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# Identification of Supply Chain Management Performance Assessment Criteria for Textile and Apparel Enterprises in Distribution Science

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## Abstract

**Purpose:** This study aims to identify the assessment criteria on textile and apparel supply chain management performance**. Research design, data, and methodology:** An integrated method of Delphi, quantitative survey, and ANP, in which Delphi with Kamet principle was applied to define the set of criteria, quantitative survey with reliability and validity test was utilized to ensure the match between the set of criteria and the whole textile and apparel industry, and ANP was used to derive weights of these criteria. **Results:** The set of supply chain management performance evaluation criteria composes of seven criteria namely order fulfillment quality, agility, costs, asset management, information sharing, innovation, and product development and 19 sub-criteria. **Conclusions:** This study theoretical contribution is the proposition of the set of evaluation criteria on supply chain performance. Regarding practical contribution, the study findings are guidelines for T&A companies in assessing and improving their supply chain capability. However, the findings are only for Vietnamese T&A context. Future research, therefore, may be expanded to other regions or countries' T&A industry. Additionally, future step to this study may be the utilization of other techniques of MCDM or methodological approaches like multiple regression, PLS-SEM in defining weights of criteria or performance evaluation.

**Keywords :** Assessment criteria, Distribution science, Textile and apparel, Supply chain management performance,

**JEL Classification Code**: L25, L67, M10

## 1. Introduction

No one can deny the fact that the textile and apparel (T&A) industry makes significant contributions to many countries, including emerging and developed countries. In Vietnam, the textile and garment industry's export turnover in 2021 reached 39 billion USD, in 2022 it reached 44 billion USD, accounting for 11% of the country's total export turnover. However, in 2023, Vietnam's T&A export turnover reached about 40.3 billion USD, down 9.2% compared to 2022. Garment exports decreased by 3.1 billion USD, equivalent to 8.9 billion USD. Fabric exports decreased by 186 million USD, equivalent to 6.9%. Fiber exports decreased by 485 million USD, equivalent to 10.3%. Raw material exports decreased by 218 million USD, equivalent to 16%. The above data shows that the T&A supply chain - from yarn to retail - is facing difficulties, with a trend of price deflation, making cost reduction the key to survival. There are four reasons to explain the above difficulty. First, consumers are becoming more demanding but also more valuable. Consumer demands are volatile and unpredictable. Second, the industrial structure changes. Big retailers and big brands are emerging and their growth is accelerating. Their expanding global reach is putting

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increasing pressure on local, traditional T&A retailers as well as on traditional supply channels. Third, the T&A industry is heavily dependent on imported fabrics, has lost its initiative, and is vulnerable. Fourth, production is fragmented, lacking chain links, increasing costs and time, reducing the competitiveness of goods. For suppliers, the ability to provide end-to-end services, from product development to delivery, and to have smooth supply chain operations, is critical to increasing their competitive advantage. These trends are having a profound impact on how and where T&A products are produced and how supply chains are operated. Companies will no longer compete with each other individually but instead compete their respective supply chains against each other (Schorr, 1998). Therefore, management of the entire supply chain by all participants in distribution science is certainly a prerequisite for the game. That supply chain management refers to the integrated management of a network of entities, starting from the supplier's supplier and ending with the customer's customer to produce and deliver goods and services to the final consumer (Lee & Ng, 1997), in recent years, has received increasing attention from academics, consultants and operations managers. In supply chain management, companies do not seek to reduce costs or improve profits at the expense of their supply chain partners but instead seek to make the supply chain more efficient (Romano & Vinelli, 2001).

One of the fundamentals of supply chain management in distribution science is measuring the performance of the entire supply chain, because no one can manage what they cannot measure. Obviously, someone's performance is how successful he is or how well he does something. Measuring something is the process of measuring its result expressed in numbers. Measuring the performance of the T&A supply chain in this topic will help managers in the T&A supply chain understand how their supply chain is currently operating and allow managers to make informed decisions and take appropriate action for effective management, in order to maintain their competitiveness. Therefore, it can be affirmed that determining criteria to evaluate the efficiency of supply chain operations is practical for T&A enterprises in the context of global integration.

The World Supply Chain Council has launched the SCOR model that links business processes, performance indicators, practices and human skills into a unified structure and is considered one of the most effective models in measuring business performance of the supply Chain. However, Vietnam's T&A industry has its own unique characteristics, specifically with four main production methods: Cut-Make-Trim (CMT), Input Sourcing (Original Equipment Manufacturing/Free On Board – OEM/FOB), Design (Original Design Manufacturing – ODM) and Brand (Original Brand Manufacturing – OBM). In particular, with the CMT method, the buyer provides the T&A enterprise with all inputs to produce the product including raw materials, transportation, designs and specific requirements. Manufacturers only perform cutting, sewing and finishing of the product. With FOB method - a higher level export method than CMT - is a form of production based on "buy raw materials, sell finished products". Accordingly, businesses actively participate in the production process, from purchasing raw materials to producing the final product. However, with Vietnamese textiles and garments, FOB is divided into 2 levels: FOB level 1 (Enterprises following this method will purchase input materials from a group of suppliers designated by the buyer) and FOB level 2 (Enterprises that follow this method will receive product designs from foreign buyers and are responsible for sourcing raw materials, producing and transporting raw materials and finished products to the buyer's port ). With ODM, T&A businesses will prepare designs, finish products and resell them to buyers. With OBM, T&A enterprises design and sell their finished products under their own brands. According to statistics, 85% of T&A enterprises out of a total of 6,000 enterprises in the entire industry in Vietnam are running their business under CMT and FOB1 methods meaning that Vietnamese T&A enterprises cannot proactively be in charge of supply source because input materials will be provided by the buyer. Therefore, completely applying the evaluation criteria according to the SCOR model will not be close to the reality of Vietnam's T&A industry. For the above practical reasons, the authors carried out this topic to determine criteria for the assessment of supply chain management performance in accordance with the reality of Vietnam's T&A industry. Scientifically, the study contributes to perfecting the theory on the assessment of supply chain management performance in distribution science. In terms of practical contribution, this study results can serve as reference documents for T&A enterprises and management agencies in the course of improving the efficiency of Vietnam's T&A supply chain.

