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Decision-making process of Thai government agent for selection of technological startup companies in pitching of concept ideas

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Abstract

The Thai government has an attempt to take the country out of the middle-income trap by using an innovation strategy to drive the economy under the Thailand 4.0 policy. In response to this policy, government agents play an important role in supporting startup companies by funding their new ideas about products or services. This research studies the decision-making process under Multiple-Criteria Decision Making (MCDM) in the selection of technology startup companies to be funded by the government agent called GISTDA. The business area of technology startups that will be a sample of this research is companies that particularly use unmanned aerial vehicles (UAV) technology. Startup pitching data at the conceptual idea will be analyzed with several techniques in the MCDM approach, such as TOPSIS. Subsequently, the rankings of each technique will be compared to find which technique is the most accurate approach to the result from GISTDA.

Keywords: tech startup, UAV, government agent, decision-making process, MCDM

1. Introduction

Thailand is a large and important economy in Southeast Asia. In order to give the Thai economy more sustainability, the Thai government has an attempt to take the country out of the middle-income trap by using an innovation strategy to drive the economy under the Thailand 4.0 policy. Thailand 4.0 focuses on promoting innovations in 5 groups of industries as follows:

- Food, agriculture and biotechnology
- Health, wellness and bio-medical
- Smart devices, robotics and mechatronics
- Digital, internet of things, artificial intelligence and embedded technology
- Creative, culture and high-value services

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In response to this policy, government agents play an important role in supporting tech startup companies by funding their new ideas about products and services. This initial fund by government agents can support tech startup companies to initiate their business in the market which will lead to income generated for their country in the future.

Typically, a government agent provides funding to new startup companies that cannot raise funds from venture capital business or other channels such as banks. Funding supported by the government through government agents is so popular in developing countries (Afful-Dadzie and Afful-Dadzie, 2016; Afful-Dadzie et al., 2015). However, government agents do not expect returns in terms of money from their investment but aim to support entrepreneurs to be able to stand in the business world and drive the national economy eventually.

This research studies the decision-making process under Multiple-Criteria Decision Making (MCDM) in the selection of technology startup companies to be funded by the government agent called GISTDA (Geo-Informatics and Space Technology Development Agency). The business area of technology startups that will be a sample of this research is companies that particularly use unmanned aerial vehicles (UAV) technology. Startup pitching data at the conceptual idea will be analyzed with several techniques in the MCDM approach such as TOPSIS(Technique for Order Preference by Similarity to an Ideal Solution) and SAW(Simple Additive Weighting). Subsequently, the rankings of each technique will be compared to find which technique is the most accurate approach to the result from GISTDA.

2. Literature review

2.1 Fund provided by government agent

Currently, the funding of government agencies is very important for technological startup companies in Thailand to build their new ideas for products and services. Besides, those companies more easily approach the government agent's fund than others such as venture capital business, angel business or bank. Governments of developing countries tend to invest in startup companies via government agents that do not expect returns from their investments but aim to support entrepreneurs to survive in the business world and generate income for their country eventually (Afful-Dadzie et al., 2015).

In funding operation, there are some differences between government agents and venture capital businesses, for example government agents need a lower return or do not require any position in funded companies. Some government agents may not monitor the business performance which leads to overspending or the funded companies do not focus on the first business idea. In the selection process, there is a lack of due diligence of venture capital and some government agents may tend to have biases or preferences in the selection process which are influenced by government supporters or politicians (Afful-Dadzie and Afful-Dadzie, 2016). Therefore, the mechanism of the decision-making process should reduce these issues effectively and be an important part of selecting promising startup companies to provide funds more efficiently as well as to secure transparency in the selection process (Junjun and Xiao, 2010).

2.2 Problems for multiple criteria decision making in private and public equity market

In the present, startup companies mainly seek funding from venture capitalists and angel investors in the seed stage, series A or series B. The funds will be used to nurture their business for surviving in the business world. From the investors' perspective, they have to carefully invest in startup companies because there is a trend that unicorn companies may not make profit as expected, and it could be in "bubble stage" for technology SMEs in the near future (Yang and Zhao, 2018). Therefore, the decision-making in selection process should be efficiently improved to make an investment in a potential company. Through a literature review, several techniques in MCDM were widely used to improve decision making in the selection process of venture capitalists, angel investors as well as government agents more efficiently.

