SUPPLY CHAIN DECISION-MAKING PROCESS – IMPACT OF LOCATION FACTORS

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Abstract

Facility location and its interconnection with other facilities in the supply chain is a strategic decision for each company. The selection of the optimal facility location and customer´s allocation to that has a long-term impact on the company´s competitiveness. Since there may not be many differences among product functions, product availability and associated logistic services play a key role in customers´ perceptions. Competition has shifted from company to company to a battle between supply chains.

The aim of this study is to outline the importance of other factors than cost, which are commonly involved in the facility location problem. Authors focus on qualitative and quantitative criteria used in context of supply chain design. The paper is based on questionnaire conducted among manufacturing and business companies of all sizes falling into one of the following sectors: automotive, toys, clothing industry, electronics and pharmaceutical industry. Comparison of which criteria prevail in the current research and which are considered relevant by companies is made. The results confirm that costs are an important factor, but other factors e.g. quality of infrastructure, quality of working environment, availability of properly skilled labour and future development expectations are as important as costs for Czech companies.

Key words: Czech Republic, Facility location, Qualitative factors

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Introduction

Since Weber (Weber, 1929) formulated the theory of spatial allocation, market conditions have changed dramatically. In recent years, it is especially noticeable in the short product life cycles, ever-increasing competition, and the individual customer requirements which change over the time and, last but not least, cost competitiveness. Location of logistics facilities is therefore to be considered in the long term perspective, in order not only to meet current market requirements, but also to be able to respond to new challenges over time.

Therefore the location of facilities in the supply chain has become a strategic decision of a companies´ management (Daskin, 1995), (Klose&Drexl, 2005), (Melo et al.). Moreover, it has become multi-criteria decision-making problem rather than single factor decision. Great importance is awarded to such a decision, especially because a wrong decision can be directly reflected in a loss of competitive advantage, not only to the company, but to the entire supply chain, as it directly affects the quality of logistics services for customers and also logistic costs, namely transportation and storage costs. It is therefore a decision that has a long-term impact on prosperity exceeding the company scope itself. Moreover, in today´s market environment, the competition shifted from company to company to the level of supply chains. Collaboration among companies is therefore inevitable, since this is the how the supply chain can a gain competitive advantage and achieve better performance results.

Thus, selection of the optimal facility location requires encompassing both quantitative and qualitative factors (Kumar et al., 2010). Although minimization of total costs is crucial for most companies, a balance between the logistic costs and the level of customer service will be required. Moreover, in practice companies face more complex decisions since other factors e.g. availability of logistic services and availability of properly skilled labour, should be taken into the consideration.

This paper outlines the importance of other location factors than cost and demonstrates the preliminary findings from an ongoing survey among firms in the Czech Republic

1 LITERATURE BACKGROUND

Prior research on facility location in the supply chain is mostly focused on the improvement of mathematical models. It is due to the fact that supply chain design has been for a long time the area of operational research that underscores mainly quantitative criteria and practical usefulness in logistics and SCM has not been taken mostly into consideration (Melo et al., 2009). Research in logistics and SCM is primarily based on single-method quantitative research designs, and qualitative methods are used sporadically (Golicic&Davis, 2012).

Researchers mostly focus on the minimization of total costs or on the minimization of delivery distances (Current et al., 1990). Supply chain design factors could be divided into quantitative and qualitative. Quantitative factors, particularly wage rates, material costs, utility costs, transportation costs and taxes are commonly researched and used (Jamalnia et al., 2014). Qualitative factors are still neglected within the relevant research field. Despite the

number of articles focused on supply chain design, only a minority of them consider qualitative criteria.