## 2. Literature Review on SCOR Model and Supply Chain Performance Measurement

Efficiency is the production of the same output with fewer inputs (Mankins, 2017). To calculate efficiency, businesses need to identify the output and input variables used in evaluating efficiency that are most relevant to their organization. These variables are determined by the business's key performance indicators - quantifiable indicators that reflect the health of an organization. According to some other authors, operational efficiency is the assessment of how well used resources are used (Tongzon, 2009; Wiegmans & Dekker, 2016).

In terms of supply chain operations, supply chain management is the integration of processes and related activities from supplier to final customer. Many researchers have looked at key supply chain operational processes to develop effective measurement frameworks. The Supply Chain Council (SCC) has developed a Supply Chain Operations Reference (SCOR) model to represent the business activities involved in each period of customer response. in 1996. The model was created to analyze and improve supply chain operations based on a number of basic principles to create a standardized method for analyzing, designing and improving operations of the supply chain. The SCOR 12.0 model includes 6 main management activities: plan, source, make, deliver, return and support (enable). The above processes are tightly coupled together to optimize supply chain networks and operations and address the unique challenges organizations face. Many studies using SCOR as a basis for measuring supply chain efficiency were conducted in the Bangladesh (Khan et al., 2023), China (He & Zhu, 2022), Indonesia (Kusrini et al., 2019), the US (Dissanayake & Cross, 2018), Yogyakarta (Bukhori et al., 2015), Brazil (Sellitto et al., 2015), New Zealand (Moazzam et al., 2018) ... In the world T&A supply chain, there are only one research of Haque et al. (2011) applying SCOR to evaluate supply chain efficiency in Hong Kong and Bangladesh. Within the scope of the authors' research, since 2011, there have been no other research projects applying SCOR to measure the efficiency of supply chain operations of the T&A industry both in the world and in Vietnam.

Regarding the method of determining criteria for evaluating supply chain performance, most research works apply desk research methods through conducting literature review (Hague et al., 2011; Öztayşi & Sürer, 2014; Sellitto et al., 2015; …). In this study, the authors proposed to apply Delphi method in determining indicators suitable to the current situation of Vietnam's T&A supply chain. This technique was proposed as the author wished to get the T&A experts' opinion on the research issues. Delphi has been employed by numerous researchers in different fields (Nong, 2022; Nong, 2023) but not in supply chain performance. It can be, therefore, considered as the novel point of this study in terms of research methodology.

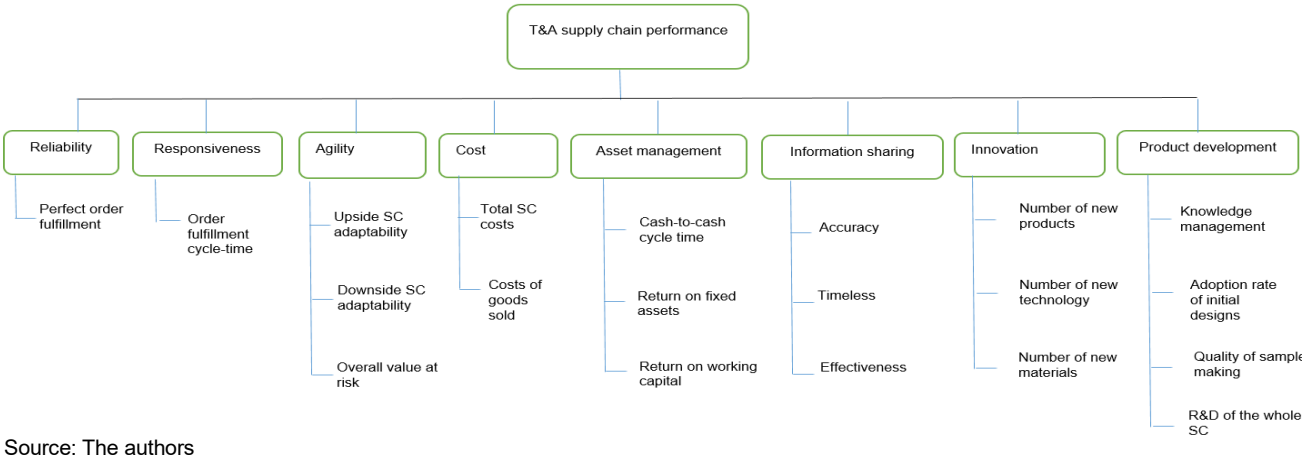
The research literature review also shows that the most commonly used technique to determine weights to evaluate supply chain performance is the Analytic Hierarchy Process (AHP) method (Öztayşi & Sürer, 2014; Charkha & Jaju, 2015; Wibowo & Sholeh, 2015; Sellitto et al., 2015; Prasetya et al., 2017; Jagan Mohan Reddy et al., 2019) for accurate, comprehensive results. However, Nong and Ho (2019) believes that there is an interaction between criteria and sub-criteria. For example Cost affects Quality or On-Time Delivery. Therefore, the authors proposed to use the Analytic Network Process (ANP) method to determine the weight of criteria to evaluate the performance of the Vietnamese T&A supply chain. This method, proposed by Saaty in 1996, is an extension of AHP to solve the limitation of hierarchical structure (Saaty, 2005).

