (2006) A typology of plants in global manufacturing networks. *Manage Sci* 52(11):1737–1750
- Voss C, Tsikriktsis N, Frohlich M (2002) Case research in operations management. *Int J Oper Prod Manage* 22(2):195–219
- Yin RK (1994) *Case study research: design and methods*. SAGE Publications, Thousand Oaks, London, New Delhi

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