1.1 Qualitative factors

Partovi presented a framework for locating facilities that included internal and external criteria using quality function deployment (QFD), analytic hierarchy process (AHP) and analytic network process (ANP). The external components of the model are customers and their wants, competitors, and the characteristics of various locations. The internal components of the model are the critical processes in the manufacturing organization. (Partovi, 2006)]

Chuang emphasized the importance of inclusion of both, qualitative and quantitative factors since the facility location is the multi-objective decision-making problem. Qualitative factors include closeness to suppliers and customers, government policies, environmental factors, quality of life, the availability of required technical labour and the availability of utilities. (Pao-Tiao, 2002)

Multi-objective analysis is convenient if conflicting criteria that cannot be measured in comparable units are involved. The current reviewed literature concerning multi-objective location analysis found four broad categories of objectives, which are; cost minimization, demand orientation, profit maximization, environmental concerns. (Current et al., 1990)]

Cost aspects of facility location decision were broadly studied in the operations research literature i.e., minimizing various combinations of the time discounted costs of construction, shortages, congestion, idle capacity, maintenance and inventory.

Qualitative factors are often critical when companies aim to create or support a competitive advantage. Strategic decisions cannot omit local workforce and its skill level since it can significantly affect the company´s performance in the market. Therefore, companies ought to emphasize qualitative factors that are required to support the overall business strategy. (Bhatnagar&Sohal, 2005)

Furthermore, the selection of the optimal facilities´ location become complex multi-objective decision-making problem that requires encompassing both qualitative and quantitative location factors such as nearness to the market, availability of raw materials, availability of needed workforce, etc. (Jamalnia et al., 2014)

Kumar underlined that the selection of the optimal facility location is a complex decision-making task that requires thorough evaluation of the influencing criteria. Some of these criteria include availability of the raw material sources and proximity of markets, availability of labour and trained manpower, environmental and political climate, government policies and taxes, ancillary industries and other resources of production. (Kumar et al., 2010)

Montibeller supported the idea that the inclusion of qualitative factors is important in the location choice as well. However, these factors are mainly not directly incorporated into the facility location analysis. (Montibeller&Yoshizaki, 2011)

2 RESEARCH FRAMEWORK

Facility location problem is a complex decision-making problem. The complexity derives from the number of factors, both quantitative and qualitative that influence the decision.

This study wants to emphasize the importance of all factors that should be included in the decision-making process about the facility location problem.

RQ1: What factors are considered important by companies in the Czech Republic when deciding on facility location?

RQ2: Are there differences between factors´ ranking across different fields and company sizes?

The authors created a list of 18 factors that are convenient for the companies having facilities in the Czech Republic. Thus, factors such as taxes, climatic conditions or security are not included.

Tab. 1: Qualitative vs. quantitative factors

Qualitative		Quantitative	
Cost oriented	Distance oriented	Logistics& Infrastructure	Environment
Cost of rent	Distance to competitor´s location	Location of logistic centres	Availability of properly skilled labour
3PL cost	Distance to production centres	Quality of infrastructure	Business risk
	Distance to suppliers´ centres	Scope and volume of provided logistic services	Ecological aspect
	Nearness to markets	Terminals of combined transport	Established business in region
	Population in regions		Future development expectations
			Local authority support/opposition

Source: Authors

Location factors are divided into quantitative and qualitative. Our focus is on qualitative factors.

2.1 Qualitative factors

Qualitative factors are those that cannot be reasonably expressed in values. However, the importance of each factor and quality scale of the qualitative factors can be properly identified only by qualitative methods.

3) Logistics & Infrastructure

i. Scope and volume of provided logistics services

Particular locations can be assessed regarding quality and quantity supply of demanded logistics services.

ii. Transport infrastructure

Low density of highways, a lack of city circles, and an insufficient number of rail/road terminals increase the number of logistics facilities operating in a particular gravity field.

iii. Logistic centres and combined transport terminals

Logistic centres and terminals of combined transport have to be connected with more modes of transport, usually road and rail in the Czech Republic.

4) Environment

i. Availability of properly skilled labour

Availability of workforce and its qualification is one of the key factors for the facility location.