From the above summary of domestic and foreign research, the authors have some comments as follows:

Firstly, regarding the research topic, for nearly two decades there has been no research on applying the SCOR model to evaluate the efficiency of the T&A supply chain both in Vietnam and around the world.

Second, in terms of research methods, there are no domestic or foreign research projects using the ANP method to determine the weights of evaluation criteria, and especially using the integration of the Delphi and ANP methods.

The above research gap will be addressed by the authors in this topic. Within the scope of the authors' knowledge, combining the SCOR model, Delphi and ANP methods to determine criteria for evaluating the performance of T&A supply chains is a new combination and suitable for the nature of supply chain operations in distribution science.




Source: The authors

**Figure 1:** Textile and apparel supply chain performance criteria

## 3. Research Design and Methodology

As presented in the above sections, Delphi and ANP were applied to determine criteria for the evaluation of the supply chain performance of Vietnamese T&A enterprises, illustrated in the research process in Figure 2.

- In phase 1, the authors conducted a literature review to select criteria to evaluate the effectiveness of the T&A supply chain management performance.
- In phase 2, the Delphi method with KAMET principles was used to determine criteria for evaluating the efficiency of the T&A supply chain in Vietnam. The group of experts participating in this method included 05 people holding management positions in the T&A supply chain, including accessories, yarn, dyeing, sewing, and distributor.

The Delphi process was as follows:

Step 1: A questionnaire was distributed to each expert to answer.

Step 2: The experts' anonymous answers were collected by the moderator who would check, filter irrelevant data and analyze them basing on KAMET principles (see Table 1). The results were then sent back to the experts.

**Table 1:** The KAMET Principles Used to Analyze Experts' Feedbacks in the Delphi Method

| Condition | Round t for Delphi questions | Round t+1 for Delphi questions |
|---|---|---|
| 1 | If $M_{qi} \geq 3.5$ and $Q_{qi} \leq 0.5$ and Vqi < 15% then qi is accepted and no need to consult the experts about qi anymore | |
| 2 | If $M_{qi} \geq 3.5$ and $V_{qi} >$ 15%, perform round 2 | If $M_{qi} \geq 3.5$ and $Q_{qi} \leq 0.5$ and Vqi < 15% then qi is accepted and no need to consult the experts about qi anymore |
| 3 | If $M_{qi} \geq 3.5$ and $Q_{qi} \geq$ 75%, perform round 3 | If $M_{qi} \geq 3.5$ and $Q_{qi} \leq 0.5$ and Vqi < 15% then qi is accepted and no need to consult the experts about qi anymore |
| 4 | If $M_{qi} < 3.5$ and $Q_{qi} \leq 0.5$ and $V_{qi} \leq$ 15% then qi is disqualified and no further qi consultation is required. | |

Source: Chu and Hwang (2008)

Where, qi: the importance of each index at different periods; Mdqi: Median; Qqi: Quartile deviation; Mqi: Mean; Vqi: Variance (the percentage of experts changing their rating)

Step 3: Basing on the moderator's feedback, the experts revised and delivered their responses back to the moderator for the next step.

The process would last till experts reached common consensus.

- In phase 3, criteria for evaluating the efficiency of the T&A supply chain determined by the Delphi method would be compiled into a questionnaire based on a 5-point Likert scale from 1 to 5 to conduct a survey at Vietnamese T&A enterprises according to the stratified sampling method to confirm and ensure the reliability of the assessment criteria set.

Survey subjects: people at the management level of businesses participating in the T&A supply chain.

Survey scale: Currently there are 6,000 T&A enterprises in Vietnam, of which 62% are in the South, 30% in the North and 8% in the Central region. Once the number of research population is known, the sample size would be calculated according to the formula of Yamane Taro (1967) where m is the population, e is the allowable error (±4%; ±5%...), then the sample size n would be calculated as:

$$n = \frac{\mathrm{m}}{1 + \mathrm{me}^2}$$

With a maximum allowable error of 10%, the sample size needed to survey according to the above formula was 98 businesses.

Survey area: in Vietnam

Method: directly and online via email, google form from 10th April to 21st April, 2024.

SPSS 26 software would be used to process data to check the reliability (Cronbach's alpha) and calculate the validity of the criteria discovered based on the factor loading coefficient. Furthermore, various statistical tests were conducted to confirm the results. Because the goal of the study is to determine criteria for evaluating the efficiency of the T&A supply chain, the study only stopped at exploring the criteria (EFA) within the industry and then tested the validity and reliability. If any criteria or sub-criteria are eliminated after running EFA and Cronbach's alpha, in-depth interviews with experts would be conducted again to find out the reasons to validate the results. The discovered criteria were then used to establish relationships between criteria and sub-criteria to determine the weights of criteria and sub-criteria according to the ANP method.

- Finally, in phase 4, the ANP method was used to determine the weights of evaluation criteria. Five experts in T&A enterprises were interviewed to make pairwise comparison among criteria. The research results were analyzed before providing policy and management implications to effectively manage the supply chain of Vietnamese T&A enterprises.

ANP is an unstructured network that handles sources, sinks, and cycles, which can handle interdependencies between criteria by calculating aggregate weights through a

supermatrix, from which the best solutions will be selected according to priority.

ANP is illustrated through the following steps (Saaty, 2005):

Step 1: The first step of ANP is to compare criteria throughout the system to form a supermatrix, which is done through pairwise comparison by asking the question "How important is a criterion?" compared to other criteria?

