Analysis of Multi-Criteria Decision Making Techniques in Determination of Textile Manufacturing Locations in the ASEAN Region

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ABSTRACT

This research aimed to find appropriate locations for helping decision makers in textile companies to select the optimal location, when planning to expand or relocate their manufacturing plants, in the ASEAN region. Our approach had three analysis steps. Firstly, we identified factors, affecting location decision of textile industry internationally, from 80 practitioner points of view extracted from questionnaires. Secondly, candidate locations, in ASEAN countries for investment, in the textile industry, were determined by considering multiple criteria, for instance macroeconomics, demand, costs and national socio-political factors and in-depth interviews with 10 key textile professionals in Thailand. Lastly, Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) and Simple Additive Weighting (SAW) methods were applied to rank the alternatives and to select the best country for expanding textile manufacturing plants.The survey identified the top six factors affecting location decisions, which included competitiveness, economic factors, logistics systems, material and production, locations and utility factors. Three AEC countries - Indonesia, Vietnam and Myanmar - were evaluated. The empirical results, from both TOPSIS and SAW methods, revealed that Vietnam was preferred, followed by Indonesia and Myanmar. This research provides significant and useful insights, that can assist textile companies and policymakers in Thailand, by focusing on critical factors and locations after starting a plan for expanding or relocating a manufacturing plant aboard. Further, the suggested methodology can be practically applied for all selection problems as well as in other regions or industries, by varying included criteria and location areas, in the scope of the study.

Keywords

ASEAN region, Location selection, Simple Additive Weighting (SAW), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), Textile Industry

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Introduction

Since the establishment of the Association of Southeast Asian Nations (ASEAN) in 1967, the ASEAN region has become an attractive investment location and advantageous for trade markets. The principle objectives of ASEAN were to create prosperous and peaceful communities and to promote economic growth, social progress, as well as cultural development, within the region. To enhance the mission, in late 2015, the ASEAN Economic Community (AEC) was established by ten member countries to further develop the Southeast Asian region [1]. The AEC country members were integrated into one market, which enabled investors to expand their markets to over 650 million people. Moreover, this integration unified the existing ASEAN as a single market and one production base; consequently, it allowed businesses to complement products and services in the region [2]. The AEC members could then facilitate free movement of goods, services, capital, skilled labor and investment among ASEAN members and at the same time eliminate cross-border tariffs. The overall effect was maximized opportunities and a better investment climate in ASEAN and provided much more efficient transport networks, including associated infrastructure.

ASEAN is a significant export market for upstream and mid-stream textile products, for example, woven fabrics, yarn and synthetic filaments, accounting for 7.2% of world exports [3]. The market has been developing rapidly, causing the volume of garment exports to grow continuously as downstream textile products, turning the ASEAN region into a prominent supplier to the global textile and garment industry. Each country in ASEAN has integrated supply chains for textiles and garments. Some countries focused on price and cost competitiveness in garment producers, whereas others focused on fiber production and textile manufacturing, for example, spinning and weaving sector. However, the upstream and midstream material production had still been insufficient to meet demand, while the quality was generally below export standards. So, those companies had to import raw materials to produce garments for export. Therefore, to improve regional competitiveness for future growth, collaborative efforts and intra-regional cooperation are required.

Nowadays, Thailand is recognized as a country with complete supply chains, ranging from raw materials, dyeing, finishing and printing, down to the design and production of finished products. According to the Thailand Board of Investment [4], there were more than 4,700 local producers in the textile sector. The current wave of globalization and technological innovation has driven the textile sector to keep moving to be more and more competitive. Recently, Thai textile industries have lost competitive edges, due to continually increasing competition in the global market. Compared to some other countries in ASEAN region, the industry has faced a number of threats and obstacles, for example, lack of both general and skilled labor, higher electricity costs, higher minimum wages and lack of protective non-tariff barriers. Even though Thailand does have strong support from the government and attractive investment incentives, there have been local challenges now and then. Because of these challenges, the Thai textile industry should seek options to obtain benefits from region integration and strategies for making further investment or expanding production bases in other ASEAN countries, that could reduce manufacturing costs, taking advantage of abundant and valuable resources, as well as tariff benefits from investment and export support measures. This will enhance competitiveness and sustainable growth of the textile industry in the global arena. Therefore, choosing the suitable country for investment is an issue should be considered by textile companies.

