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# Decision support for production localization: Process, activities and localization factors

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## Abstract

Traditional production location decisions are mainly based upon economic factors while factors that facilitate decision makers in selecting the most suitable production location in terms of operations performance are rarely considered. Therefore, this paper presents a developed decision support for production localization that emphasises operational factors to be considered in the decision making. The research methodology combines a literature study with a multiple case study method. The findings are synthesised into a five phase decision process for making production localization decisions in practice. For each of these phases, key activities with related tools and expected output are developed.

**Keywords:** Production location decision, Decision process, Localization factors

## Introduction

Due to the globalization and growing market an increasing number of companies have multiple sites all over the world. Managing an international network of geographically dispersed manufacturing sites has become an increasingly important task for managers, as discussed by (e.g. Ferdows, 1997; Vereecke and Van Dierdonck, 2002). Managing and organising effectively an integrated network can offer economic advantages and superior operating conditions and thus can contribute to competitive advantages. However, many manufacturing companies find it difficult to design their production network in an effective way. Problems often arise due to different reasons, where one typically is the fact that the production location decision is based on pure cost evaluations which do not reveal the complete picture (Cheng et al., 2011).

It has also been argued that another reason for moving a company's processes and operations to another location is the attempt to solve existing problems in a quick way instead of solving the real problems (Oshri, 2011). The effect of such decisions is not always easy to analyse since, decision makers do generally not evaluate past decisions, to analyse if they have fulfilled the expected projections (Porter and Rivkin, 2012).

In consequence of this one-sided perspective, it has been argued that companies must develop a more balanced view when making a production location decision, including both qualitative and quantitative factors (Ferdows, 1989; Yang and Lee, 1997). According to MacCarthy and Atthirawong (2003), a wide range of factors may potentially influence the production location decision process. Yet, one factor which has received surprisingly little attention in earlier studies on production localization is the *operations* phase, i.e. the management of serial production, despite its evident effect on the ability to accomplish desired benefits. Earlier research has shown that problems often arise in executing the production location decision, i.e. during the production relocation or establishment. For example, Fredriksson (2011) concludes that one of the largest risks with product relocation is that full-scale production is not reached as planned. This concern is supported by Madsen (2009) stating that when production is transferred between two manufacturing units, the production ramp-up to the demanded level can take years. Deviations from the plan often have substantial and negative impacts such as decreased delivery reliability, longer lead times, lower product quality and extra costs and thus on the company's profitability. Thus, as shown in previous research (Bruch *et al.*, 2012) the production location decision cannot be totally separate from the performance assessments, i.e. knowledge of consequences and impact on production performance is important to consider when making a production location decision.

Despite the need for this kind of knowledge, there are manufacturing companies that take production location decisions at a strategic level without understanding the implications on operational capabilities. Cheng *et al.* (2011) argue that it is not sufficient to view different plants as black boxes, it is also important to consider what happens inside the plants. Research is lacking on how operational factors affect production localization decision, i.e. research that includes aspects of both the design and the operation of the production system should be included in the decision making process.

The purpose of the research presented in this paper is to develop a decision support for production localization that also emphasises operational factors to be considered in the decision making.

The remainder of the paper starts by presenting a brief literature study on production location decision process and factors, forming a frame of reference for the study. The following section introduces the material and methods employed in gathering the empirical data. Next section presents the findings from the four case studies, building the empirical base. Drawing on the literature study and the case studies, the following section discusses critical aspects of location decisions from the cases and concludes by introducing a proposed production location decision process, validated by a series of workshops. Finally, the paper is concluded by its theoretical and managerial implications.

## **Frame of reference**

### *Literature on production location decision process*

In general, production location decisions can be achieved without changing the total number of plants of the company's network. The location decision can be related to both the need to find a new manufacturing location but also to both relocation and reallocation of manufacturing (Pongpanich, 1999; Vos, 1991). A production location decision can relate to different settings, such as 1) the search for a new production location, 2) the decision to improve manufacturing capabilities, 3) the decision to relocate production, 4) the decision to reallocate production and 5) the decision to close production. The need to understand type of production location is important since each

type differs in focus and scope and thus has different implications on the suitable production location alternatives.

Production location decisions have a direct impact on both short and long-term performance and profitability of the manufacturing company and should be considered as one of the most important and critical decisions a multinational company has to make (Porter, 1986; Yip, 2001). However, Porter and Rivkin (2012) state in recent research that location decisions are rarely taken by means of rigorous processes. Since location decision processes are so complex and dynamic they are often made on the basis of simple rules of thumb; “we follow our customers” or “we focus on wage rates”, rough estimates since “the numbers can be made to say anything”, or history “mergers have left us with five R&D centres spread around the globe rather than two larger ones in the U.S. and Germany” (Porter and Rivkin, 2012).