Relative importance values can be determined using a scale from 1 to 9 to indicate equal importance to extremely important.

$$W = \begin{array}{c} \\ e_{11} \\ e_{12} \\ \vdots \\ e_{1n_1} \\ e_{21} \\ e_{22} \\ \vdots \\ e_{2n_2} \\ \vdots \\ e_{m1} \\ e_{m2} \\ \vdots \\ e_{mn_m} \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & & C_2 & \cdots & C_m \\ e_{11} \cdots e_{1n_1} & e_{21} \cdots & e_{2n_2} & \cdots & e_{m1} \cdots e_{mn_m} \end{array} \\ \begin{bmatrix} W_{11} & W_{12} & \cdots & W_{1m} \\ & & & \\ W_{21} & W_{22} & \cdots & W_{2m} \\ \vdots & \vdots & \vdots & \vdots \\ W_{m1} & W_{m2} & \cdots & W_{mm} \end{bmatrix} \end{array} \begin{array}{l} \\ C_1 \\ \\ \\ \\ W = C_2 \\ \\ \\ \vdots \\ \\ C_m \\ \\ \end{array}$$

Where, $C_m$ denotes the $m_{th}$ cluster, $e_{mn}$ denotes the $n_{th}$ element in the $m_{th}$ cluster, and $W_{ij}$ is the main eigenvector of the influence of the elements compared in the $j_{th}$ cluster with the $i_{th}$ cluster. In addition, if the $j_{th}$ cluster does not affect the $i_{th}$ cluster, then $W_{ij} = 0$. Therefore, the form of the supermatrix depends greatly on the diversity of the structure.

Step 2: Calculate the influence level (i.e. calculate the main eigenvector) of the elements (criteria) in each component (matrix).

Step 3: Form the supermatrix based on the above eigenvectors and structure.

Step 4: Correctly convert all column totals to units to derive the weighted supermatrix.

Step 5: Raise the weighted super matrix to the limiting power like the equation below to get the global priority vector.

$$\lim_{k\to\infty} W^k.$$

If the supermatrix has a periodic effect, then the limiting supermatrix is not the only supermatrix. Cesaro total will be counted for priority. General Cesaro was built as

$$\lim_{k\to\infty}\left(\frac{1}{N}\right)\sum_{r=1}^{N} W_r^k,$$

To calculate the average effect of the limiting supermatrix where Wr denotes the rth limiting supermatrix. Otherwise, the supermatrix will be raised to a large power to obtain the priority weights.

All the above steps are performed using Super Decision Software designed by Saaty in 2004.

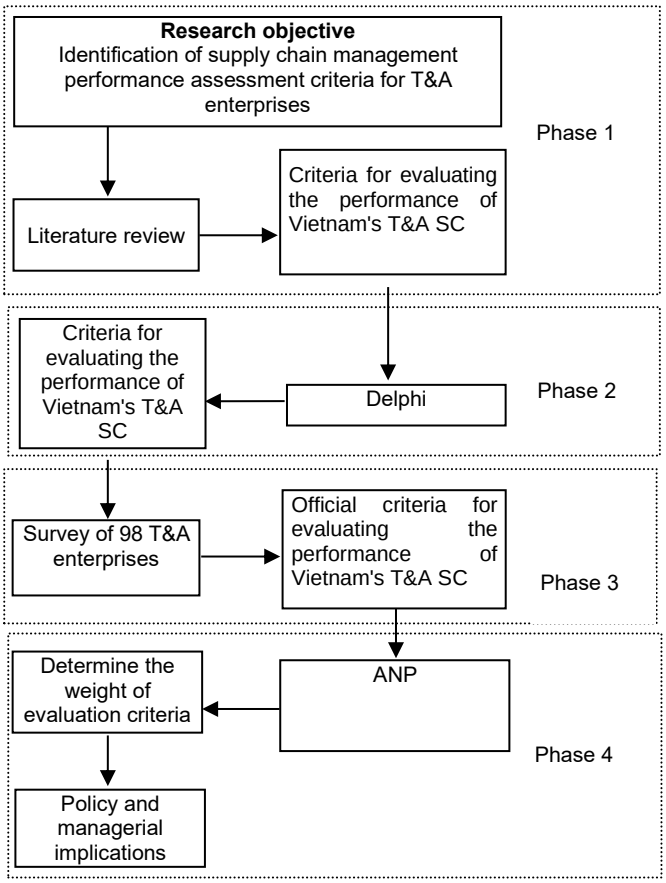



**Figure 2:** Research Design

## 4. Findings

### 4.1 Textile and Apparel Supply Chain Performance Criteria

#### 4.1.1. Phase 1 – Literature Review

After a review of literature on SCOR model and previous research, T&A supply chain performance evaluation criteria are summarized in Figure 1.

#### 4.1.2. Phase 2 – Delphi Method with KAMET Principles

The determination of performance evaluation criteria is of extreme importance in the assessment of supply chain efficiency. As illustrated in the research process (Figure 2), evaluation criteria in this study were determined through

Delphi technique associated with the KAMET principles. After three rounds of consideration from five experts in T&A industry, 7 level-1 criteria and 19 level-2 criteria were selected mentioning order fulfillment quality, agility, cost, asset management, information sharing, innovation, and product development. As *reliability* and *responsiveness* both mention order fulfillment ability of supply chain, there was suggestion that they should be merged and changed their names to *order fulfillment quality*. The suggestion was then accepted by all participants through their statistical feedback. Ability of knowledge management belonging to Product development was deleted as it did not meet statistical requirements (see Table 2).