Location selection has conflicting criteria both quantitative, *e.g.* cost and economic, and qualitative, *e.g.* on-time delivery and quality, factors and a finite set of alternatives [5-6]. This problem is addressed in the literature as a Multi-Criteria Decision Making (MCDM) problem [7]. Recently, several MCDM techniques have been effectively applied to investigate to find optimal in this type of problem. These techniques enable the simultaneous assessment of numerous measurable and non-measurable strategic and operational criteria and allow relevant decision makers to make subjective judgments, regarding different alternatives, with respect to some evaluation criteria [8]. A number of MCDM techniques have been applied to this problem. Some frequently used techniques were Analytic Hierarchy Process (AHP), Analytical Network Process (ANP), Decision-Making Trail and Evaluation Laboratory (DEMATEL), Elimination and Choice Translating Reality (ELECTRE), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), Vise Kriterijumska Optimizacija I Kompromisno Resenje (VIKOR), Simple Additive Weighting (SAW) and Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE). Example of recently applications location decision can be found in Cheng *et al.* [9], Koleva *et al.* [10], Lee *et al.* [11] Dweiri *et al.* [12], and Sopha *et al.* [13]. However, there is no study relevant to textile location selection, particular in the ASEAN perspective.

TOPSIS was widely applied in MCDM problems to determine facility locations [14], while SAW is one of the simplest and most practical methods, based on weighted averages [15]. Since, these techniques are simple, flexible and commonly used for making practical decisions, we adopted these two and compared them in selecting a suitable textile manufacturing location. Therefore, we aimed to 1) identify and rank factors, that affect global location decisions, 2) screen alternative ASEAN countries, which have potential for Thai textile industry investment expansion, and 3) compare between TOPSIS and SAW methods for selecting the best alternative.

This paper firstly introduces the textile industry in Thailand with a brief of ASEAN and AEC benefits in section 1. In section 2, materials and methods are explained, followed by section 3, which describes results. The final section discusses the perspectives and concludes.

Materials and Methods

Enterprises always face situations with several choices of actions with conflicting objectives based on multiple criteria, *i.e.* a multi-criteria decision problem [16]. It is a branch of operations research, which evaluates various conflicting criteria in decision making environments. Multi-Criteria Decision Analysis (MCDA) methods are rigorous approaches supporting the decision making process: they minimize the concerns of the final decision makers. They have typically been employed for priority setting, which involves human judgment. To follow this method, the performance of alternative courses of actions, in respect of criteria, is evaluated by breaking down the complex contexts into smaller parts. Thus, it is easy for the decision makers to understand the problem clearly and a solution can be explored in a holistic manner [17].

Some common strategies in Multi-Criteria Decision Making (MCDM) methods are TOPSIS [8,18], SAW [19-21] or Analytic Hierarchy Process [18], sometimes even two or more methods are integrated. In this paper, we compared TOPSIS and SAW methods for location selection for the textile industry. These methods are explained in the following sections.

TOPSIS method

TOPSIS is a prominent MCDM method, initially described by Erdoğmus *et al.* [22] and further developed by Hwang and Yoon [23]. TOPSIS evaluates the rank of various alternatives. The straightforward concept is to select an alternative, which is nearest the positive-ideal solution and farthest from the negative-ideal solution. TOPSIS is a reasonable and understandable method, and a measureable assessment accounts for both ideal and non-ideal choices at the same time [24]. One of the benefits of TOPSIS is that the method avoids pair-wise comparison. TOPSIS has the following steps:

(1) Construction of normalized decision matrix

The normalized value, r_{ij}, is constructed. Vector normalization is frequently used for calculating the normalized value [25]. The procedure depends on the type of attribute.

