

RESTRUCTURING A PRE-EXISTING SUPPLY NETWORK IN THE FMCG INDUSTRY AND ANALYSIS OF STAKEHOLDERS CONFLICTS

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Abstract

Purpose: This paper seeks to provide an understanding of the key parameters to consider in the decision making process for restructuring effectively and efficiently a pre-existing supply network of a fast-moving consumer goods (FMCG) supply network in the Asia Pacific region. The perspectives of the various stakeholders are compared, and the differences highlighted.

Design/methodology/approach: We apply the combined fuzzy Analytic Hierarchy Process (fAHP) and fuzzy TOPSIS to select the critical parameters to consider in the decision making process, to determine weights of the criteria/sub-criteria, and finally identify the best actionable strategies to implement across the supply network.

Findings: The preliminary results suggest that the manufacturer and distributors have different motivations and hence have conflicting objectives for the optimization of their respective supply chains. While the manufacturer focuses on enhancing the availability of goods on the shelves of the final stores, the distributor would rather prioritize on cost savings and inventory minimization. This leads to myopic optimization and highlights an opportunity for better synchronization.

Research limitations/implications: The main limitation of this work is the sample size used in the analysis, leaving us with a guarded conclusion. MCDM would need to be extended to include the conflicting motivations and objectives for bi-level optimization

Practical implications: The practical results provided by this paper bring a real-life understanding of the stakeholders' conflicting views and motivations for the optimization of their supply chains.

Originality/value: It adds value to the supply chain management literature by providing an actual case study. This case is able to support bi-level decision making when designing cost effective and time responsive supply networks, taking note of the various stakeholders' objectives when framing a model for solution.

Keywords: Supply network restructuring, MCDM, Fuzzy-AHP, Fuzzy-TOPSIS

Introduction

A supply network (SN), which typically includes various stakeholders like suppliers, manufacturers, third party logistics service providers (3PLs), distributors, stores, and final consumers, starts with input of raw materials and ends with product consumption (Yanfang, et al., 2016). Due to market globalization and raised competitiveness, stakeholders within the same SN are nowadays required to work even more closely one to another as to drive cost savings and overall SN effectiveness (Jang, et al., 2002). However, effective coordination manufacturing-distribution (MD) remains a major challenge, with competitiveness and profitability of the various organizations being constantly at stake. In the context of fast-moving consumer goods (FMCG) sector, challenges derived from MD conflicts are further magnified by the combination of factors such as rampant market competitiveness and low customer retention, especially in developing geographies of Asia Pacific region.

Previous research groups have developed a fair number of model in the domain of MD conflicts and coordination, but only a limited number of researches, with practical applications, are actually available. Few scholars have given attention to development of model and algorithms, and even fewer link the conceptual developments with practice. Yanfang et al. (2016) have developed a bi-level programming to

model an integrated MD that involved both conflict and coordination. The model considers the core firm as the leader in the hierarchical process that makes strategic decisions (e.g. closing/opening new warehouses, warehouse locations) as to minimize the total cost to reach out to the market. In the lower level, the distributors' objective is to minimize the costs in just in their own branches, and make decisions based on core firm's decisions. A hybrid approach which combines fuzzy logic controller algorithm with priority-based two stage genetic algorithm is proposed to address the optimization problem, and a real world example is used to test the model and the algorithm. Sabri & Beamon (2000) looked at both strategic and operational MD planning from the standpoint of multi-objective decision analysis and measurement of system performances as to incorporate cost, customer service levels, and flexibility. Other research groups like Liang (2008) and Chen (2010) have respectively focused their efforts on developing a multi-objective linear programming to solve integrated multi-product and multi-time period production/distribution MD planning decisions and investigating the effects of various factors relevant to item substitution on two-echelon MD networks in decentralized SN. In the reality, stakeholders included within the same SN, might have conflicts due to their own aims and interests (Xu, et al., 015), and MD planning might get significantly impacted by the mutual influences of such conflicts (Yanfang, et al., 2016). To date, no research has dealt with MD problem involving supply chain restructuring in developing nations in the case of more than one decision maker involved. Limited literature is available about actual case studies on MD conflicts and conflictive views on key parameters⁷ to consider in the decision making process for restructuring effectively and efficiently a pre-existing supply network in the Asia Pacific region. To fill this research gap, we have integrated fuzzy Analytic Hierarchy Process (fAHP) and fuzzy TOPSIS to a real world MD case in the FMCG sector. The remainder of the paper is structured as follows. Section 2 sets the background of the research. Attention is paid to multi criteria decision making methods, particularly fuzzy AHP and fuzzy TOPSIS methods. The complete framework of methodology is then presented in section 3. Section 4 describes the case at hand, situational analysis, criteria and alternatives for the case. Results are presented in section 5. Finally, the implications of this research are presented in Section 6.

