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# Supply chain competitiveness: measuring the impact of location factors, uncertainty and manufacturing practices

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## Abstract

Supply chain performance is impacted by several factors beginning with the plant location decision. Existing literature has tended to predominantly emphasize quantitative factors such as transport costs, exchange rates, labour rates and taxes. While there are existing models that capture qualitative variables, there is limited research linking these variables with measures of the firm's operational competitiveness. In this paper, we propose a framework that includes qualitative factors concerning plant location decisions, supply chain uncertainty, and manufacturing practices. We argue that a joint consideration of such factors helps explain supply chain competitiveness. Data from a large sample study is used to test the model. Our results largely support the assertion that there is a significant relationship between qualitative plant location factors such as labour, infrastructure, business environment, political stability, proximity to markets, proximity to suppliers, key competitors' location, supply chain uncertainty and broad manufacturing practices and the operational competitiveness of supply chains as measured by quality, flexibility, inventory turnover and responsiveness.

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## 1. Introduction

One of the most important and far reaching decisions faced by operations managers is deciding where to locate new manufacturing facilities. This is a strategic decision involving irreversible allocation of the firm's capital, and often has a crucial impact on key measures of the firm's supply chain performance such as lead time, inventory, responsiveness to demand variability, flexibility, and quality. With the emergence of efficient supply chain management as an important frontier of competition, the facility location decision becomes even more significant.

An imperative for an effective location decision is for managers to assess each potential location in terms of its impact on key operational performance measures like lead time, inventory, responsiveness etc., and not be swayed by cost savings alone. For instance, a firm that wants to implement total quality management programs in a new location must evaluate the competence of the local

workforce and its impact on the quality of its products and services. Similarly, a firm setting up a manufacturing plant in a third world country to take advantage of lower labour costs, must assess if the poor infrastructure or the non-availability of skilled personnel may erode its capability to compete on time. Past research (MacCormack et al., 1994) suggests that the location decision framework used by managers predominantly emphasizes quantitative analyses that trade-off transport costs, scale economies, and other cost based variables. Such a focus, while yielding short term cost benefits maybe poor in terms of other measures of competitiveness like lead time, inventory, and responsiveness. In this paper, we address the question of how effective past location decisions are enhancing the competitiveness of global supply chains. This question is of consequence to both practitioners and academics.

The rest of this paper is organized as follows. In the next section, we review segments of literature focusing on the role of qualitative factors in plant location. The next two sections discuss the research framework and the methodology. Analysis and findings are then presented and finally discussion of the results and conclusions are presented.

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## 2. Literature review

The plant location problem has been studied extensively in the operations research literature from the viewpoint of cost aspects of the decision i.e., minimizing various combinations of the time discounted costs of construction, shortages, congestion, idle capacity, maintenance and inventory. Such a focus neglects key qualitative factors that are often central to creating or supporting a competitive advantage. We will not address these cost based optimization models in this paper but interested readers are referred to Brandeau and Chiu (1989), Reville and Laporte (1996) and Owen and Daskin (1998) for recent reviews pertaining to these models. In this paper, our focus is on those frameworks that incorporate qualitative factors into the plant location decision and this is discussed in the next section. Later, we make reference to research relating to supply chain uncertainty and manufacturing practices as these have an important impact on supply chain performance. Finally, supply chain performance measures and supply chain uncertainty.

### 2.1. Qualitative factors in plant location

From the viewpoint of incorporating qualitative factors in the location decision, the most widely used technique is a weighted checklist approach in which various important but diverse factors like proximity to customers, business climate, legislation, tax incentives and other support factors are rated on a weighted scale and combined into an aggregate score. The selected site is the one with the best aggregate score. Details and applications in a wide variety of industries are reported by Bowersox and Closs (1996), Chase et al. (1998), Ballou (1999) and Krajewski and Ritzman (1999) among others. Such an approach can lead to subjective results depending on the preferences of the decision-maker. Moreover, there has been little attempt in previous research to measure the effectiveness of such a weighting mechanism.

Schmenner (1982) tested the significance of qualitative variables for the plant location decision and reported a comprehensive survey of the plant location/re-location practices among Fortune 500 companies in the US. The study identified favourable labour market, nearness to market, quality of life in the area, nearness to supplies, low labour rates as the most important variables considered by managers in the location decision. The author reported marked variations in the above responses (i.e., importance of the variables) among different industry groups. Schmenner (1979) emphasized that a location strategy focused chiefly on financial assessments could often result in a poor solution and recommended re-location and opening of new branches over on-site expansion. Schmenner (1983) outlined the concept of plant life cycle based on the changing charters that plant managers face over different phases of the life of the plant.

MacCormack et al. (1994) examined the impact of the global trading environment, new production systems, and new technologies on the plant location decision. The authors suggested that existing literature approached the plant location problem narrowly, focused on quantitative data such as transport costs, exchange rates, taxes, and labour rates, as opposed to qualitative factors such as infrastructure, worker skills, local government regulations and access to suppliers. For example, plant location decisions that ignore skill levels of local workforce could significantly affect the ability of the firm to implement new process technologies, or can limit the effectiveness of total quality management programs. Therefore, companies ought to emphasize qualitative factors that are required to support overall business strategy. Only after establishing a set of desirable location options, based on qualitative factors, should companies refine choices using cost based algorithms. Khurana and Talbot (1998) proposed that a richer understanding of plant roles could be obtained by focusing on an assessment of manufacturing capabilities and plant missions in global manufacturing networks. Using case and survey data in the global colour picture tube industry, they found that plant manufacturing capabilities along with plant location criteria were important factors in defining plant missions. The authors concluded that plants which considered location factors congruent to their respective missions and capabilities were found to enjoy higher business performance in comparison to plants that did not consider capabilities in conjunction to plant location factors.

Ferdows (1997) described how superior manufacturers gain competitive advantage by methodically charting strategic roles for their foreign factories. He suggested that companies that locate plants in foreign countries merely to benefit from tariff and trade concessions, cheap labour, capital subsidies, and reduced logistics costs do not tap the full potential of their foreign factories. In contrast, companies use their foreign plants not only to gain access to usual incentives described above, but also to get closer to their customers and suppliers, to attract skilled and talented employees, and to create centres of expertise for the entire company and enjoy higher levels of performance.

The above line of research raises the important issue of benchmarking the relative efficiency of the location decision given different charters and roles that different plants have defined for themselves. The “self” performance of the plants over time therefore needs to be assessed in conjunction with the comparative performance of competitor plants. This in turn raises the issue of supply chain performance measures that will be discussed in a later section.

### 2.2. Supply chain uncertainty

The complex and dynamic interactions between supply chain entities lead to considerable uncertainty in planning. Uncertainty tends to propagate up and down the supply chain and this affects supply chain performance.

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