For benefit attribute,

$$r_{ij} = x_{ij} / \sqrt{\sum_{i=1}^{m} x_{ij}^2} \quad (1)$$

For cost attribute,

$$r_{ij} = 1 - (x_{ij} / \sqrt{\sum_{i=1}^{m} x_{ij}^2}) \quad (2)$$

where $i = 1, \dots, m$; $j = 1, \dots, n$; m is the number of attribute value in each criterion, n is the number of criteria and x_{ij} is original score of decision matrix.

(2) Determination of the weighted normalized decision matrix

The weighted normalized decision matrix is computed on the basis of:

$$v_{ij} = w_j r_{ij} \quad (3)$$

where w_j is a weight of criterion, $j \in [1,\dots,n]$, given $w_j \in [0,1]$ with $w_1+w_2+\dots+w_n = 1$.

These weights are determined by the decision maker or other methods for example rank ordered centroid (ROC) and rank sum (RS) methods.

(3) Calculation of the ideal and negative ideal solutions

Determine the positive ideal solution (PIS) and the negative ideal solution (NIS) by using eqs. (4) and (5):

For PIS: $A^* = \{v_1^*, \dots, v_n^*\} = \{(\max_i (v_{ij}), j \in J) (\min_i (v_{ij}), j \in J')\}$ $i = 1, \dots, m$ (4)

For NIS: $A' = \{v_1', \dots, v_n'\} = \{(\mathrm{mini}\ (v_{ij}), j \in J) (\max_i (v_{ij}), j \in J')\}$ $i = 1, \dots, m$ (5)

where J is associated with a benefit or “the more, the better” criterion, and J' is associated with a cost or “the less, the better” criterion.

(4) Calculation of the separation value

We calculated distances as m-dimensional Euclidean distances from the alternatives for each evaluation scheme, computed by using eqs. (6) and (7):

$$D_i^* = [\Sigma (v_j^* - v_{ij})^2]^{½} \quad i = 1,\dots,m \quad (6)$$

$$D_i' = [\Sigma (v_j' - v_{ij})^2]^{½} \quad i = 1, \dots, m \quad (7)$$

(5) Calculation of the relative closeness coefficients (CC_i)*

$$CC_i^* = D_i'/(D_i^* + D_i') \qquad 0 < CC_i^* < 1 \quad (8)$$

(6) Ranking of alternatives by CC_i values*

Finally, CC_i* values are sorted in descending order and the maximum value chosen. The set of maximum values of CC_i* scores is labelled the more prior alternative [25-26]. According to Chen *et al.* [27], CC_i* can be classified into 5 levels to identify the current status of the solutions, see Table 1.

Table1. Meanings of CC_i* for five sub-intervals

Closeness coefficient (CC_i*)	Assessment status
[0,0.2)	Not recommended
[0.2,0.4)	Recommended with high risk
[0.4,0.6)	Recommended with low risk
[0.6,0.8)	Approved
[0.8,1.0]	Approved and Preferred

Taken from Chen *et al.* [27]

Simple Additive Weighting (SAW)

The SAW method [28], or weighted summation model or weighted linear combination, is simple and commonly used in MCDM techniques in many fields [19-21]. It searches for the number of rankings for each alternative, according to each criterion. The best alternative is the one with the highest score. This method normalizes the decision matrix to form a scale to allow ready comparison with other alternatives. Subsequently, the normalized values of criteria for alternatives will be multiplied by the criterion weights, w_j. Steps in the method follow:

$$A_i = \sum_{j=1}^{m} w_j r_{ij} \qquad (9)$$

whereas A_i represents rank of alternative i, r_{ij} is the normalized score of alternative i with respect to criterion, j, calculated using eqs. (10) or (11) depending upon whether those criteria are costs or benefits.