Literature Review

Multi Criteria Decision Making (MCDM) indicates a discipline of operations research that considers decision problems in a context of a number of decision criteria (Triantaphyllou et al., 1998). Specifically, MCDM includes a series of techniques "aimed at supporting decision makers faced with evaluating alternatives taking into account multiple, and often conflictive, criteria" (Thokala, 2011). A generic MCDM modelling can be developed in a multi-step approach which includes: a) Identification of alternative solutions, b) Definition of criteria (or attributes) against which the alternatives are to be compared, c) Determination of scores that reflect the value of an alternative's expected performance on the criteria, and, d) Determination of criteria weights that measure the relative values of each criterion as compared to others (Thokala, 2011). It follows a concise description of the fuzzy MCDM tools utilized in this research: fAHP and fuzzy TOPSIS.

Fuzzy AHP (fAHP)

Fuzzy AHP integrates Saaty's AHP theory with fuzzy set theory. In the fAHP methodology, experts are required to provide in inputs in the form of linguistic expressions in a pairwise comparison matrix. Then, values are converted using fuzzy judgment matrices, whereby all elements and weight vectors are represented by triangular fuzzy numbers. Finally, fuzzy arithmetic operators are used to rank the alternatives on the bases of the rank of fuzzy numbers (Viswanadham & Samvedi, 2013).

For the case at hand, fAHP is used to determine the criteria weightage (score), and criteria will be compared using linguistic terms shown in Table 1. These factors will be then be used to make pairwise comparison matrices. The weights of the criteria for strategy⁸ selection are found from these matrices using the synthetic extent value method described in Tang & Lin (2011).

⁷ In this paper, the word "parameter" is used interchangeably with "criterion"

⁸ In this paper, the word "strategy" is used interchangeably with "scenario"

Numerical values	Definition	Fuzzy triangular scale
1	Equally Important (Eq. Imp)	(1, 1, 3)
2	Weakly Important (W. Imp)	(1, 3, 5)
3	Fairly Important (F. Imp)	(3, 5, 7)
4	Strongly Important (S. Imp)	(5, 7, 9)
5	Absolutely Important (A. Imp)	(7, 9, 11)

Table 1. Linguistic terms and corresponding Triangular Fuzzy Numbers (TFN), fAHP

Fuzzy TOPSIS

TOPSIS is a MCDM method which allows to rank alternative solutions from a finite set of alternatives. TOPSIS starts with the determination of ideal positive and negative solutions. Then, alternatives are compared with these ideal solutions, and distances calculated. Scores will be determined upon the values of such distances. Usually, the alternative which is the closest to ideal positive and the farthest from ideal negative is ranked as optimum. Fuzzy TOPSIS integrates Chen's TOPSIS theory with fuzzy set theory, by utilizing triangular fuzzy numbers and introducing crisp Euclidean distance in between them (Viswanadham & Samvedi, 2013).

Fuzzy TOPSIS is here used to determine the score on strategies' expected performances on criteria. Experts are required to provide in inputs in the form of numerical values in a comparison matrix, and after converting the values into fuzzy numbers using linguistic terms shown in Table 2, calculation are performed. The score on strategies' expected performances on criteria are found from these matrices using the method described in Kutlu & Ekmekçioğlu (2012).