### 4.1.3. Phase 3 – Quantitative Survey

Quantitative survey was conducted on 112 T&A companies. Out of 112 companies, 76 are from apparel, 24 from textile, and 12 are from other fields including yarn, accessories and distributors. Regarding capital size, 50% of companies are small, 42% are of medium scale, and the rest is large-sized. Mentioning type of enterprises, joint stock enterprises account for 33.9%, limited liability 42.9%, private companies 19.6%, and state-owned companies 3.6%. All T&A companies involve in different levels of production, from CMT to OBM. On the whole, it is well stated that samples represent all characteristics of the T&A industry.

The survey results depict that Cronbach's alpha ranged from 0.667 to 0.885, which was reliable and acceptable for the next statistical analysis (Table 3). The importance of each criterion is also presented in Table 3, where the mean values got above 3.60, indicating the utmost importance of these criteria from the T&A companies' perspective.

EFA was then executed to explore the evaluation criteria. The result showed that: (1) factor loading of all criteria got higher than 0.4, which means these criteria were reliable; (2) KMO coefficient getting 0.611 indicates it's appropriation for factor analysis; (3) Bartlett test with significance of 0.000 depicted all criteria are appropriate for factor analysis; (4) The cumulative percentage reached 73.564, indicating 73.564% of variance were explained by the criteria; (5) Eigenvalue got 1.044 (>1), showing that rotated factor result stopped at the seventh factor (Table 4).

As a result, the set of seven criteria and 19 sub-criteria on supply chain evaluation has been concluded through EFA.

**Table 3:** Reliability Test

| Criteria | No. of items | Cronbach's alpha | Mean |
|---|---|---|---|
| Order fulfillment quality | 2 | 0.741 | 3.89 |
| Agility | 3 | 0.667 | 3.87 |
| Costs | 2 | 0.739 | 3.67 |
| Asset management | 3 | 0.885 | 3.99 |
| Information sharing | 3 | 0.707 | 3.82 |
| Innovation | 3 | 0.762 | 3.74 |
| Product development | 4 | 0.752 | 3.60 |

Source: The Authors

**Table 4:** Rotated Component Matrix

| Sub-criteria | Criteria | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| ASM3 | .912 | | | | | | |
| ASM2 | .900 | | | | | | |
| ASM1 | .890 | | | | | | |
| INN3 | | .893 | | | | | |
| INN1 | | .754 | | | | | |
| INN2 | | .649 | | | | | |
| PRD2 | | | .841 | | | | |
| PRD1 | | | .804 | | | | |
| PRD3 | | | .784 | | | | |
| INS3 | | | | .865 | | | |
| INS2 | | | | .756 | | | |
| INS1 | | | | .637 | | | |
| AGL2 | | | | | .800 | | |
| AGL3 | | | | | .758 | | |
| AGL1 | | | | | .700 | | |
| COS1 | | | | | | .872 | |
| COS2 | | | | | | .858 | |
| OFQ2 | | | | | | | .869 |
| OFQ1 | | | | | | | .851 |
| Eigenvalue | 1.044 | | | | | | |
| Cumulative | 73.564 | | | | | | |
| KMO | 0.611 | | | | | | |
| Sig. | 0.000 | | | | | | |

Source: The Authors

### 4.1.4 Phase 4 – ANP method

Basing on the EFA result, the interviews between the author and five experts were taken place to define the interdependence among criteria and sub-criteria and make pairwise comparisons between criteria and sub-criteria (Figure 3).

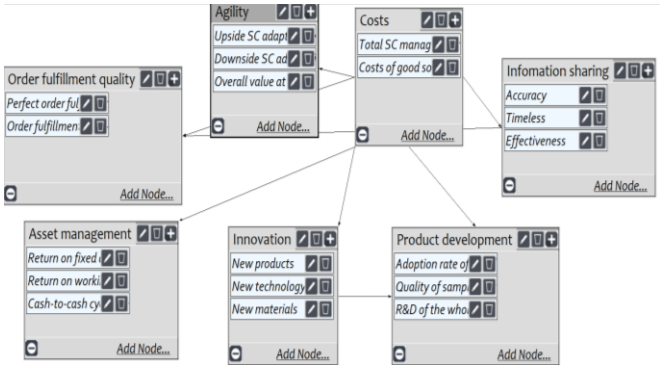



**Figure 3:** Interdependence among Criteria and Sub-Criteria

The weights of these criteria are shown in Table 5. It is noted that order fulfillment quality is the most significant criterion whilst information sharing is the least concerned one. This finding is quite different from the findings of other

researchers in which returns (profitability) is the most attractive, followed by costs, product development, information sharing … For sub-criteria, the number of new technology is considered most in the process of supply chain evaluation as it affects almost other criteria namely order fulfillment quality, agility, returns …, as explained by experts.

**Table 5:** The Weights of Supply Chain Evaluation Criteria

| Criteria | Normalized By Cluster | Limiting |
|---|---|---|
| **Order fulfillment quality** | **0.242108** | |
| Perfect order fulfillment | 0.60704 | 0.146969 |
| Order fulfillment cycle-time metrics | 0.39296 | 0.095139 |
| **Agility** | **0.061096** | |
| Upside SC adaptability | 0.40952 | 0.02502 |
| Downside SC adaptability | 0.39129 | 0.023906 |
| Overall value at risk | 0.19919 | 0.01217 |
| **Asset management** | **0.2266** | |
| Return on fixed assets | 0.7167 | 0.162405 |
| Return on working capital | 0.23732 | 0.053776 |
| Cash-to-cash cycle time | 0.04598 | 0.010419 |
| **Costs** | **0.124413** | |
| Total SC management cost | 0.94939 | 0.118116 |
| Costs of goods sold | 0.05061 | 0.006297 |
| **Innovation** | **0.236479** | |
| Number of new products | 0.08489 | 0.018868 |
| Number of new technology | 0.85031 | 0.188989 |
| Number of new materials | 0.0648 | 0.014403 |
| **Product development** | **0.081325** | |
| Adoption rate of initial designs | 0.17484 | 0.014219 |
| Quality of sample making | 0.82516 | 0.067106 |
| R&D of the whole SC | 0 | 0 |
| **Information sharing** | **0.0422** | |
| Accuracy | 0.25 | 0.01055 |
| Timeless | 0.25 | 0.01055 |
| Effectiveness | 0.5 | 0.0211 |

