Categorization of Subjectivity of Government Policies for Sustainable Supply Chains: Perspectives of Thai

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Abstract - **This study aims to classify the subjective perspectives of foreign government policies on sustainable supply chains for achieving Sustainable Development Goals (SDGs), using inputs from experts in Thailand. In this study, three broad policy categories were identified: supply chain digitalization, integration, and nearshoring. Through a literature review, 24 policies were identified. The Q-sort method was applied to classify these policies based on the perspectives of Thai industry experts, aiming to obtain consensus. The result shows that the inter-rater agreement was substantial. Finally, this study develops a hierarchy model for prioritization of policies for enhancing the supply chain performance aligned with the SDGs to convert a complicated problem to a hierarchical system of elements to enhance understanding of supply chain development policies.**

Keywords - **Supply chain management, national policies, policy classification, Q-sort method, Thai expert perspectives**

I. INTRODUCTION

Efficient supply chain management is paramount for organizations to optimize operations, reduce costs, and enhance customer satisfaction. By aligning supply chain practices with the United Nations Sustainable Development Goals (SDGs), responsible economic objectives (e.g. sustainable sourcing), environmental sustainability, and social impact are promoted, fostering long-term business success and global sustainable development.

Governments play a vital role in shaping and implementing policies that guide sustainable supply chain management practices aligned with the SDGs. These policies are instrumental in promoting sustainable supply chain management globally, addressing environmental, social, and economic requirements and aspects of supply chains.

For emerging countries like Thailand, studying foreign government policies provides valuable insights into successful strategies and approaches implemented by other nations. Analyzing these policies can inform the development of effective and tailored policies in Thailand, facilitating sustainable growth, economic development, and international collaborations.

Given the abundance of policies, a classification system based on specific criteria becomes necessary for effective categorization. The primary objective of this policy classification is to enhance the understanding of management policies and their potential impacts [1]. Furthermore, it aims to identify variations and similarities among policies, by defining distinct policy classes, establishing a policy hierarchy for transformation processes, and developing and validating the elements of a formal policy definition.

The Q-sort method serves as a crucial tool for obtaining consensus among experts, providing a foundation for understanding subjective perspectives. It enables systematic sorting and classification of expert opinions, fostering agreement and consensus-building within the expert group.

Therefore, this study focuses on analyzing the subjective perspectives of foreign government policies for sustainable supply chains using inputs and opinions from Thai experts, employing the Q-sort method. The goal is to attain expert consensus and insights for the development of supply chain policies, potentially guiding policy formulation in

Thailand and enhancing international understanding.

II. METHODOLOGY

A. The research methodology

The methodology can be summarized as follows:

1. Conduct a literature review on government policies related to sustainable supply chains in support of the SDGs.
2. Interview experts in Thailand to identify policy categories.
3. Utilize the Q-sort method to classify each policy into its respective category:
   - Develop a Q-sort questionnaire with categories from step 2, including a "N/A" option and policies from step 1.
   - Experts sort policies using the questionnaire, considering category and policy details. "N/A" can be chosen if a policy doesn't fit any category.
4. Analyze the collected data, calculating agreement measures (K and K_j). If below 0.65, experts re-sort policies until K and K_j exceed 0.65. Policies not meeting the 80% agreement threshold are eliminated.
5. Develop a hierarchical model to prioritize government policies for enhancing supply chain performance based on expert agreement levels.

This methodology facilitates a systematic approach to classify policies and prioritize them for improving supply chain performance in alignment with the SDGs.

B. The Q-sort methodology

The Q-sort methodology is based on ranking items according to individual subjective preferences. It allows experts to express their opinions and reach a consensus through a systematic sorting process. Chance agreement refers to the level of agreement that can occur by chance alone in the sorting process.

The Q-sort methodology uses the kappa statistic to assess the level of agreement among experts in classifying policies, indicating the degree of consensus and reliability in the categorization process. This method is to have experts act as judges and sort the items into several categories [2]. Fleiss' kappa (K), which is a statistical measure of inter-rater agreement was employed to evaluate the level of agreement between two or more raters.