Numerical values	Definition	Fuzzy triangular scale
1	Extremely Worse than current	(1, 1, 2)
2	Much Worse than current	(1, 2, 3)
3	Slightly worse than current	(2, 3, 4)
4	No Impact	(3, 4, 5)
5	Slightly Better than current	(4, 5, 6)
6	Much Better than current	(5, 6, 7)
7	Extremely Better than current	(6, 7, 7)

Table 2. Linguistic terms and corresponding Triangular Fuzzy Numbers (TFN), f-TOPSIS

Methodology

A combination of fAHP and fuzzy TOPSIS was applied using the following multi-step approach:

1. Identification of all potential actionable strategies, or scenarios, to implement across the supply network, using inputs from local supply chain experts;
2. Definition of a comprehensive set of parameters for strategy selection against which the alternatives are to be compared, using inputs from local supply chain experts;
3. Determination of criteria weightage (score) that measure the relative importance of each parameter as compared to others, using cross-comparison of selection criteria and fAHP;
4. Determination of scores that reflect the value of a strategy's expected performance on the criteria, using fuzzy TOPSIS;
5. Rank of strategies, using cross-comparison of strategies and score of criteria.

Figure 1 shows a visual representation of framework of methodology.

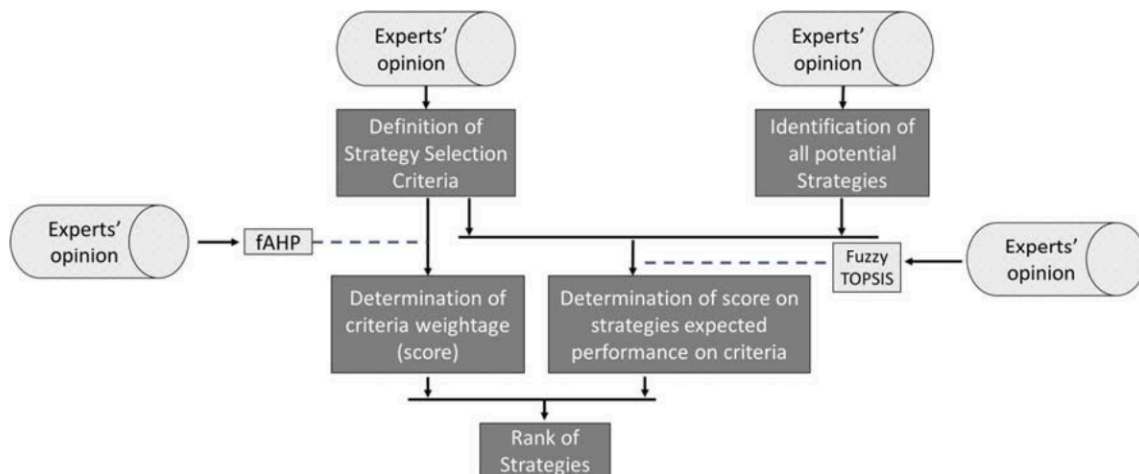


Figure 10. Framework of Methodology

Problem Case

Located in the South East Asia region, Indonesia is the 15th largest nation in the world which covers 1,811,569 square kilometres of land and 5,800,000 square kilometres of water. From east to west, the country spans three time zones and counts over 260 million people with a yearly population growth rate of 1.49%. For an archipelago with more than seventeen thousand islands with such a large logistical activity, poor domestic and international connectivity continues to be an alarming issue hindering the nation from achieving its goal of becoming of the world's 10 largest economies by 2025 (Westphal, 2014). Due to the combination of factors such as heavy reliance on land transportation (78.32% of transportation cost are for on wheels transports with a subsequent underutilization of maritime corridors), road congestion, worsening traffic conditions, poor infrastructures e.g. to support intermodal transportation, empty backhaul⁹, bureaucracy and onerous regulations across the 33 local governments (provinces), logistics cost¹⁰ are extremely high and constitute a serious impediment to the country economic growth [(Westphal, 2014), (Indonesia-Investments, 2013)]. The low performances of the logistics system in fact is dragging down the country's export capabilities and constraining it from a quick and significant reduction of the notorious in-country disparities¹¹ with the provision of an easier and cheaper access of the commodities on the domestic market (Indonesia-Investments, 2013) Prices of primary commodities – including fuel – are quite heterogeneous with the extreme East side of the country experiencing prices of to 20 times more expensive than Jakarta.