In addition, x_{ij} is the initial value of alternative, i, with respect criterion, ***j***, in a decision matrix and w_j is weight value of each criterion.

For this study, the rank sum (RS) method was used to find the criteria weight.

For benefit attributes,

$$r_{ij} = \left\{ \frac{x_{ij}}{Max_i x_{ij}} \right\} \qquad (10)$$

For cost attributes,

$$r_{ij} = \left\{ \frac{Min_i x_{ij}}{x_{ij}} \right\} \qquad (11)$$

Weighting method

An important step, in an MCDM model, assigns weights for those criteria. However, it is difficult to select a suitable weighting method. Several methods; for instance, AHP, weighted score method and Elimination and Choice Translating Reality (ELECTRE) and others, have been used in MCDM applications in the literature [29]. In some cases, decision makers assign weights to criteria empirically. The ranking method is the easiest for decision makers as they only rank all the criteria depending upon their importance, *i.e.* the most important criterion = 1, second = 2, next = 3, and so on. Once a rank is assigned for a set of criteria, weights will then be calculated. The common methods are rank sum (linear), rank reciprocal (inverse) and rank exponent [30-31]. Saeid *et al.* [32] found that rank sum (RS) outperformed other rank-order weighting methods, using simulation. Therefore, we used rank sum (RS) to calculate weights of criteria affecting location decisions for textile investment.

The weight, *wj*, in the rank sum (RS) method is computed [21]:

$$w_j = (2(n+1-r_j))/(n(n+1)) \qquad (12)$$

where r_j is the rank of the criterion**,** $j \in [1,2,..., n]$.

Preliminary screening of location alternatives for textile industries in ASEAN region

Figure 1 shows a map of ASEAN map [33] -the scope of the study area. However, as suggested by Root [34], the all available countries should be considered to identify the target location set. The preliminary selection was an important step for screening alternatives for further input to the selection model [35]. Thus, we must compare and evaluate country characteristics, taking macroeconomic factors, demand factors, cost factors, as well as socio-political factors of each ASEAN country, into consideration. These countries should have more skills, as well as being leading manufacturers and distributors in textile and garment products. In addition, we interviewed key professional members of 10 Thai textile companies as part of the location screening process. By following these steps, three countries, Indonesia, Vietnam and Myanmar, were chosen for evaluation.

Fig 1. Scope of the study area: taken from [33]

Factors influencing location decisions

The initial stage of this research was dedicated to find the present position and obstacles facing the Thai textile industry, including identifying criteria that affect location decisions internationally. Site visits, face-to-face interviews and discussions with government officers, Thailand Textile Institute (THTI), Thai Garment Manufacturers Association (TGMA) and management team who had textile company experience were involved. Then, a questionnaire was designed for identifying key criteria that affect locating facilities internationally. A set of 11 main criteria were determined from literature review and the interviews. The questionnaire used a 1 to 5 Likert scale, representing “minimal influence (1)”, …, “maximum or high influence (5)” [36]. Questionnaires were distributed to 80 Thai textile companies. After the questionnaires were returned, we computed weights from average score and mean score of 11 ranking factors. Column 6, in Table 2, shows ranks of those criteria based on their importance: 6 criteria had a mean score in Column 3, higher than 4.00, and were adopted for further study.