Reference [3] proposed a generalization of Cohen's kappa statistic to the measurement of agreement among multiple raters and multiple categories. Fleiss' kappa, K, among raters, is calculated as in

$$K = \frac{\sum_{i=1}^{N}\sum_{j=1}^{k} n_{ij}^2 - Nn[1+(n-1)\sum_{j=1}^{k} p_j^2]}{Nn(n-1)(1-\sum_{j=1}^{k} p_j^2)} \quad (1)$$

The approximate variance of K, $Var(K)$, as in

$$\left(\frac{2}{Nn(n-1)}\right)\left(\frac{\sum_{j=1}^{k} p_j^2 - (2n-3)\left(\sum_{j=1}^{k} p_j^2\right)^2 + 2(n-2)\sum_{j=1}^{k} p_j^3}{\left(1-\sum_{j=1}^{k} p_j^2\right)^2}\right) \quad (2)$$

Fleiss's kappa of the j^{th} category, the agreement on a particular assigning an item to the j^{th} category, an agreement on a particular category is calculated, as in

$$K_j = \frac{\sum_{i=1}^{N} n_{ij}^2 - Nnp_j(1+(n-1)p_j)}{Nn(n-1)p_j(1-p_j)} \quad (3)$$

The approximate variance of K_j, $Var(K_j)$, as in

$$\frac{(1+2(n-1)p_j)^2 + 2(n-1)p_j(1-p_j)}{Nn(n-1)^2 p_j(1-p_j)} \quad (4)$$

The proportion of all assignments which are to the j^{th} category, as in

$$p_j = \frac{\sum_{j=1}^{k} n_{ij}^2 - n}{n(n-1)} \quad (5)$$

Where N is the total number of items, n is the number of ratings per item, k is the number of categories into which assignments, and n_{ij} is the number of raters who assigned the i^{th} item to the j^{th} category.

C. Statistical hypotheses

The hypothesis may be tested by referring the quantity $Z = K/\sqrt{Var(K)}$ to tables of the standard normal distribution. Therefore, the $1-\alpha$ confidence interval for kappa is approximated as $K \pm z_{(1-\alpha/2)}\sqrt{Var(K)}$

The null hypothesis, H_0: There is no consensus among raters.

Reference [4] established agreement categories based on the values of Kappa (K) as follows:

- Slight agreement: K = 0-0.21
- Fair agreement: K = 0.21-0.40
- Moderate agreement: K = 0.41-0.60
- Substantial agreement: K = 0.61-0.80
- Excellent agreement: K > 0.80

However, several studies have considered scores $K \geq 0.65$ to be acceptable [4].

III. RESULTS

Twenty-four policies from six countries including the USA, Taiwan, Germany, Korea, Canada, and the Dominican Republic were identified based on the literature review. Table I provides a summary of these policies.

TABLE I
THE RESULTS OF THE LITERATURE REVIEW ON GOVERNMENT POLICIES RELATED TO SUPPLY CHAIN MANAGEMENT

Government Policies	References
Labor Skill Improvement	[5]
Enhancing cyber security	[5]
Tax Incentive Package	[5]
Encouraging digital technology/devices development	[5]
Modernizing digital law and regulation	[5]
Promoting R&D of manufacturing technology	[5]
Investment in Digital Economy	[6]
Investment in Digital Technology Infrastructure	[6]
Reducing Bureaucratic Obstacles	[6]
Talent mobility	[6]
Providing digital standard	[7]
Enhancing personal data protection system	[7]
Expanding free trade zone for business logistics	[8]
Expanding free trade agreement	[8]
Expanding free trade agreement	[8]
Financial Capital Loan	[8]
Enhancing capabilities of SMEs	[8]
Intellectual property protection	[9]
Assisting technology transition	[10]
Offering subsidies for relocation expenses	[10]
Serving as intermediaries for network connections	[11]
Facilitating information flow	[11]
Enhancing environment regulation	[11]
Improving data transparency	[11]