In such a challenging – yet high potential - country, designing an effective and efficient SN is the key enabler to increase margin profits. We look at identify the critical parameters to consider in the decision making process of restructuring a pre-existing SN along with the best actionable strategies to implement across the SN, while capturing both manufacturer and distributor views in a pilot from the FMCG sector.

Selection Criteria for Strategy Selection

A pool of 12 sub-criteria to compare the scenarios against have been defined. The scenario which is expected to perform best against each criteria will be the one which, based on experts' inputs, has highest potential for maximizing simultaneously availability of goods at final stores (OSA), while reducing cost and cash across the SN. The MCDM hierarchical structure for the case at hand is in Figure 2.

⁹ Cargo fill rate from Papua/Maluku back to Java is usually in the range 25%-30%

¹⁰ Indonesia-Investments (2013) estimates that logistics cost in term of respective national GDP among ASEAN countries are at 27% for Indonesia, 13% for Malaysia, 8% for Singapore.

¹¹ Contributions to national GDP: Java 58.5%, Sumatra 22%, Kalimantan 8%, Sulawesi 6%, Bali 3%, Papua and Maluku 2.5%.

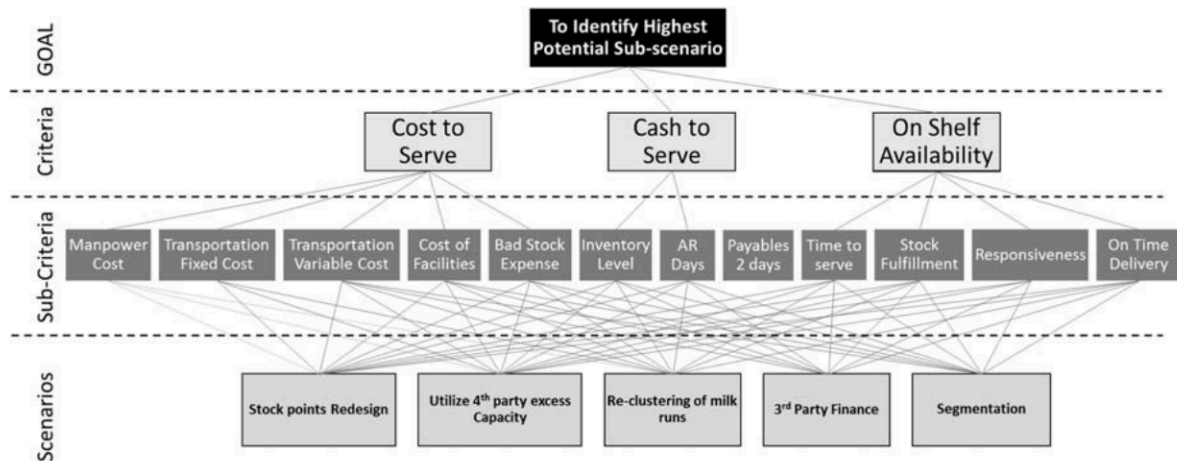


Figure 11. MCDM Hierarchical Structure

It follows a brief description of the various criteria and sub-criteria.

C1 Cost to Serve. This criterion refers to the total cost needed to deliver the goods from the main in-country Distribution Centre (DC), to the store. Five sub-criteria that is Manpower Costs (C_{11}), Transportation Fixed Cost (C_{12}), Transportation Variable Cost (C_{13}), Cost of Facilities (C_{14}), and Bad Stock Expense (C_{15}) are defined.