Table 2. Ranking criteria according to their importance

Criterion (1)	Weight from AVG (%) (2)	Average score (3)	(4) =(2)×(3)	% (5)	Ranking (6)
Location	0.09	4.09	0.368	9.05	5
Utility	0.09	4.02	0.362	8.88	6
Logistics System	0.09	4.54	0.409	10.04	3
Competitiveness	0.09	4.63	0.417	10.30	1
Material and Production	0.09	4.32	0.388	9.53	4
Economic	0.09	4.59	0.413	10.13	2
Infrastructure	0.09	3.85	0.347	8.52	9
Government	0.09	3.91	0.352	8.59	7
Labor	0.09	3.83	0.345	8.47	10
Technology	0.09	3.89	0.350	8.58	8
Risk	0.09	3.58	0.322	7.91	11
Total	1.00	45.25	4.073	100	

Results

Assigning weights for criteria

Six criteria from Table 2, which had scores more than 4.00, *i.e*. competitiveness, economy, logistics system, material and production, location and utility, were selected for our new model. After that, rank sum (RS) weighting formulae were used to compute weights of those six criteria. Table 3 shows the weight of each criterion, calculated from eq. (12).

Table 3. Weight of each criterion using rank sum method

Criteria	Weight
Competitiveness	0.286
Economic	0.238

Utility	0.044
Logistics System	0.194
Material and Production	0.143
Location	0.095

Determining qualified alternative countries

Three locations, *i.e.* Indonesia, Vietnam and Myanmar, were evaluated by five experts using a linguistic rating (1-10) scale for the relative strength between two indicators. Table 4 shows an example of ratings of each country, with respect to each of criterion, from one expert point of view.

Table 4. Input values of the TOPSIS method

Criteria	Weight	Indonesia	Vietnam	Myanmar
Competitiveness	0.286	7	8	6
Economic	0.238	7	8	7
Utility	0.044	6	7	5
Logistics System	0.194	6	8	7
Material and Production	0.143	9	8	6
Location	0.095	6	8	7

Evaluation of alternatives by implementing TOPSIS method

Table 5 shows the weighted normalized decision matrix, along with the positive (PIS) and negative (NIS) ideal solutions, computed using eqs. (4) and (5). Using eqs. (6) and (7), the separation measures of each alternative from the PIS and NIS were obtained. Subsequently, the relative closeness to the ideal solution (CC_i*) was computed by eq. (8) and listed in Table 6. When the closeness coefficients of three alternatives were ranked from the largest to the smallest, Vietnam was 0.83424, whereas Indonesia was 0.54231 and Myanmar was 0.16766. Thus, Vietnam was the best alternative location with an acceptable score, while Indonesia was recommended as low risk, and Myanmar was not recommended, with $CC_i^* < 0.2$ [27].

Table 5. Weighted normalized decision matrix

Criteria	Indonesia	Vietnam	Myanmar	A*	A'
Competitiveness	0.114269	0.105231	0.145904	0.105231	0.145904
Economic	0.139284	0.149998	0.121427	0.149998	0.121427
Utility	0.024154	0.029608	0.021816	0.029608	0.021816
Logistics System	0.095050	0.132391	0.105234	0.132391	0.095050
Material and Production	0.096846	0.083640	0.063830	0.096846	0.063830
Location	0.048491	0.058474	0.057048	0.058474	0.048491

Table 6. Closeness coefficients and location ranking

	Country		
	Indonesia	Vietnam	Myanmar
D_i*	0.04148	0.01321	0.06604
D_i'	0.04914	0.06647	0.01330
CC_i+	0.54231	0.83424	0.16766
Rank	2	1	3
Decision	Recommended - low risk	Approved and preferred	Do not recommended

Location countries ranking by SAW method

Table 7 shows the normalized decision-making matrix and weights used for the SAW method. Preferences for alternative A_i were calculated by eq. (9) and SAW results are listed in Table 8. The country with the maximum weighted sum will be the best location alternative.

Table 7. Normalized decision-making matrix and weights used for SAW

Criteria	Indonesia	Vietnam	Myanmar	Weight
Competitiveness	1.225806	1.290323	1	0.286
Economic	0.928571	1	0.809524	0.238
Utility	0.815789	1	0.736842	0.044
Logistics System	0.717949	1	0.794872	0.194
Material and Production	1	0.863636	0.659091	0.143
Location	0.829268	1	0.97561	0.095

Table 8. Preference of alternatives from SAW method

	Indonesia	Vietnam	Myanmar
A_i	0.829256	0.869532	0.698021

Using SAW, Vietnam was more sustainable than the others, at 0.829256, whereas Myanmar was the least preferred at 0.698021.