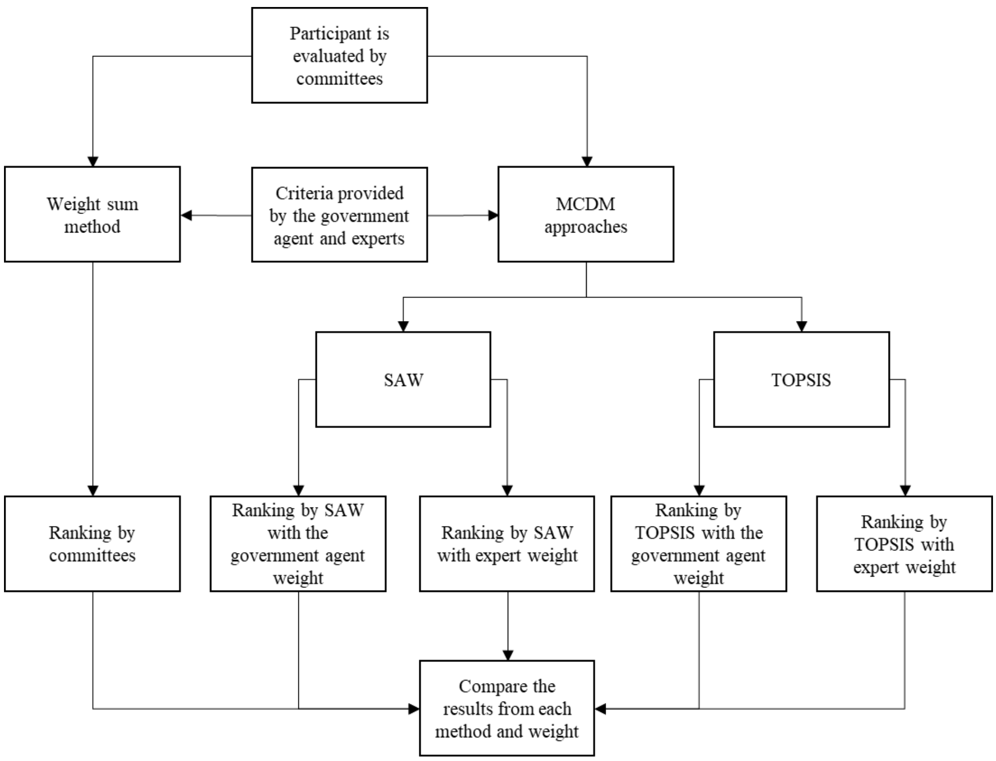
Shin and Lee (2000) proposed MCDM using the Analytic Hierarchy Process (AHP) to evaluate new ventures for investment from which investors expected high returns in the future. The main criteria of management, technical and marketing capabilities were used, and each main criterion consisted of 3 sub criteria. One advantage of the AHP was the explicit structure of the venture selection process. However, the AHP used the pairwise comparison for the selection of alternatives that should come from the same industry. Beim and Levesque (2004) used Multi-Attribute Value Theory (MAVT) to support the venture capitalist's decision making to select attractive companies for their investment. This method could reduce the biases of decision makers and bring transparency to the selection process. Decision makers would mainly evaluate business plans with four criteria which were management and governance, the flexibility of offers, marketing and return on investment. They were the goal of the selection. MAVT supported decision makers to evaluate business plans thoroughly and systematically (Beim and Levesque, 2004). Junjun and Xiao (2010) studied the selection process of investors to evaluate venture capital companies for their investments by using the fuzzy AHP technique.