In this study, the expert panel consists of five scholars with extensive research experience in supply chain management, averaging 18 years of experience in the field. Through interviews, the experts identified three major policy categories: supply chain digitization, integration, and nearshoring. These categories were determined based on the input obtained from the experts regarding various aspects of supply chain management. The experts determined each category as follows:

- Supply chain digitalization refers to government strategies and regulations promoting the adoption and integration of digital technologies to enhance sustainability in supply chain operations.
- Supply chain integration policy refers to government strategies and regulations aimed at fostering collaboration and coordination among supply chain partners to support sustainable practices in supply chain management.
- Nearshoring policy refers to government initiatives or regulations that promote and incentivize companies to relocate production or sourcing activities closer to their home market or nearby regions to support sustainable supply chain management.

The Q-sort questionnaire was developed, which had three categories: supply chain digitalization category (A), supply chain integration category (B), and nearshoring category (C), as well as a "not applicable (N/A)" category and the 24 policies. The experts were asked to evaluate the 24 policies as to whether they are the supply chain digitization category, the supply chain integration category, the supply chain nearshoring category, or none of these.

Fleiss' kappa, K, (Fleiss, 1971), a measure of inter-rater agreement used to determine the level of agreement between two or more raters, is used to evaluate an agreement among five raters. Based on the evaluation data provided by five experts, the Q-sort results in terms of the kappa value and agreement of each category are shown in Table II.

TABLE II
STATISTICS FOR MEASURING THE OVERALL AGREEMENT AND THE AGREEMENT ON A PARTICULAR CATEGORY (n = 5 EXPERTS, N = 24 POLICIES, and k = 3 CATEGORIES), THE FIRST ROUND

Categories	K or K_j	$Var(K)$ or $Var(K_j)$	Z
Overall	0.3223	0.0030	5.889
A	0.3813	0.0357	2.018
B	0.2256	0.0487	1.022
C	0.4434	0.0253	2.786
N/A	0.0948	0.0301	0.547

Table II revealed that the overall agreement (K) and agreement for each category (K_j) were below 0.65, indicating inconsistency in expert assessments. Besides, after evaluating the responses of the initial round of Q-sort questionnaires, we found that thirteen policies did not meet the agreement threshold of 80%. Consequently, these policies were eliminated from further consideration.

In the subsequent Q-sort round, we focused on the remaining 11 policies that had achieved an agreement of 80% or higher as shown in Table III. The experts were then requested to sort each policy into its appropriate category. The resulting Q-sort outcomes, as provided by the five experts, are summarized in Table IV.

TABLE III
THE Q-SORT RESULTS FOR SORTING 11 REMAINING POLICIES THAT MEET THE AGREEMENT THRESHOLD OF 80%

Government Policies	Number of experts in each category				Consensus Category	Agreement (%)
	A	B	C	N/A		
Enhancing cyber security	5				A	100%
Encouraging digital technology/devices development	5				A	100%
Modernizing digital law and regulation	5				A	100%
Promoting R&D of manufacturing technology		5			B	100%
Talent mobility			5		C	100%
Providing digital standard	4	1			A	80%
Expanding free trade agreement		1	4		C	80%
Serving as intermediaries for network connections		5			B	100%
Enhancing capabilities of SMEs		5			B	100%
Offering subsidies for relocation expenses		1	4		C	80%
Improving data transparency	1	4			B	80%

Table III presents the classification of the 11 policies into three distinct groups. The first group, labeled as supply chain digitalization (A), includes policies such as enhancing cyber security, encouraging digital technology/devices development, modernizing digital laws and regulations, and providing digital standards. The second group, categorized as supply chain integration (B), comprises policies such as promoting research and development of manufacturing technology, serving as intermediaries for network connections, enhancing capabilities of small and medium-sized enterprises (SMEs), and improving data transparency. The third group, known as nearshoring (C), consists of policies related to talent mobility, expanding free trade agreements, and offering subsidies for relocation expenses. These policy categories provide a clear overview of the diverse policy measures aimed at enhancing supply chain performance.

After eliminating thirteen policies that did not meet the agreement threshold of 80%, Table IV demonstrated an improved agreement level, with the overall agreement (K) and agreement for each category (K_j) surpassing 0.65.