- C_{11} Manpower Cost – it refers to overall labour costs which includes manpower for deliveries (i.e. drivers, helpers) & warehousing (i.e. lift drivers, pickers etc.)
- C_{12} Transportation Fixed Cost – it refers to transportation assets and related depreciation
- C_{13} Transportation Variable Cost – it refers to transportation time and its equivalent cost in terms of fuel, maintenance etc.
- C_{14} Cost of Facilities – it refers to rent of third party storage facilities (rental of warehouse building, warehouse utilities) and/ or owned ones (depreciation, property tax)
- C_{15} Bad Stock Expense – it refers to costs related with damaged items

C2 Cash to Serve. This criterion refers to the amount of cash which are invested to keep stockpiles. Three sub-criteria that is Inventory level (C_{21}), AR Days (stores – DO) (C_{22}), and Payables 2 days (C_{23}) are defined

- C_{21} Inventory Level – it refers to overall level of stockpiles held at different Distribution Centres, including opportunity costs for “in transit” inventories.
- C_{22} AR Days (stores – DO) – Account Receivables, meaning how soon stores need to pay the distributor after goods are received
- C_{23} Payables 2 days – it refers to how soon the Distributor needs to pay the manufacturer after good is received

C3 On-Shelf Availability. This criterion includes three sub-criteria that is Time to Serve (C_{31}), Stock Fulfilment (C_{32}), and Responsiveness (C_{33}), and On Time Delivery (C_{34})

1. C_{31} Time to Serve – it refers to the timeframe between the placement of an order by a Store and received shipment from a Distribution Centre
2. C_{32} Stock Fulfilment – Service Rate to Stores
3. C_{33} Responsiveness – it refers to capabilities of the supply chain network to adapt and quickly respond to unforeseen events (i.e. market needs, introduction of new products, disruptions)
4. C_{34} On Time Delivery – it refers to the amount of items delivered to customers on time and in full.

Alternative Actionable Strategies (Scenarios)

Five unique scenarios have been identified as suitable for the pilot case in analysis and their concise description, with a list of possible benefits for each, is available in Table 3.

No	Scenario	Possible Effects
1	Stock points Re-design	Warehouses more strategically placed → Reduce lead time, transport costs → increase OSA, reduce cost to serve
2	Utilize 4 th Party Excess Capacity	Convert fixed transport and warehouse cost to variable costs → reduce cost to serve. Reduce empty backhaul, optimize utilization of warehouse → reduce cost to serve
3	Re-clustering of Milk Runs	Optimize delivery capacity → reduce cost to serve
4	3 rd Party Finance	Stores have financial ability to buy sufficient goods to meet demand → increase OSA. Distributor receives cash earlier → distributor also have increase financial ability to buy goods to meet demand → increase OSA
5	Segmentation	Prioritize deliveries and/or increase delivery frequency to specified customers → increase OSA, reduce cost to serve.

Table 3. Description of Scenarios

Results

To collect qualitative information from practitioners for the a) Cross Validation of MCDM Framework, b) Determination of criteria weightage (score), and c) Determination of scores that reflect the expected performances of each scenario on the criteria, a survey on MS Excel was distributed to respondents during direct face-to-face interviews at an ad-hoc workshop event held in Jakarta in December 2016. The questionnaire was pretested on one sample composed of two supply chain specialist working in the regional manufacturer office of Singapore. After the pre-tests, the questionnaire was revised to suit the Indonesian scenario. Sample of responders were carefully chosen and cross function representatives identified (i.e. Logistics, Distribution, Customers, Transportation, Finance etc.). This helped to gain multi-perspective and relevance for the local context. In total, 10 individual responses from the manufacturer were collected. Likewise, additional 2 aggregated group responses from the distributor were also collected. Since responses were in the form of pairwise comparisons, consistency ratio to verify the level of consistency of data was required and was guaranteed using real time verifications in MS Excel platform. An example of asked question to determine criteria weightage (score) that measure the relative importance of each parameter as compared to others was "If you were to re-design your supply chain, what Criteria would you consider as more relevant?". An example of asked question to determine the scores that reflect the value of a strategy's expected performance on the criteria was "If you were to implement scenario XX, how do you rate its impact on the identified sub-criteria YY?".