Although automatic systems are implemented in the facilities, some positions are still cheaper to operate by people, moreover technically skilled labour are indispensable.

ii. Ecology

Ecology can play important role when the preferred location is not approved in urban plan. Furthermore, when a company stores and distributes chemical substances close proximity to ecologically valuable and protected area, it can induce significant cost or preclude the location.

iii. Local authority support

Local authority decisions can have a crucial effect on whether the location is approved or not.

iv. Quality of working environment

If a company wants to attract employees, it has to offer them adequate conditions for living in the area. The presence of schools, hospitals and social amenities plays an important role in this aspect.

v. Future development expectations

A company should consider future growth, and therefore, the location should be able to provide space for possible expansion.

vi. Established business in region

Some regions in Czech Republic are designated as new industrial zones, since there are unused properties from earlier established factories.

vii. Business risk

Considering facility location, the risk could be connected to a possible loss of employees and customers due the establishment of a new competitor in the same area.

The data collection period was established for five months during the second half of 2015. The questionnaire was sent to approx. 800 selected manufacturing or business companies of all sizes (small, medium and large enterprises). The authors prepared a list of 2,000 companies as a target group for further research. The target group are companies with representation in the Czech Republic within one of the aforementioned sectors. The questionnaire was sent to the sample including companies from the described sectors, from different regions in Czech Republic electronically. Since the questionnaire encompasses a wide range of questions concerning the strategic decisions of the company, the authors carefully selected the key informants. Thus, the recipient of the email is the logistics or supply chain manager (if this role is not held in the company, it is sent directly to the CEO). The questionnaire response rate is around 5 %. Every company is contacted via an email that includes a cover letter, instruction sheet and the questionnaire. To increase the response rate, as well as sending the questionnaire to the right person, pre-notification calls were made. Managers were invited to participate and the authors offered them a copy of the questionnaire´s results.

The response rate is low; although, enough questionnaires are received in order to formulate a conclusion, moreover some companies are willing to continue with the research and cooperate on semi-structured interviews. Although most companies understood the questions well, there were some discrepancies in a few questionnaires. Moreover some companies were not able to finish the questionnaire for different reasons. Some of the questionnaires had to be discarded.

3 RESULTS, DISCUSSION AND FUTURE RESEARCH

Recipients were asked to rate the selected factors from one to 18 and assign them corresponding weights; allocating 200 points among 18 factors. Table 1 indicates the ranking of the factors ordered by relevance within manufacturing and business companies.

Since the requirements of manufacturing and business companies are different in nature, factors that influence the facility location are different as well. As Table I shows, the

most important factor for manufacturing companies is the distance to production centres, whereas business companies most appreciate the close proximity to their customers; however, both mentioned quality of infrastructure and the cost of rent. The second most important factor for business companies is business risk. Manufacturing companies are more focused on cost and distance factors compared to business companies that emphasize customers and all related factors that can attract them. There are three factors - population in regions, future development expectations and competitor´s location – which have significantly higher importance for business companies. The most important factor for manufacturing companies – production centres - is one of the less important for business companies.

However quality of infrastructure could be deemed a qualitative factor, it can significantly diminish the total cost. Business companies are more interested in factors that cannot be simply optimized by mathematical methods, such as the availability of properly skilled labour, future development expectations or quality of the working environment.

Tab. 2: Factors´ranking: Manufacturing vs. Business companies

Ranking	Manufacturing companies	Business companies
1	Production centres	Nearness to markets
2	Cost of rent	Business risk
3	Nearness to markets	Cost of rent
4	Quality of infrastructure	Quality of infrastructure
5	3PL cost	3PL cost
6	Availability of properly skilled labour	Quality of working environment
7	Location of logistic centres	Future development expectations
8	Scope and volume of provided logistics services	Availability of properly skilled labour
9	Quality of working environment	Population in regions
10	Business risk	Competitor´s location
11	Suppliers´ centres	Production centres
12	Ecological aspect	Scope and volume of provided logistics services
13	Future development expectations	Location of logistic centres
14	Combined transport terminals	Suppliers´ centres
15	Established business in region	Local authority support/opposition
16	Local authority support/opposition	Ecological aspect
17	Population in regions	Established business in region
18	Competitor´s location	Combined transport terminals