TABLE IV
STATISTICS FOR MEASURING THE OVERALL AGREEMENT AND THE AGREEMENT ON A PARTICULAR CATEGORY (n = 5 EXPERTS, N = 11 POLICIES, and k = 3 CATEGORIES), THE SECOND ROUND

Categories	K or K_j	$Var(K)$ or $Var(K_j)$	Z	p-value
Overall	0.7464	0.0054	10.589	<0,001
A	0.8429	0.0841	2.906	0.0037
B	0.6970	0.0926	2.290	0.0220
C	0.7985	0.0617	3.215	0.0013
N/A	-	-	-	-

IV. DISCUSSION

Based on the results presented in Table IV, the overall inter-rater agreement, as measured by Fleiss' kappa, is 0.7464. The variance of kappa, Var(K), is 0.0054, and the z-value is 10.589. The confidence interval for the inter-rater agreement falls between 0.766 and 0.787, with a p-value of less than 0.001. Therefore, the null hypothesis is rejected at a significant level of $\alpha = 0.05$. These findings indicate that the observed agreement among the raters is not due to chance, and the inter-rater agreement is substantial. Furthermore, the p-values for the three categories (0.0037, 0.0220, and 0.0013) presented in Table III also reject the null hypotheses at $\alpha = 0.05$, suggesting substantial inter-rater agreement for all three policy categories.

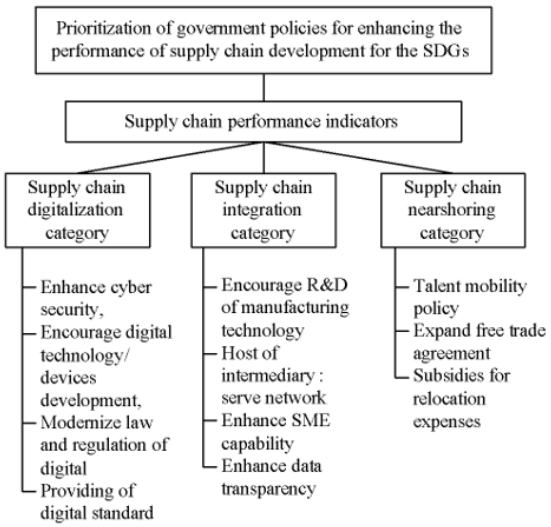

Fig. 1. The 4-level hierarchy model for prioritization of government policies for enhancing SC performance for the SDGs.

To prioritize and evaluate the effectiveness of policy measures, it is crucial to establish well-designed performance indicators. Building on the

findings, a hierarchical model has been developed to prioritize government policies aimed at enhancing supply chain performance in alignment with the SDGs. This model, illustrated in Fig. 1, provides a structured framework for guiding the assessment and prioritization of policies.

Fig. 1 depicts a hierarchical model with four levels, which could be used to prioritize government policies for enhancing supply chain performance in future research. The top-level objective focuses on prioritizing policies for improving the performance of supply chain development in alignment with the SDGs. The second level represents supply chain performance indicators. The third level represents the three policy categories. The lowest level represents individual policies. This hierarchical model provides a structured framework for evaluating and prioritizing policies to enhance supply chain performance. This could be particularly useful for countries in the developing world, with divergent pathways, priorities, measures, and progress in the implementation of SDGs [12]

V. CONCLUSION

This study examines the perspectives of foreign government policies on sustainable supply chains toward achieving UN SDGs. The Q-sort method was utilized to reach a consensus among experts. A literature review identified 24 policies from six countries, and interviews with Thai experts revealed three key policy categories: supply chain digitalization, integration, and nearshoring. Policies failing to meet the 80% agreement threshold were excluded from subsequent rounds, resulting in 11 policies for further analysis. The inter-rater agreement was found to be substantial. Additionally, a hierarchical model was developed to prioritize government policies that enhance supply chain performance in support of the SDGs. This model simplifies the complexity of the issue and can be used as a guide for managing the development of supply chain policies aligned with the SDGs in Thailand. However, further research is required to generalize research findings as the current study is limited to government policies from only six countries.

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