The evaluation system in this study had three levels of hierarchy, namely high, medium and low levels. In each level, the attributes of venture capital companies would be considered, such as ethic, capabilities, performance and risk eagerness. With this system, good venture capital companies would be selected more efficiently and undesirable consequences would be eliminated from their investments (Junjun and Xiao, 2010). As another application of fuzzy AHP, Zhang (2012) brought the method to prioritize risks that could support venture capitalists to reduce risks in the venture selection process and maximize return on investment as venture capitalists' objective (Zhang, 2012). There was an interesting method of MCDM that was fuzzy goal programming that was used for the application of the venture capitalist's decision-making process. Venture capitalists used this method to select appropriate startup companies that had already passed the seed stage of funding (Aouni et al., 2014). Next, Afful-Dadzie et al. (2015) proposed a method of decision-making that was fuzzy PROMETHEE to select potential startup companies that were appropriate to the government venture capitalist's investment. Afful-Dadzie and Afful-Dadzie (2016) used the fuzzy Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) in the decision-making process of government venture capital that this technique could reduce biases of decision makers and build transparency in the process. There was a study of the selection process for technological SMEs in the USA by Yang and Zhao (2018), who proposed modified PROMETHEE II in the process. They found that startup businesses in the USA were in the bubble stage; therefore, venture capitalists should pay more attention to the selection process than the past and improved the selection process more efficiently (Yang and Zhao, 2018). As is implied by the literature reviewed, MCDM could be widely applied to the problem of venture capitalist's decision-making process and improve the venture selection process to increase efficiency, transparency, and return on investment as well as reduce biases and risks of decision makers.

3. Methodology

The research methodology consists of 2 methods, which are observation and numeric analysis. For observation, the researcher attended the conceptual idea competition in the UAV startup 2019 program, which was held with the cooperation of GISTDA and National Innovation Agency (NIA). This program has been operating since 2017 with the main objective to fund particularly technological entrepreneurs, who have been developing UAV technology for building products and services. Participants of this program were divided into two groups based on applications. One group is concerned with dual-use technology, that is a UAV could be used for 2 applications. The other group is concerned with disaster technology, that is UAVs could be especially used in disaster situations such as flooding. In the competition, the researcher could observe the decision-making process of the committees, and the criteria and their weighting and evaluated scores of each participant could be used as the input for numeric analysis to calculate results.

Figure 1. Research framework for numeric analysis



For numeric analysis, MCDM approaches used in this research consisted of the weight sum method, SAW and TOPSIS. The methods are appropriate with the data from the selection process in which each committee member evaluated participants' performance by the cardinal score. One of the most popular methods for MCDM is the AHP that will not be used in this research because the committee of the competition did not evaluate participants' performance by a pairwise comparison method, but they used the preemptive decision making for evaluation (Opasanon, 2017). However, the technique of pairwise comparison will be used to construct the weights of experts, which are an outsider's opinion to support the decision of selecting qualified participants to pass the next round and provide a fund for building prototypes. The research framework that is used in this paper is shown in Figure 1.

The analysis used the scores evaluated by the committee as input to well-known MCDM approaches, weight sum method, SAW and TOPSIS to identify qualified participants for the next round of incubation and prototype building. Seven criteria used here were weighted with 2 different methods, one is weights by the government agent and the other is weights by experts with a pairwise comparison. The results of three MCDM approaches would be compared to find differences and which approach is the most accurate approach to the result from GISTDA.

3.1 Multiple-Criteria Decision Making (MCDM)

Currently, a key problem in starting a business is to find out capital to nurture the business activities of the company. Although there are several sources of funds for ventures, they should prove their performance or potential in making profits and business growth. From the investors' perspective, to discover some promising ventures for investment is necessary for a return from the investment in the future. Therefore, the decision-making process for selecting a venture to invest is very important. To improve the decision-making process more efficiently, the theory of MCDM is applied to the problem of selecting tech startup companies for investment.

There are many applications of MCDM to solve several problems in daily life (Atmojo et al., 2014), businesses (Afshari et al., 2010; Afshariet al., 2012; Bayrak et al., 2007; Chou et al., 2008; Kaur and Kumar, 2013; Melia, 2016), logistic (Opasanon, 2017), education (Deni et al., 2013; Saghafian and Hejazi, 2005) and so on. The main purpose of MCDM is selecting the best alternative from all alternatives (Hwang and Masud, 2012; Saravisutra, 2016; Velasquez and Hester, 2013). Mathematically, MCDM can be expressed as a matrix format as shown in (1).

$$\begin{array}{c} \\ A_1 \\ A_2 \\ \cdots \\ A_m \end{array} \begin{array}{c} \begin{matrix} C_1 & C_2 & \cdots & C_n \end{matrix} \\ \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \end{array} \quad (1)$$

where x_{ij} is the rating of alternative A_i with respect to criterion C_j.