Measurement of constructs –Results on strategy selection

As briefly mentioned in the literature review, collected data (pairwise comparison matrixes) were initially translated into fuzzy numbers (triangular distribution), then aggregated and normalized. Using MATLAB software, weights of criteria and sub-criteria (Table 4 and 5) were determined using fAHP algorithm, and results inputted for prioritization of scenarios (Figure 6) which was carried using fuzzy TOPSIS.

Criteria	Criteria Weight	Sub criteria	Sub criteria Weight	Final Value
Cost	0.402	Manpower	0.472	0.190
		Transportation Fixed Cost	0.203	0.082
		Transportation Variable	0.157	0.063

		Cost		
		Cost of Facilities	0.102	0.041
		Bad Stock Expense	0.066	0.026
OSA	0.486	Time to Serve	0.225	0.109
		Responsiveness	0.211	0.103
		On Time Delivery	0.251	0.122
		Stock fulfilment	0.390	0.190
Cash	0.112	Inventory	0.591	0.066
		AR days (stores-DO)	0.242	0.027
		Payables 2 days (DO-PG)	0.167	0.019

Table 4. Criteria and sub-criteria weights (manufacturer)

Criteria	Criteria Weight	Sub criteria	Sub criteria Weight	Final Value
Cost	0.4315	Manpower	0.122	0.05
		Transportation Fixed Cost	0.180	0.08
		Transportation Variable Cost	0.171	0.07
		Cost of Facilities	0.366	0.16
		Bad Stock Expense	0.161	0.07
OSA	0.1738	Time to Serve	0.264	0.028
		Responsiveness	0.347	0.042
		On Time Delivery	0.307	0.035
		Stock fulfilment	0.082	0.014
Cash to Serve	0.3947	Inventory	0.135	0.053
		AR days (stores-DO)	0.6	0.341
		Payables 2 days (DO-PG)	0.265	0.105

Table 5. Criteria and sub-criteria weights (distributor)

Scenario	Manufacturer		Distributor	
	Score	Rank	Score	Rank
Segmentation	0.64	1	0.75	1
Re-clustering of Milk Runs	0.54	2	0.45	3
Stock points re-design	0.47	3	0.43	5
Utilize 4th Party Excess Capacity	0.46	4	0.44	4
3rd Party Finance	0.44	5	0.67	2

Table 6. Prioritization of scenarios

Conclusion

The preliminary results suggest that the manufacturer and distributors have different motivations for the optimization of their respective supply chains.

In terms of criteria, the manufacturer focuses on enhancing the availability of goods on the shelves of the final stores, whereas the distributor would rather prioritize on cost savings and inventory minimization. In terms of sub-criteria, while from manufacturer perspective the key cost to reduce in order to achieve efficiency is manpower, the distributor would rather focus efforts over optimization of warehousing assets. In terms of scenario to prioritize both parties see the value segmentation, although there is a substantial

difference over the 3rd party finance, which appears to be a priority only for the distributor. This is in line with the concern of the distributor over cost and inventory minimization.

Outcomes of these initial analysis highlight that - due to the different companies' aims and interests - conflicts among stakeholders operating within the same SN exist. Operational efficiency gets clearly affected by such frictions, which ultimately lead to a myopic optimization of the SN. However, a clear opportunity for better synchronization is also highlighted.

This study has few limitations. The sample size we have used for the current analysis is limited, and a greater sample size would have provided deeper insights. Hence, a wider sample of supply chain experts can be employed to reinforce the results for the case at hand. The scope of MCDM needs to be widened to include the conflicting motivations and objectives for bi-level optimization. Second limitations regards the weights (scores) calculated for the identified parameters for strategy selection. Specifically, findings on the relative values for each criterion as compared to others, cannot be generalized to other contexts. Each country has its own peculiarities in terms of logistics landscape, and each sector has its own peculiarities too, and therefore by changing sector and country the rank of criteria may change.

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