The production location decision process is concerned with the way in which the decisions are reached, i.e. it describes the progress through the stages of gathering and analysing information for a final production location decision. The study by Benner and Tushman (2002) illustrates the importance of exploring processes. The authors conclude that since processes are repeated and repetition through routines not only reduces the time to carry out the activity but also reduces the variance in performance of the routine, the proficiency can be increased. According to Pongpanich (1999) a structured decision making process for production location can provide several practical benefits such as facilitating the decision making, ensuring that important factors are not overlooked, providing useful guidelines or reducing the demands on senior management time.

An empirically based production location decision process is proposed by Pongpanich (1999). His decision process includes several critical aspects important to consider for reaching a production location decision such as the product perspective in the decision making, a wide range of location factors and the strategic role of the plant. The framework consists of four stages: (1) Investigation, (2) Identification, (3) Evaluation and (4) Selection.

Others who have made research-based contributions to the production location decision processes are e.g. Cheng *et al.* (2009), Hoffman and Schniederjans (1994) or Oshri (2011). Their models all have in common that they suggest a process with a logical sequence of generic phases that should support the decision makers in making the best decision. However, although the supported models are helpful in assisting companies in making these often complex and difficult decisions, these models do not reflect operational issues either, as previously highlighted.

#### *Theories on factors affecting production location decision*

Within the decision making process dealing with the selection of the most suitable production location, factors can be classified in many ways (e.g. Hoffman and Schniederjans, 1994; MacCarthy and Atthirawong, 2003; Vereecke and Van Dierdonck, 2002). Despite the differences in the classification of factors. Earlier research emphasises that it is not sufficient to have a traditional one-dimensional cost minimisation approach; rather a holistic approach when making production location decisions is needed. For example, access to low-cost production, proximity to market and access to skills and knowledge have been identified as strategic factors that are important for production location decisions (Ferdows, 1989; Vereecke and Van Dierdonck, 2002). The study by Meijboom and Voordijk (2003) show that it is not enough to only incorporate internal motives in the decision making process but also external factors and factors related to the general environment. External factors includes for example the stage of the product-life-cycle, the level of adaption of

technology, the responsiveness within the region, transportation and logistics considerations, while the general environment refers to macro economical context, political/juridical circumstances and culture. MacCarthy and Atthirawong (2003) add infrastructure, proximity to competition, quality of life to the list of important factors to consider when making a production location decision. The capability of specific production sites regarding aspects of quality, delivery, flexibility and cost have been mentioned by e.g. Pongpanich (1999) and Chai *et al.* (2009).

In general, the factors that should be considered for the production location decision may depend on the specific situation. For manufacturing companies it is important to be located where the most favourable factor conditions can be found (Yip, 2001) and as a result, it is important to select, analyse and evaluate the right location criteria (Yang and Lee, 1997) in order to reach the best production location decision. A shift towards a balanced view on perspectives is needed where company strategic implications as well as relevant affecting factors related to the countries' different circumstances, manufacturing economic performance and production system concept have to be included in the production localisation decision. As Porter (1986) argues the competitiveness of the manufacturing company is influenced by a combination of the company's intangible assets and the characteristics of the location.

However, although there is a common agreement to consider a comprehensive set of factors in production location decisions, many manufacturing companies still overlook or underestimate the current and future hidden cost associated with operating abroad (Porter and Rivkin, 2012). The same researchers further state that while cost savings from offshoring such as low-wages, benefits, energy costs or taxes are visible to the decision makers, direct or indirect higher costs may be unclear. As a result, the costs of locating production at a subsidiary may be much higher than expected and thus not be optimal or may even reduce the value for the company itself.

### **Research design**

The purpose of the research presented in this paper is accomplished by a literature review and a multiple case study method. Applying the case study method gives the possibility to study a contemporary phenomenon, which is difficult to separate from its context, but necessary to study within it to understand the dynamics involved in the setting (Halinen and Tornroos, 2005). Being interested in capturing a more complete and contextual assessment of the complex process of making a production location decision, the case study method was deemed suitable.

The research design followed two steps. First, a general production location decision process was derived from the literature and factors important to consider in the decision making process were categorised. The derived process was detailed in terms of activities by means of three case studies at Swedish manufacturing companies. Operations-related issues considered or experienced by the case study companies when making a production location decision were studied in order to create knowledge about how operational factors could be integrated into the decision making process. Finally, in order to validate the developed process, a series of dialogue workshops with five companies in a research project concerning production localization was carried out.