Source: The authors

Taking the results of supply chain evaluation criteria exploration into consideration, it can be revealed that SCOR has been adjusted when being applied to T&A industry. Reliability and Responsiveness are now merged to Order fulfillment quality. Additionally, the set of evaluation criteria composes of not only Agility, Costs, and Asset management but also Innovation, Product development, and Information sharing. The priority order of these criteria is Order fulfillment quality, Innovation, Asset management, Costs, Product development, Agility, and Information sharing. Order fulfillment quality is the best concerned criterion in Vietnam's T&A industry. This finding is in line with the research result of Haque et al. (2011), which depicts the similar characteristics of Vietnamese T&A supply chain to Bangladesh's. Under the feedback of T&A experts, this set of criteria is of necessity and fits with the features of the T&A industry in the new age, making the set of criteria more comprehensive and updated.

Looking at the sub-criteria, we can see that new technology is the most concerned criterion, which implies that T&A industry has been deeply affected by the industry 4.0. This is a novel point of the study compared to the research of Haque et al. (2011), Charkha and Jaju (2014, 2015) … The next two significant sub-criteria to evaluate T&A supply chain management performance are Return on fixed assets and Perfect order fulfillment. This means that profitability and ability to fulfill orders are much attractive. Unlike previous research, R&D of the whole supply chain in this study is not considered important, being ranked last in the set of priorities. This can be explained to be the unique feature of Vietnam T&A industry, which undertakes CMT and FOB production methods mainly.

**Table 2:** Delphi with Kamet Principle Analysis Result

| Criteria | Description | 1st round | | | | 2nd round | | | | 3rd round | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $M_{qi}$ | $V_{qi}$ | Qqi | Result | $M_{qi}$ | $V_{qi}$ | Qqi | Result | $M_{qi}$ | $V_{qi}$ | Qqi | Result |
| **Level 1** | | | | | | | | | | | | | |
| Reliability | Ability to deliver a perfect order | 4.4 | 80% | 0.75 | Go to round 2 | | | | | | | | |
| Responsiveness | The speed at which the supply chain delivers products to customers. | 4.4 | 30% | 0.5 | Go to round 2 | | | | | | | | |
| Order fulfillment quality | Ability to fulfill orders | | | | | 4.6 | 30% | 0.5 | Go to next round | 4.8 | 20% | 0.25 | Accepted |
| Agility | Ability to respond to market changes and remain competitiveness. | 5 | 0% | 0.0 | Accepted | 5 | 0% | 0.0 | Accepted | | | | |
| Costs | The costs of operating the supply chain | 4 | 50% | 0.5 | Go to round 2 | 4.6 | 30% | 0.5 | Go to round 3 | 4.8 | 20% | 0.25 | Accepted |
| Asset management | Metrics related to the supply chain's effective use of resources | 4 | 50% | 0.5 | Go to round 2 | 4.4 | 30% | 0.5 | Go to round 3 | 4.8 | 20% | 0.25 | Accepted |

| Criteria | Description | 1st round | | | | 2nd round | | | | 3rd round | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $M_{qi}$ | $V_{qi}$ | Qqi | Result | $M_{qi}$ | $V_{qi}$ | Qqi | Result | $M_{qi}$ | $V_{qi}$ | Qqi | Result |
| Information sharing | To measure the level of sharing information between members in the supply chain. The flow of information shared in the supply chain is evaluated through its accuracy, timeliness and effectiveness. | 3.8 | 20% | 0.25 | Accepted | | | | | | | | |
| Innovation | Innovation, such as new technology and new materials, is a sustainable factor for supply chains to achieve competitive supply chain advantage. | 5 | 0% | 0 | Accepted | | | | | | | | |
| Product development | New product development capacity of the enterprise | 4.6 | 30% | 0.5 | Go to round 2 | 4.8 | 20% | 0.25 | Accepted | | | | |
| **Level 2** | | | | | | | | | | | | | |
| **Order fulfillment quality** | | | | | | | | | | | | | |
| Perfect order fulfillment | A measure of an organization's ability to deliver a perfect order | 5 | 0% | 0 | Accepted | | | | | | | | |
| Order fulfillment cycle-time metrics | The average amount of time between the customers' order until the customer receives delivery. | 4 | 50% | 0.5 | Go to round 2 | 4.8 | 20% | 0.25 | Accepted | | | | |
| **Agility** | | | | | | | | | | | | | |
| Upside supply chain adaptability | A measurement of the supply chain's ability to adapt when increasing order quantities continuously for 30 days. | 4.2 | 70% | 0.75 | Go to round 2 | 4.4 | 30% | 0.5 | Go to round 3 | 4.2 | 20% | 0.25 | Accepted |
| Downside supply chain adaptability | A measurement of the supply chain's ability to adapt when reducing order quantities continuously for 30 days before shipping without inventory or cost penalties. | 3.8 | 120% | 0.75 | Go to round 2 | 4.6 | 30% | 0.5 | Go to round 3 | 4.8 | 20% | 0.25 | Accepted |
| Overall value at risk | Total value at risk is a statistic that quantifies the level of financial loss that can occur to a supply chain within a specific time frame. | 4.4 | 80% | 0.75 | Go to round 2 | 4.8 | 20% | 0.25 | Accepted | | | | |
| **Costs** | | | | | | | | | | | | | |
| Total supply chain management cost | The sum of the costs associated with level 2 processes to plan, source, deliver, and return. | 4 | 50% | 0.5 | Go to round 2 | 4.0 | 50% | 0.5 | Go to round 3 | 4.2 | 20% | 0.25 | Accepted |
| Costs of goods sold | The cost associated with buying raw materials and producing finished goods. | 4 | 50% | 0.5 | Go to round 2 | 4.2 | 20% | 0.25 | Accepted | | | | |
| **Asset management** | | | | | | | | | | | | | |
| Return on fixed assets | The return an organization receives on its invested capital in supply chain fixed assets. | 3.8 | 20% | 0.25 | Accepted | | | | | | | | |
| Return on working capital | A measure of profit on the amount of cash consumed calculated as after-tax operating income/net working capital. | 3.8 | 20% | 0.25 | Accepted | | | | | | | | |
| Cash-to-cash cycle time | The time it takes for an investment to flow back into a company after it has been spent for raw materials. | 4 | 50% | 0.5 | Go to round 2 | 4.2 | 20% | 0.25 | Accepted | | | | |
| **Information sharing** | | | | | | | | | | | | | |
| Accuracy | The accuracy of the information shared. | 4.2 | 70% | 0.75 | Go to round 2 | 4.2 | 20% | 0.25 | Accepted | | | | |