Comparison of SAW and TOPSIS methods

Table 9 compares SAW and TOPSIS methods. From both methods, Vietnam was the best location for expanding or relocating a manufacturing plant, followed by Indonesia and Myanmar.

Table 9. Comparison of TOPSIS and SAW results

Effectiveness of alternative	Indonesia	Vietnam	Myanmar
Alternative evaluation by TOPSIS	0.54231	0.83424	0.16766
Rank of alternative by TOPSIS	2	1	3
Alternative evaluation by SAW	0.829256	0.869532	0.698021
Rank of alternative by SAW	2	1	3

Discussion

Since location greatly affects a business's future, selecting the appropriate operating locations becomes a top priority. We explored factors that would affect location decisions for a textile mill and a framework for selecting a suitable country for investment in a textile mill. The significance of the findings are discussed below.

Major factors influencing location decision

We found the top three criteria, affecting location decisions for textile investment internationally, were 1) competitiveness factors, 2) economic factors and 3) logistics system factors. Our findings differed from Atthirawong and Panprung [37], who suggested that the labor factor had been the most important factor, affecting Thai garment companies. This discrepancy can be explained by noting that the textile industry is capital-intensive, whereas the garment industry is a labor-intensive. Capital-intensive refers to industries that require large capital expenditures to maximize return on investment. As mentioned by Rahman and Kabir [38] and MacCarty and Atthirawong [39], the significance of those factors will vary with types of industries, environment and even size of business. Hence, to choose a location for investment, factors, which have a major influence on economic growth must be considered to maximize profit. In our study, we expected and found that competitiveness was the most important factor, which subsequently affects policies to promote growth and development of all types of businesses. Aiginger *et al.* [40] stated that competitiveness ought to be measured through productivity, in line with the work of Porter [41]. These factors were managerial technical skills, access to inputs, physical infrastructure and technology support, and so on [42]. These important factors of the textile industry would be different from those for the garment industry, which is driven by the labor environment. Therefore, garment companies would need to find locations, in which had pools of available workers, whereas textile companies require a country in which an excellent return on investment is foreseen.

The second important factor highlighted in our study was the economic factor, which was related to the economic system of the country where the firm operated. Economic factors, include employment levels, customs duties, inflation rate, interest rate, tax incentives and tax structure, for instance. MacCarty and Atthirawong [39] argued that these factors were widely mentioned in location decisions, which were external factors, controlled by host governments. Those factors also differ from one country to another [43] and affect performance and decision making of an organization. Examples are Woolworths, retail stores in UK, which were closed down since economic factors had squeezed the financial position of the business [44]; whereas, Woolworths in Australia showed a positive growth, due to the rising disposable income of consumers [45].

The third rank factor found was the logistics factor. It is consistent with Atthirawong and Panprung [37], who found that logistics factor was ranked in the top three of eleven factors. Logistics plays a key role in the economy today and can be classified into inbound and outbound logistics [46]. Inbound logistics involves activities of moving raw materials and parts to the storage or the production location, whereas outbound logistics involves moving finished products to end consumers. This factor becomes one of the important constraints for smooth production and distribution operations, which could enhance business competitiveness, as well as attract investors to invest in the country [47-48]. The efficiency and connectivity of national logistics systems are an important determinant [49]. Therefore, we concluded the logistics factor was important for location selection in all types of business.