3.2 Simple additive weighting (SAW)

The simple additive weighting method is well known as the weighted linear combination or scoring method is the most frequently used MCDM technique (Saravisutra, 2016). This method is based on the weight sum method. The total score is calculated for each alternative by multiplying the scale rating for each attribute value by the importance weight assigned to the attribute and subsequently, summing the product's overall attributes (Afshari et al., 2010; Hwang and Masud, 2012). The SAW method needs a comparable scale for all elements in the decision matrix. The comparable scale is calculated by Equation (2) for both positive and negative criteria (Hwang and Masud, 2012; Melia, 2016).

$$r_{ij} = \begin{cases} \dfrac{x_{ij}}{\max\limits_i x_{ij}} & \text{if j is a positive criterion} \\ \dfrac{\min\limits_i x_{ij}}{x_{ij}} & \text{if j is a negative criterion} \end{cases} \quad (2)$$

where r_{ij} is the rating performance normalized of alternative A_i (i = 1, 2, 3, …, m) in criterion C_j (j = 1, 2, 3, …, n). The total score of each alternative comes from the weights of each attribute that is shown in Equation (3).

$$V_i = \sum_{j=1}^{n} w_j \, r_{ij} \tag{3}$$

where greater V_i indicates that alternative A_i should be selected as a good alternative. Basically, the summation of the normalized weights is equal to 1.

3.3 Technique for order preference by similarity to an ideal solution (TOPSIS)

TOPSIS is based on the selection of the alternative that has the shortest distance from the positive ideal solution and the farthest from the negative ideal solution so that the selected alternative by TOPSIS is probably the best. (Hwang and Masud, 2012; Parida and Sahoo, 2013; Saravisutra, 2016). TOPSIS assumes that each attribute in the decision matrix (1) takes either monotonically increasing or monotonically decreasing utility. Therefore, the steps of TOPSIS, which are used in this research, are shown as follows:

Step 1: Calculate the normalized decision matrix as Equation (4).

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \tag{4}$$

Step 2: Calculate the weighted normalized decision matrix.

$$V_{ij} = r_{ij} W_j \tag{5}$$

where W_j is the weight of j-th element and $\sum_{j=1}^{n} W_j = 1$.

Step 3: Determine positive ideal and negative ideal solution.

$$A^+ = \{V_1^+, V_2^+, \dots, V_n^+\}, \text{ where } V_j^+ = \max_i v_{ij} \Big| j \in J' \tag{6}$$

$$A^- = \{V_1^-, V_2^-, \dots, V_n^-\}, \text{ where } V_j^- = \min_i v_{ij} \Big| j \in J' \tag{7}$$

Step 4: Calculate the Euclidean distance from positive ideal solution.

$$S_{i^+} = \sqrt{\sum_{j=1}^{n} \left(V_{ij} - V_j^+\right)^2}, \ \text{i = 1, 2,…, m} \tag{8}$$

Calculate Euclidean distance from negative ideal solution.

$$S_{i^-} = \sqrt{\sum_{j=1}^{n} \left(V_{ij} - V_j^-\right)^2}, \ \text{i = 1, 2,…, m} \tag{9}$$

Step 5: Calculate the relative closeness to the ideal solution.

$$C_{i^+} = \frac{s_{i^-}}{(s_{i^+} + s_{i^-})} \tag{10}$$

The relative closeness is valued between 0 and 1. If the value approaches 1, it means that the alternative will approach the positive ideal solution.

Step 6: The alternatives can be ranked according to the descending order of C_{i^+}. The alternative with the largest value of C_{i^+} is the best one.

3.4 Pairwise comparison

This research used weights of the criteria from three experts who had relevant experiences with technology and business management, business consulting, as well as selection of tech startup companies. The weights from the experts were used for calculation as an outsider's opinion for the decision maker. The weights were obtained by the pairwise comparison technique that was based on Saaty's theory of the AHP. Each criterion will be compared with another criterion, one by one. For each comparison, the criterion that is the most important will be assigned a score according to the intensity of importance in Table 1 to show how much important it is (Afshari et al., 2010; Opasanon, 2017).