| Criteria | Description | 1st round | | | | 2nd round | | | | 3rd round | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $M_{qi}$ | $V_{qi}$ | Qqi | Result | $M_{qi}$ | $V_{qi}$ | Qqi | Result | $M_{qi}$ | $V_{qi}$ | Qqi | Result |
| Timeless | The timeless of the information shared. | 4.2 | 20% | 0.25 | Accepted | | | | | | | | |
| Effectiveness | The effectiveness of the information shared. | 4 | 50% | 0.5 | Go to round 2 | 4.2 | 20% | 0.25 | Accepted | | | | |
| **Innovation** | | | | | | | | | | | | | |
| Number of new products | Number of new products introduced to the market each season. | 4.4 | 30% | 0.5 | Go to round 2 | 4.2 | 20% | 0.25 | Accepted | | | | |
| Number of new technology | Number of new technologies applied. | 4.6 | 30% | 0.5 | Go to round 2 | 4.6 | 30% | 0.5 | Go to round 3 | 4.8 | 20% | 0.25 | Accepted |
| Number of new materials | The amount of new material used. | 4.6 | 30% | 0.5 | Go to round 2 | 4.6 | 30% | 0.5 | Go to round 3 | 4.8 | 20% | 0.25 | Accepted |
| **Product development** | | | | | | | | | | | | | |
| Ability of knowledge management | A measurement of managing the related knowledge inside the supply chain, which is calculated by the number of new merchandise are brought into the market on time to meet the customers' demands. | 3.4 | 30% | 0.5 | Go to round 2 | 3.3 | 0% | 0.0 | Deleted | | | | |
| Adoption rate of initial designs | Number of times the original design was accepted. | 3.6 | 30% | 0.5 | Go to round 2 | 3.8 | 20% | 0.25 | Accepted | | | | |
| Quality of sample making | Number of times the sample is accepted / number of times the sample is made. | 4.4 | 30% | 0.5 | Go to round 2 | 4.2 | 20% | 0.25 | Accepted | | | | |
| R&D of the whole supply chain | Resources involved in design, which are calculated by input costs of design/revenue of the entire supply chain. | 4.8 | 20% | 0.25 | Accepted | 4.8 | 20% | 0.25 | Accepted | | | | |

Source: The authors

## 5. Conclusion

To identify supply chain management performance evaluation criteria, the study employed an integrated method of Delphi, quantitative survey, and ANP, in which Delphi with Kamet principles was applied to define the set of criteria, quantitative survey with reliability and validity test was utilized to ensure the match between the set of criteria and the whole T&A industry, and ANP was used to derive weights of these criteria. The results show that the set of supply chain management performance evaluation criteria composes of seven criteria namely order fulfillment quality, agility, costs, asset management, information sharing, innovation, and product development and 19 sub-criteria.

This study theoretical contribution is the proposition of the set of evaluation criteria on supply chain performance in distribution science. Regarding practical contribution, the study findings are guidelines for T&A companies in assessing and improving their supply chain capability. However, the findings are only for Vietnamese T&A context. Future research, therefore, may be expanded to other regions or countries' T&A industry. Additionally, future step to this study may be the utilization of other techniques of MCDM or methodological approaches like multiple regression, PLS-SEM in defining weights of criteria or performance evaluation.