The case study companies were selected to include a wide variety of companies with respect to the degree of internationalisation (i.e. from no current production localization abroad to high degree of internationalisation) and their need to include operational factors into the design of production networks. The companies were all part of relatively large corporate groups within manufacturing industry. The purpose of the sampling was to collect data that allow for in-depth understanding and theoretical replication (Yin, 2009).

When collecting case data, the focus was on identifying and analysing the underlying factors used during the production localization decision process. Empirical data were collected through interviews, observations and document studies. The collected data were analysed in two steps. First, the individual cases were analysed (i.e. within case analysis). Second, the findings from each case study were compared with the findings found in the comparative cases (i.e. cross-case analysis)

In order to validate the developed process, a dialogue workshop series with five companies in a long term research project concerning the process for production localization were carried out. Three of the companies had been represented in the previous case studies. The dialogues concerned the (1) design and scope of the process and corresponding templates and tools, (2) input and output to each stage and templates and (3) handling of risks.

## **Empirical findings**

### *Case A: The manufacturing expansion case*

Case company A was a joint venture of two multinational companies and market leader in its product segment. The studied company did not have any subsidiaries abroad and all manufacturing took place in Sweden. However, the company was in an expansive phase where production volumes were predicted to increase. Since customers were located all over the world it was found necessary to analyse where the company should build up its future production capacity. The analysis of the empirical findings revealed the following decision making process:

1. Appointment and organization of the project: The management of the company identified seven potential markets for the company which should be studied in the project and a project task was formulated. A steering committee was selected and a project team assigned.
2. Analysis of the current situation: A detailed analysis of the current situation was carried out regarding critical factors affecting the production location such as product; production, sourcing, labour and automation and technology level. Further, order winners and qualifiers were identified and the situation of the markets and competitors analysed.
3. Scenario analysis: In order to handle the uncertainty concerning future needs a scenario analysis of potential future scenarios was made. From the developed scenarios a SWOT analysis including the production conditions, feasibility and development for each market was derived.
4. Analysis matrix: Based on the previous steps an analysis matrix was created. In the analysis matrix each factor was listed by its impact on the production location decision for the company and thereafter given the value Good (G), Average (A) or Poor (P) for each market.
5. Decision making: Based on the analysis of the available information, a possible production location for expansion was selected.

Although the company did not have any formal process for making a production localization decision, much emphasis was placed on getting a detailed understanding of the current situation concerning the market and the impact of a production expansion abroad. Further, the company had assigned their own work group focusing on the conceptual design of the future production system.

### *Case B: The European relocation case*

Case company B was a large multinational manufacturing company organized in product divisions. The study concerned a case where the company considered the

production location of an existing product family to be renewed within an expanding international market. The product was a business-to-business product and the production was to be kept within the company's existing manufacturing domain and footprint (production network). The decision process and factors are described in detail by Bruch *et al.* (2012). The company had no formal decision process for making the production localization, rather the decision making process was based on an non-articulated or formalized process of the following five steps

1. Identification of drivers for change: The change was triggered by a need to move out of the current facility, but motivated by the top management in terms of closeness to market, reduction of sites, functional integration (with R&D etc.) and poor profitability at the current manufacturing site.
2. Making a first strategic decision: A strategic decision was taken in an exclusive top management team. No specific financial product cost calculation was made and the initial business case was based on the strategic intent, meeting the drivers from step 1. Expectations on volumes, profitability, and rough product and process costs were included in the decision making.
3. Analysis of consequences: A smaller project group performed a consequence analysis of relocating production, including a risk evaluation, where the key risks concerning both uncertainty and potential impact on volume, price and delivery performance were identified and assessed.
4. Making the final decision: For the decision of where to locate production a cost benefit calculation was made, based on an anticipated production volume. Organisational capabilities, the impact on production performance and the need of approval by customer for new product generation were not anticipated in detail but had a major impact on the success of the relocation project.

Based on earlier experiences the company has established a non-articulated decision making process. The process reveals that cost and market issues were most important in the decision making while operational issues were rarely considered.

