



Determine the priority level of factors influencing the supply chain flexibility in manufacturing businesses in Vietnam

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Abstract

Flexibility determines the effectiveness of the supply chain and the competitive capability of businesses. The purpose of this study is to assess the prioritization of factors influencing the flexibility of supply chains in manufacturing enterprises in Vietnam. The research examines the impact of six groups of factors on the flexibility of the supply chain, including: commitment of top leadership, supply chain strategy, information sharing capability of the IT system, supplier relationships, employee flexibility, and machinery and equipment and facilities serving production/logistics. The Analytic Hierarchy Process method is employed in the study. The research results indicate that the factors of information sharing capability of the IT system and machinery and equipment and facilities serving production/logistics have the most significant impact on the flexibility of the supply chain, followed by supplier relationships, supply chain strategy, commitment of top leadership, and employee flexibility.

Keywords: Supply chain flexibility; manufacturing enterprises; Analytic Hierarchy Process method.

Received 28 August, 2023; Revised 06 Sep., 2023; Accepted 08 Sep., 2023 © The author(s) 2023.

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I. Introduction

Each business plays a role as a link within a network of interconnected and increasingly complex relationships through the procurement, production, and distribution of products into the market, known as the supply chain (Christopher, 1992). The supply chain for each product includes fundamental members such as suppliers, manufacturers, distributors, and customers (Chopra et al., 2007). Among these, manufacturing enterprises hold a pivotal role in the activities of producing products and supplying them to meet societal demands. For the supply chain to function effectively, these links require close coordination and efficient utilization of resources such as human capital, machinery, equipment, finances, and information.

Flexibility is a firm's response to external uncertainty (Newman et al., 1993), adapting to influences not only from within the company (Holweg, 2005) but also the ability of each company in the supply chain to efficiently cope with disruptions and breakdowns (Swafford et al., 2006a). Supply chain flexibility (SCF) is one of the crucial attributes of a supply chain alongside resilience and adaptability (Waters, 2011). Voudouris and Consulting (1996) assessed supply chain flexibility through order response time (Voudouris and Consulting, 1996). When considering SCF as a unified entity throughout the system, we need to differentiate between internal and external flexibility (Malhotra and Mackelprang, 2012; Ko et al., 2018). Internal flexibility demonstrates a company's capacity to adjust various production processes effectively, whereas external flexibility reflects the extent to which supply chain partners (e.g., suppliers) are willing and able to make changes to meet the lead company's unexpected requirements (Sánchez and Pérez, 2005; Stevenson et al., 2007; Enrique et al., 2022).

Several studies have identified factors influencing supply chain flexibility. Based on the Resource-Based Theory, firms need to focus on their internal resources in relation to the external environment and identify factors affecting SCF. Factors influencing supply chain flexibility that have been addressed in numerous studies include top leadership commitment (Kumar et al., 2015; Goyal et al., 2018), supply chain strategy (Fantazy et

al., 2009; Chandak et al., 2019), information sharing capability of the IT system (Khalayleh et al., 2022; Enrique et al., 2022), supplier relationships (Singh et al., 2017; Goyal et al., 2018; Khalayleh et al., 2022), employee flexibility (Winkler, 2009; Khalayleh et al., 2022), and machinery, equipment, and facilities serving production/logistics (Chan et al., 2017).

In recent years, the Analytic Hierarchy Process (AHP) introduced by Saaty (1980) has been a widely used method for evaluating the prioritization of influencing factors, determining the importance of criteria, and ranking choices. The AHP method is developed based on pairwise comparisons between factors, as well as options, standards, and evaluation criteria. The objective of this study is to apply the AHP method to identify the factors influencing supply chain flexibility in manufacturing enterprises in Vietnam.

II. Analytic Hierarchy Process

In this study, the Analytic Hierarchy Process (AHP) method introduced by Saaty (1980) is employed to determine the prioritization of factors influencing the flexibility of supply chains in manufacturing enterprises. The AHP is a pairwise comparison method in measurement theory (Saaty, 2008). It involves breaking down complex problems into factors and organizing them in a hierarchical structure. Each factor is then evaluated through pairwise comparisons to determine their relative significance and preferences. Rattanavarin (2007) highlighted the advantages of AHP, which include (a) ease of use due to the hierarchical chart format, (b) precision, (c) straightforward prioritization with numerical results, (d) capability to handle both subjective and objective factors, and (e) reduction of decision bias.

AHP has found applications in various decision-making domains such as supplier selection, resource allocation, production enhancement, and environmental impact assessment. Cheng and Li (2001) proposed an eight-step method for implementing AHP, outlined as follows:

- Clearly define the decision problem.
- Define the criteria relevant to the decision problem, often informed by a review of relevant literature.
- Construct the decision hierarchy, with the top level representing the decision goal, the second level comprising main criteria, the third level including secondary criteria (if needed), and the final level representing the available choices.
- Gather expert opinions and data. Typically, 5 to 7 experts are considered reliable, as excessive data complicates management and increases costs (Melon et al., 2008).
- Create a pairwise comparison matrix. To compare factors, it's essential to assess the intensity of importance for each pair, as factors are not equally important. Saaty (1980) introduced a fundamental scale with nine intensity levels, as shown in Table 1. Pairwise comparisons are conducted for all factors in the matrix. A value of 1 ($a_{ij} = 1$) suggests equal importance, while a value of 5 ($a_{ij} = 5$) signifies one factor is much more important than the other, and 9 ($a_{ij} = 9$) implies extreme significance. The importance of each factor is only compared within a pair over the diagonal line; for instance, if a_{12} is 7, then a_{21} is $1/7$.
- Estimate the relative weight of elements at each level in the hierarchy through model analysis.
- Calculate the consistency ratio (CR) to assess the pairwise comparison's consistency. Inconsistencies arise when, for example, factor A is deemed twice as important as factor B, and factor B is twice as important as factor C. Such inconsistencies require adjustments and result re-evaluation. Saaty (1980) provided an average random index (RI) value for matrices of order 1 to 10, based on a sample size of 500. As shown in Table 2, an acceptable CR value is 0.1 or less. If it exceeds this threshold, recalculating or revisiting the assessment is necessary.
- Compile the rating results for each criterion to establish their priority.

Table 1. Fundamental scale of AHP (Saaty, 1980)

Intensity of importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Moderate importance of one over another	Experience and judgment slightly favor one activity over another
5	Essential of strong importance	Experience and judgment strongly favor one activity over another
7	Very strong importance	An activity is strongly favored and its dominance demonstrated in practice
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation
2, 4, 6, 8	Intermediate values between the two adjacent judgments	When compromise is needed

Table 2. Random Index (RI)

Matrix size	Random consistency index (RI)
1	0
2	0
3	0.58
4	0.9
5	1.12
6	1.24
7	1.32
8	1.41
9	1.45
10	1.49

III. Results of the Analysis of Factors Influencing Supply Chain Flexibility in Vietnamese Manufacturing Enterprises

In this section, the AHP method was employed to determine the prioritization of factors influencing the flexibility of supply chains in manufacturing enterprises in Vietnam. A decision panel consisting of three selected experts was convened to evaluate six factors, namely: High-level leadership commitment (F1), Supply chain strategy (F2), Information sharing capability of the IT system (F3), Supplier relationships (F4), Employee flexibility (F5) and Machinery, equipment, and facilities serving production/logistics (F6). Table 3 presents the average comparison matrix assessment of six factors by the committee.

Table 3. Average comparison matrix assessment of six factors by the committee

Committee	Factors	F1	F2	F3	F4	F5	F6
D1	F1	1.00	0.50	0.25	0.33	1.00	0.25
	F2	2.00	1.00	0.50	0.50	2.00	0.50
	F3	4.00	2.00	1.00	2.00	4.00	1.00
	F4	3.00	2.00	0.50	1.00	3.00	0.50
	F5	1.00	0.50	0.25	0.33	1.00	0.25
	F6	4.00	2.00	1.00	2.00	4.00	1.00
D2	F1	1.00	0.33	0.20	0.25	2.00	0.20
	F2	3.00	1.00	0.50	1.00	6.00	0.50
	F3	5.00	2.00	1.00	1.00	9.00	1.00
	F4	4.00	1.00	1.00	1.00	8.00	1.00
	F5	0.50	0.17	0.11	0.13	1.00	0.11
	F6	5.00	2.00	1.00	1.00	9.00	1.00
D3	F1	1.00	0.50	0.25	0.33	0.50	0.25
	F2	2.00	1.00	0.50	0.50	1.00	0.50
	F3	4.00	2.00	1.00	2.00	2.00	1.00
	F4	3.00	2.00	0.50	1.00	2.00	1.00
	F5	2.00	1.00	0.50	0.50	1.00	0.50
	F6	4.00	2.00	1.00	1.00	2.00	1.00
Average	F1	1.000	0.444	0.233	0.306	1.167	0.233
	F2	2.250	1.000	0.500	0.667	3.000	0.500
	F3	4.286	2.000	1.000	1.667	5.000	1.000
	F4	3.273	1.500	0.600	1.000	4.333	0.833
	F5	0.857	0.333	0.200	0.231	1.000	0.287
	F6	4.286	2.000	1.000	1.200	3.484	1.000

Table 4 presents the results of evaluating the consistency ratios of the committee.

Table 4. Consistency ratios of the committee

Decision makers	CI	RI	CR	Results
D1	0.0182	1.24	0.0147	Satisfy the requirements
D2	0.0139	1.24	0.0112	Satisfy the requirements
D3	0.014	1.24	0.0113	Satisfy the requirements

Table 5 presents the results of determining the prioritization of factors influencing supply chain flexibility in Vietnamese manufacturing enterprises. The research findings indicate that factors F3 and F6 are the most influential factors on supply chain flexibility, followed by factors F4, F2, F1, and F5.

Table 5. Prioritization of factors influencing supply chain flexibility

Factors	Priority level
F1	0.0630
F2	0.1475
F3	0.2786
F4	0.2150

F5	0.0542
F6	0.2417

IV. Conclusion

Supply chain flexibility plays a vital role in enhancing the competitive capabilities of businesses. This study aimed to determine the prioritization of factors influencing supply chain flexibility in manufacturing enterprises in Vietnam. Six groups of factors were utilized in the research, including top leadership commitment, supply chain strategy, information sharing capability of the IT system, supplier relationships, employee flexibility, and machinery, equipment, and facilities serving production/logistics. The Analytic Hierarchy Process method was employed in this study. The research results indicate that factors F3 and F6 have the most significant impact on supply chain flexibility, followed by factors F4, F2, F1, and F5.

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