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## References

Bukhori, I. B., Widodo, K. H., & Ismoyowati, D. (2015). Evaluation of poultry supply chain performance in XYZ slaughtering house Yogyakarta using SCOR and AHP method. *Agriculture and Agricultural Science Procedia*, *3*, 221-225. https://doi.org/10.1016/j.aaspro.2015.01.043

Charkha, P. G., & Jaju, S. B. (2014). Designing innovative framework for supply chain performance measurement in textile industry. *International Journal of Logistics Systems and Management 1*, *18*(2), 216-230. https://doi.org/10.1504/IJLSM.2014.062327

Chu, H. C., & Hwang, G. J. . (2008). A Delphi-based approach to developing expert systems with the cooperation of multiple experts. *Expert systems with applications, 34*(4), 2826-2840. doi:https://doi.org/10.1016/j.eswa.2007.05.034

Dissanayake, C. K., & Cross, J. A. (2018). Systematic mechanism for identifying the relative impact of supply chain performance areas on the overall supply chain performance using SCOR model and SEM. *International Journal of Production Economics*, *201*, 102-115. https://doi.org/10.1016/j.ijpe.2018.04.027

Haque, K. M. A., Hossain, M. M., Hossain, M. S. J., Islam, M. A., Hassan, M., Shamshuzzaman, M., & Hossain, M. D. (2011). Performance evaluation of Bangladeshi apparel and textile supply chain network, a case study. *Performance Evaluation*, *1*(1), 211-218

He, J., & Zhu, J. (2022). Evaluation on risk factors of elderly services from the perspective of integrated SCOR model. *International Journal of Information Systems in the Service Sector*, *14*(1), 1–18. https://doi.org/10.4018/IJISSS.2022010102

Jagan Mohan Reddy. K, Neelakanteswara Rao. A, & Krishnanand. L. (2019). A review on supply chain performance measurement systems. *Procedia Manufacturing, 30,* 40-47. https://doi.org/10.1016/j.promfg.2019.02.007

Khan, M. M., Bashar, I., Minhaj, G. M., Wasi, A. I., & Hossain, N. U. I. (2023). Resilient and sustainable supplier selection: an integration of SCOR 4.0 and machine learning approach. *Sustainable and Resilient Infrastructure*, *8*(5), 453-469. https://doi.org/10.1080/23789689.2023.2165782

Kusrini, E., Caneca, V. I., Helia, V. N., & Miranda, S. (2019, December). Supply Chain Performance Measurement Using Supply Chain Operation Reference (SCOR) 12.0 Model: A Case Study in AA Leather SME in Indonesia. In *IOP Conference Series: Materials Science and Engineering* (Vol *697(*1), p.012023). IOP Publishing.

Lee, H. L. & Ng, S. M. (1997). Introduction to the special issue on global supply chain management. *Production and Operations Management*, *6*(3), 191-192. https://doi.org/10.1111/j.1937-5956.1997.tb00425.x

Mankins, M. (2017). Great companies obsess over productivity, not efficiency. *Harvard Business Review*, 3

Moazzam, M., Akhtar, P., Garnevska, E., & Marr, N. E. (2018). Measuring agri-food supply chain performance and risk through a new analytical framework: a case study of New Zealand dairy. *Production Planning & Control*, *29*(15), 1258-1274. https://doi.org/10.1080/09537287.2018.1522847

Nong, N. M. T., & Ho, P. T. (2019). Criteria for supplier selection in textile and apparel industry: a case study in vietnam. The *Journal of Asian Finance, Economics, and Business, 6*(2), 213-221. https://doi.org/10.13106/jafeb.2019.vol6.no2.213

Nong, N. M. T. (2022). An application of delphi and dea to performance efficiency assessment of retail stores in fashion industry. *The Asian Journal of Shipping and Logistics*, *38*(3), 135-142. https://doi.org/10.1016/j.ajsl.2022.05.001

Nong, T. N. M. (2023). Performance efficiency assessment of Vietnamese ports: An application of Delphi with Kamet principles and DEA model. *The Asian Journal of Shipping and Logistics*, *39*(1), 1-12. https://doi.org/10.1016/j.ajsl.2022.10.002

Öztayşi, B., Sürer, Ö. (2014). Supply Chain Performance Measurement Using a SCOR Based Fuzzy VIKOR Approach. In: Kahraman, C., Öztayşi, B. (eds) Supply Chain Management Under Fuzziness. *Studies in Fuzziness and Soft Computing, 313*. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-53939-89

Prasetya, W., Natalia, C., Kristiana, S. P. D., Aldi, B. E., Silalahi, A., Monique, K., & Oktavia, C. W. (2017). Performance measurement and analysis of coffee supply chain with scor method (case study of north sumatera coffee). *Ijrdo-journal of business management*, *3*(11), 01-17.

Romano, P. & Vinelli, A. (2001). Quality management in a supply chain perspective: strategic and operative choices in a textile-apparel network. *International Journal of Operations & Production Management*, *21*(4), 446-460. https://doi.org/10.1108/01443570110381363

Saaty, T. (2005). *Theory and Applications of the Analytic Network Process. Decision Making with Benefits, Opportunities, Costs and Risks.* Pittsburgh, PA: RWS Publications.

Schorr, J. E. (1998), *Purchasing in the 21st Century.* John Wiley & Sons, Inc., New York

Sellitto, M. A., Pereira, G. M., Borchardt, M., Da Silva, R. I., & Viegas, C. V. (2015). A SCOR-based model for supply chain performance measurement: application in the footwear industry. *International Journal of Production Research*, *53*(16), 4917-4926. https://doi.org/10.1080/00207543.2015.1005251

Tongzon, J. L. (2009). Port choice and freight forwarders. *Transportation Research Part E: Logistics and Transportation Review, 45*(1), 186-195. doi:https://doi.org/10.1016/j.tre.2008.02.004

Wibowo, M. A., & Sholeh, M. N. (2015). The analysis of supply chain performance measurement at construction project. *Procedia Engineering*, *125*, 25-31. https://doi.org/10.1016/j.proeng.2015.11.005

Wiegmans, B., & Dekker, S. (2016). Benchmarking deep-sea port performance in the Hamburg-Le Havre range. *Benchmarking: An International Journal, 23*(1), 96-112. doi:https://doi.org/10.1108/BIJ-04-2013-0050