Table 1. Saaty's 1-9 scale of pairwise comparison

Intensity of importance	Definition
1	Equally preferred
2	Equally to moderately
3	Moderately preferred
4	Moderately to strongly
5	Strongly preferred
6	Strongly to very strongly
7	Very strongly preferred
8	Very strongly to extremely
9	Extremely preferred

Subsequently, the comparative matrix can be constructed and will be used to calculate average random consistency further. The comparative matrix, denoted by *A*, is shown in (11).

$$A = \begin{bmatrix} 1 & a_{12} & a_{13} & \cdots & a_{1n} \\ 1/a_{12} & 1 & a_{23} & \cdots & a_{2n} \\ 1/a_{13} & 1/a_{23} & 1 & \cdots & a_{3n} \\ \vdots & \vdots & \vdots & 1 & \vdots \\ 1/a_{1n} & 1/a_{2n} & 1/a_{3n} & \cdots & 1 \end{bmatrix} \tag{11}$$

For instance, the number of comparisons is $N = n(n-1)/2$, where n is the number of criteria used. Following the development of the matrix, priority weights of criteria are calculated through the eigenvalues and eigenvectors as follows.

$$\lambda_{max} = \sum_{j=1}^{n} a_{ij} \frac{W}{W_i} \tag{12}$$

Eigenvector can be calculated by Equation (13).

$$A \times W = \lambda_{max} \times W \tag{13}$$

where *W* is an eigenvector value that expresses the relative important weight of elements in the same hierarchy. λ_{max} is the maximum eigenvector of the comparative matrix. After the maximum eigenvector is obtained, the consistency will be checked to see which inconsistency may give a vague result. In the pairwise comparison method, the consistency index (*CI*) is used to measure inconsistency and the consistency ratio (*CR*) measures the coherence. Therefore, *CI* and *CR* can be calculated by Equation (14).

$$CI = \frac{\lambda_{max}-1}{n-1},\ CR = \frac{CI}{RI} \tag{14}$$

where *RI* is the random consistency index that can be obtained by checking the matrix size in Table 2.

Table 2. Random consistency index

Size of matrix	1	2	3	4	5	6	7	8	9	10
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

CR which is used for checking errors that might occur to the pairwise comparison, is at the acceptable level or not. For the consistency ratio of the matrix size n ≥ 5 (Opasanon, 2017), if the *CR* is less than or equal to 0.1, the ratio is acceptable. If *CR* is greater than 0.1, the weighting should be reviewed thoroughly and adjusted until *CR* is acceptable.

In the case of multiple decision makers, the matrix of each decision maker will be calculated by using the geometric mean as follows. Assume that matrix A^d represents matrix *A* of decision maker *d* (Opasanon, 2017).

$$A^d = \begin{bmatrix} 1 & a_{12}^d & \cdots & a_{1n}^d \\ a_{21}^d & 1 & \cdots & a_{2n}^d \\ \vdots & \vdots & 1 & \vdots \\ a_{n1}^d & a_{n2}^d & \cdots & 1 \end{bmatrix} \tag{15}$$

Find an averaged matrix $\bar{A}$ of A^d, $d = 1, 2, 3, \ldots, K$.

$$\bar{A} = \begin{bmatrix} 1 & \bar{a}_{12} & \cdots & \bar{a}_{1n} \\ \bar{a}_{21} & 1 & \cdots & \bar{a}_{2n} \\ \vdots & \vdots & 1 & \vdots \\ \bar{a}_{n1} & \bar{a}_{n2} & \cdots & 1 \end{bmatrix} \tag{16}$$

where $\bar{a}_{ij}$ = the geometric mean of $\{a_{ij}^1, a_{ij}^2, \ldots, a_{ij}^K\}$ as difined in Equation (17).

$$\bar{a}_{ij} = \sqrt[K]{a_{ij}^1 \cdot a_{ij}^2 \cdot a_{ij}^3 \cdot \ldots \cdot a_{ij}^K} \tag{17}$$

where K = number of decision makers. After that, matrix $\bar{A}$ is used to find the weighting matrix (W) and also consistency is checked by the calculation of consistency ratio (CR).