#### *Case C: The China expansion case*

Case company C was a global manufacturing company with production sites in ten countries globally. The production location decision was based on the need to expand production capacity to be able to handle the demands of the BRIC countries. The company had recently released a new strategy to increase market shares in BRIC countries by adjusting their mature products to the specific customer needs in these countries. Despite that the company had experience of production localization decision no formal decision process was implemented. The decision of where to expand production was based on the following steps:

1. Identification of drivers for change: The main drivers for change were related to the market; market proximity, capture/ maintain market share, provide rapid delivery to customers.
2. Making a first strategic decision: The top level management decided that four different alternatives should be developed and studied in detailed and further compared. The four alternatives were: 1. Increase production capacity at the current production location in Sweden; 2. Build up production (manufacturing and assembly) in China, i.e. the china plant should be a copy of the Sweden plant; 3. Produce the product with a partner in China; and 4. Assemble the product in-house in China but source all parts and components from suppliers in China. The last alternative implied a derivation from the make and buy strategy.
3. Evaluation of each alternative: Each alternative was evaluated according to a predefined cost-benefit analysis but no comprehensive risk analysis was carried

out.

4. Making the final decision regarding the region: Since the investment costs were considerably smaller in the final alternative it was selected for the purpose of building the required production capacity in China including assembly in-house.
5. Making the final decision regarding the site: After the selection of the region and evaluation was made of where to locate in China, the company decided to locate the plant close to the already existing production activities.

The main reason why alternative 4 was cheapest was that no expensive manufacturing equipment had to be purchased. However, as the company did not make any risk evaluation, particularly knowledge about the impact and risks concerning the decision to source all components from by suppliers in China was limited by the top-level management.

## **Analysis**

### *Production location decision processes*

The three case studies illustrate different ways to perform the production location decision process. Only one of the studied companies that participated in the workshop series had recently developed a formal production location decision process that was based on the gained experience captured from a number of localization projects. The developed process was a first draft to be further developed in the future. The other studied companies did not have a standardized and implemented process to be used in production location decisions. As a result, there was generally no guidance on how to identify, evaluate and select the best possible production location in all studied companies.

At the same time the production location decision was made by few management people at the top-level in the studied cases. The findings also indicate that those responsible for project execution having detailed knowledge of operational issues from earlier projects were not involved in the process of finding the production location that best fitted the needs of the company.

Further, in Case B, the relocation of the production also included major investments in new production equipment. Based on earlier experience of relocation projects the employees involved in the execution project did not want to move production equipment as this often implies major difficulties in problems. Much of the knowledge related to operating the equipment in the best way was not documented, which made it difficult to transfer the knowledge to a new site. Further, the investments implied an improvement and upgrade of the performance of the production equipment which led to performance improvements based on the investments and not on the new production site. However, the ability to improve the production performance in the Swedish manufacturing site by investments was not considered as an alternative by the manufacturing company.

### *Factors in the production location decisions*

The results indicate that the production performance only played a minor role when selecting the production location. Strategic and cost-based considerations (like product cost, proximity to market etc.) were the most important factors considered in the decision making process, which is in line research in (Ferdows, 1989; Vereecke and Van Dierdonck, 2002). As a result, these factors over-ruled the operational ones and thus the potential production performance of the future production system at the new location was not considered as a decision parameter.

The understanding of the impact on operational aspects such as the importance of a

good production flow or high resource utilization seemed to be limited at top-level management i.e. those managers involved in the decision making. Aspects such as the level of automation or the conceptual solution of the production system were only considered into detail in Case A. In Case B and Case C operational aspects only played a minor role. These two cases illustrate when the production localization decision is made by top-level management which is not active in the actual project execution. As a result, these decision makers may have difficulties in fully estimating the costs and risks involved in the production localisation project with regard to operational aspects. For example, in Case C the company had actually departed from their sourcing strategy without understanding the risks involved. Thus, our findings confirm the results of Porter and Rivkin (2012) that in most of the cases direct and indirect hidden costs of moving operations are often neglected.

### **A proposed process for making the production location decision**

The dialogue workshop series confirmed that the companies had non-articulated stage-gate-based development processes as well as templates for e.g. investment calculations to be considered in the localization process. Some of the companies had checklists and guidelines for relocation projects and risk analyses. It became clear that the general production location decision process should be of an open inclusive format, presenting a gross list of potential activities, tools and templates, rather than a fixed activity schedule with specified templates to use. The existing broad body of company specific tools for cost calculation, risk assessment and business plans should be included as well when necessary. All companies involved in the validation of the proposed method considered it to be of great value to define a comprehensive process including relevant potential decision aspects necessary to consider when deciding about a future production location.