Source: Authors

Regarding the size of the company, there are significant discrepancies as well. Small enterprises are most interested in factors as production centres, business risk, and future

development expectations. Medium enterprises appreciate close distance to their production (supplying) centres but unlike to small business they especially prefer closed proximity to customers and the cost of rent. Large enterprises prefer 3PL cost and cost of rent, however, this result is quite misleading since evaluation of the first three factors is almost the same. Notwithstanding, the size of the company, quality of the infrastructure is important for all respondents. All rated the quality of infrastructure as the 4th most important factor. The larger the company, the less important is business risk. Combined transport terminals are more important for large enterprises; the reason could be due to the fact that they export more.

The ecological aspect is still not fully appreciated among companies in the Czech Republic. However, the results showed that the smaller the company, the higher the ecological aspect is rated. Although there is no significant evidence that any of the respondents prefer qualitative factors over quantitative, and vice versa, the research confirmed that qualitative factors are important and enter into the decision-making process regarding facility location.

Tab. 3: Factors´ranking: Small vs. medium vs. large companies

Ranking	Small enterprises	Medium enterprises	Large enterprises
1	Production centres	Production centres	3PL cost
2	Business risk	Nearness to markets	Cost of rent
3	Future development expectations	Cost of rent	Nearness to markets
4	Quality of infrastructure	Quality of infrastructure	Quality of infrastructure
5	Nearness to markets	Business risk	Location of logistic centres
6	3PL cost	Availability of properly skilled labour	Quality of working environment
7	Cost of rent	3PL cost	Availability of properly skilled labour
8	Quality of working environment	Quality of working environment	Production centres
9	Scope and volume of provided logistics services	Scope and volume of provided logistics services	Business risk
10	Ecological aspect	Established business in region	Future development expectations
11	Availability of properly skilled labour	Distance to suppliers	Combined transport terminals
12	Local authority support/opposition	Ecological aspect	Population in regions

13	Established business in region	Future development expectations	Scope and volume of provided logistics services
14	Distance to suppliers	Local authority support/opposition	Distance to suppliers
15	Competitor´s location	Location of logistic centres	Competitor´s location
16	Location of logistic centres	Competitor´s location	Ecological aspect
17	Combined transport terminals	Population in regions	Local authority support/opposition
18	Population in regions	Combined transport terminals	Established business in region

Source: Authors

Conclusion

This paper proposed factors that should be included in the supply chain network decision-making process based on literature research, practical experience and research among companies in the Czech Republic. The authors emphasize the necessity to consider not only a narrow number of quantitative factors, but establish a complex approach embedding both quantitative and qualitative factors.

The survey results confirmed that the importance of qualitative factors should not be overlooked; their relevance in supply chain network design is noticeable. The survey conducted in the Czech Republic confirmed the importance of a multi-criteria approach to facility location in the supply chain. Such an approach is relevant in all business environments, where other considerations beyond total costs are crucial in the supply chain design e.g. future development expectations, quality of working environment or competitor´s location. The results of the survey acknowledged that incorporation of a particular factor in the supply chain network decision-making process greatly depends on the unique specifics of a particular supply chain and company. This study confirms that the qualitative criteria can significantly influence whether a particular location could be the right site for a logistic facility or not.

The research has two major limitations: researchers who focus on improving of mathematical models mostly do not mention criteria that enter the model. Czech supply chain managers selected important criteria from the group of 18 available criteria and assign them a weighting of importance. It does not necessarily mean that these criteria were taken into consideration when their facility location was chosen, but shows it is how they perceive that they would make that decision today. Since the study confirmed the necessity of future research on how qualitative criteria influences the decision making process about facility

location, the authors have already started in-depth interviews with participating companies to reveal how the inclusion of qualitative criteria into the decision-making process about facility location influences the company´s performance.

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