Qualified alternative country

TOPSIS and SAW methods were used to compare the alternatives in selecting a suitable country for expanding or relocating a manufacturing plant. Both methods were shown to be very effective and successful tool for solving these problems. Experiments, with both algorithms, led to identical rankings. However, TOPSIS outperformed SAW, in that it provided additional information. This was consistent with Chu *et al.* [50], who also found the same rankings with TOPSIS and SAW, when evaluating the accomplishments of knowledge communities. Additionally, the CC_i* value from TOPSIS can determine the assessment status of the alternatives [27].

Vietnam was found to be the most suitable country for the Thai textile industry to expand a manufacturing plant internationally. We attribute that this was because Vietnam has a very large market, with a population of ~95 million. In terms of education, ~2.4 million students have registered in higher education institutions. Among the ASEAN member countries, Vietnam's economy has robust GDP growth, at 7% in 2019 [51]. Moreover, Vietnam has long experience in textile and garment industries. Presently, there are a large number of investors from various countries, *e.g.* China, Hong Kong, Taiwan and Korea, who have invested in the garment industry, which is a downstream of the whole supply chain. It is clear that there will be an increased demand for garment products, which will result in an increase of total domestic textile production, as well as building up a stronger supply chain for the textile and garment industries.

Indonesia is considered to be among the top ten textile and garment producing countries worldwide [52]. In 2019, Indonesian exports of textiles and garments was ~US$138 billion [53]. However, the overall export trend is downward [54]. Recently, there was a low level of investment in the textile sector in Indonesia resulting in shrinking productivity. Old production technology caused an increased energy cost and also affected product quality. Furthermore, being an island country, Indonesia naturally faces infrastructure obstacles affecting their supply chains [55], resulting in higher logistics costs and longer lead times. These challenges seem to make Indonesia less attractive than Vietnam.

The garment sector in Myanmar has grown significantly over the past five years. Garment industry exports were ~US$4.37 billion in the fiscal year 2018-19 [56]. However, our study revealed that Myanmar would not been recommended for expanding textile manufacturing plants, even there were strong demand from the garment sector within the country. We attribute this to poor infrastructure in Myanmar and an underdeveloped bureaucracy [57]. Poor logistics systems will definitely lead to high costs and risks. Those major bottlenecks will delay export and import procedures, affecting product movement in the supply chain, as well as threatening competitiveness [58]. Moreover, in 2018, the American Insurance Company [59] gave Myanmar an overall score of “high” for risk, reflected in hindrance of political, economic, legal, taxation, operational and security aspects of the country. In conclusion, these factors made Myanmar to be the least preferred option.

Conclusions

The location decision problem is an important issue to achieve strategic investment and enhance market competitive for business. The problem needs a Multi-criteria Decision Making method, including qualitative and quantitative criteria. Thus, the development of a location decision-making method is of substantial significance. In this paper, relevant criteria were derived from a field study using a questionnaire from respondents who were managers in Thai textile companies, who planned to locate facilities abroad. Based on the calculation, six criteria were selected for further investigation. Three AEC countries - Indonesia, Vietnam and Myanmar - were considered as alternatives. TOPSIS and SAW algorithms were used for ranking locations. Both methods led to identical rankings. Vietnam was more favorable than the other two.

This research will benefit scholars and academics, in the relevant areas of location decision and management science, as it recommends a framework of key criteria and a new model for successful implementation in a textile industry. Although, the scope of this study was particular focused on Thai textile industry, we believe that the model is generic which can be extended to other regions or industries.

Future work

In future work, the accuracy of model could be varied according to the weight of expert opinion. Therefore our further study will focus on other factors, relating to sustainable industry, using more expert commitments. Other similar MCDM techniques for ranking, *e.g.* Vlse Kriterijumska Optimizacija I Kompromisno Resenje (VIKOR), or Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE) could be used to compare results and verify the robustness and reliability of the model, through sensitivity analysis. Also future extension, by taking complex relationships among major location criteria into consideration, could use other MCDM methods, for example Fuzzy Analytical Network Processes (FANP).

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CONFLICTS OF INTEREST

We declare no conflict of interest.

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