A fundamental approach of the research presented in this paper is that development and operations of the production system must be integrated in the process of choosing the best production location. By synthesising the findings of the case studies and the dialogue workshop series a five phase process for making production localization decisions is proposed. The process provides guidance on how to identify, evaluate and select the most suitable production location with regard to the operations. For each of these phases, key activities with related templates and expected output are identified. The conceptual idea of the production location decision making process builds on the research of Pongpanich (1999). By dividing the production location decision making process into generic phases with concrete activities including guidelines and a description of outputs of each phase, managers can be supported in making effective production location decisions. The decision making process is also influenced by the work of McIvor (2000) who argues that a framework should include both prescriptive and explanatory elements. While the prescriptive elements assist practitioners to carry out activities in a certain way (what should be done, how should it be done and why should it be done), the explanatory elements refer to how things are perceived. McIvor (2000) also points out that a framework useful for practitioners should consist of a number of logically sequential steps that support a structured work approach to the decision making process. The developed production location decision process is illustrated in figure 1.

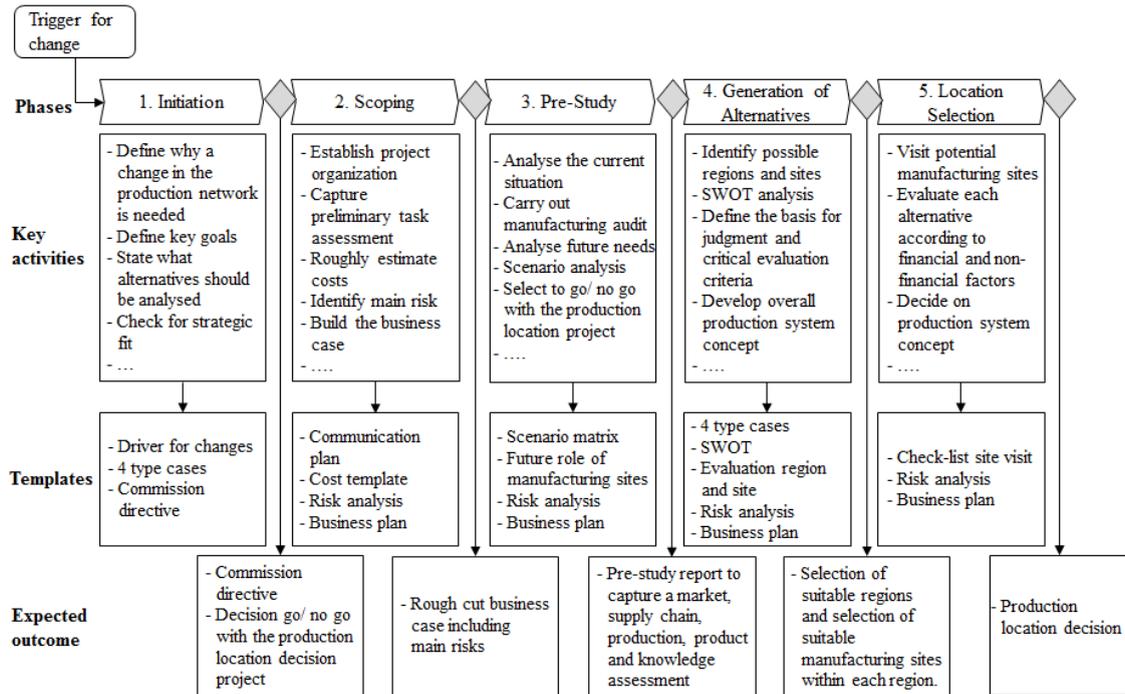


Figure 1- The production location decision process with five generic phases including key activities, templates and delivery

## Conclusion

Production localization deals with determining the geographic site for a firm's production operations. Manufacturing companies face this challenge in different situations and it is a grand challenge to define the steps, criteria and evaluations to be made during this process. Overall, the strategic location decisions at the case companies were based more on a "gut feeling" than on analytical facts and knowledge of the impact of operations. Thus, our research confirms the need for supportive tools in the production location process. It is clear from the empirical findings that the studied manufacturing companies would have benefitted from an improved decision support to understand the implications of production location on the operational performance.

By focusing on operational factors in the decision making process of selecting a production location, this study complements earlier research on production location decisions. The developed and industrially verified process, factors and activities contribute by a more balanced set of decision variables than merely product cost minimization, and include the aspects of production system design and operation into the early localization decision phases.

The proposed production localization tool intends to facilitate and encourage decision makers to devote more time to develop comprehensive business cases having a holistic perspective when designing and managing the production location network. The implication of our study is that managers need to carefully consider the effects of production localization decisions on operations. This is because the operation performance is different at different locations. In situations where production is located abroad, it is critical to pay extra attention to the current and future costs as suggested caused by operating abroad. It is important to remember that productivity improvements could also be accomplished by improvements and investments at the home location.

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