4. Results

This research has obtained the data of evaluated scores and weights of criteria used in the conceptual idea competition from GISTDA. Since the names of participants should not be revealed in this paper, we blinded them and instead, used team1, team2, …, team16 to represent them. In this program, 16 participants passed the interview stage, but unfortunately, team5, team8 and team9 could not attend the conceptual idea stage of the competition. Finally, there were 6 teams in the dual-use tech group and 7 teams in the disaster group. At this stage, there were 7 committee members that evaluated the project of each participant by using cardinal scores concerning each criterion. Seven criteria had been regularly updated by the government agency over the past 3 years. The final criteria and their weights are listed in Table 3.

Table 3. Criteria used in the conceptual idea stage

Criteria	Abbreviation	Weight
Answer to current issue	CR1	0.15
Benefit to dual use tech or disaster	CR2	0.15
Technology feasibility	CR3	0.15
Uniqueness and newness of products and services	CR4	0.15
Business idea	CR5	0.15
Clarity of user groups or customers	CR6	0.15
Profile and experience of entrepreneurship team	CR7	0.1

On the other hand, we asked the three experts to score weights of seven criteria by the pairwise comparison method as in Equation 11 to 14. The consistency ratios of the three experts were 0.093, 0.085 and 0.092, respectively. The ratios did not exceed 0.1 meaning that the weights from the experts were consistent and acceptable (Opasanon, 2017). Subsequently, the comparative matrices of the experts were combined with Equation 15 to 17 to find the average matrix of the three experts. The results of the pairwise comparison and the average matrix of the multiple decision makers are shown in Table 4.

From comparing the weights of both types, it was found that the weights of the government agent were 0.15 from criteria CR1 to CR6 but criteria CR7 was 0.1 only, while the weights of experts were 0.13, 0.16, 0.14, 0.15, 0.17, 0.18 and 0.07 respectively. It could be seen that the experts would mostly focus on the criteria of clarity of user group and customer which meant the participants or startup companies should evidently know who their customers are. In another case, the experts less focused on the profile and experiences of the entrepreneurship team that was the same as the government agent's point of view. On the other side, the government agent equally focused on the importance of the answer to the current issue, benefit to dual-use tech or disaster, technology feasibility, uniqueness and newness of products & services, business idea and clarity of user groups or customers.

Table 4. Normalized weights of the experts which are calculated by pairwise comparison

Criteria	CR1	CR2	CR3	CR4	CR5	CR6	CR7	Total	Weight
CR1	0.12	0.12	0.08	0.10	0.16	0.10	0.23	0.92	0.13
CR2	0.15	0.16	0.24	0.14	0.16	0.10	0.20	1.14	0.16
CR3	0.19	0.09	0.13	0.16	0.19	0.11	0.09	0.95	0.14
CR4	0.19	0.18	0.13	0.16	0.16	0.14	0.10	1.06	0.15
CR5	0.12	0.16	0.12	0.16	0.16	0.35	0.12	1.18	0.17
CR6	0.19	0.25	0.19	0.18	0.07	0.15	0.20	1.23	0.18
CR7	0.04	0.05	0.11	0.11	0.09	0.05	0.07	0.52	0.07

Subsequently, both the weights of the government agent and the experts were brought to calculate the results of each group by the three MCDM approaches, weight sum, SAW, and TOPSIS methods respectively. For the calculation using the SAW method, evaluated scores of each group would be calculated by Equation 2 to 3 with the weights of the government agent and the experts. Next, the evaluated scores of each group would be calculated by the TOPSIS method as in Equation 4 to 10 with the two sets of weighting. The results calculated by the three MCDM approaches are shown in Table 5 for the dual use group and in Table 6 for the disaster group.

Table 5. Results of the three MCDM approaches for the group of dual use tech (team ranking)

Participant	Committee	Weighting by government agent			Weighting by expert			Competition result
		Weight sum	TOPSIS	SAW	Weight sum	TOPSIS	SAW	
Team1	6	6	6	6	6	6	6	Not qualified
Team2	3	3	3	3	3	3	3	Qualified
Team3	1	1	1	1	1	1	1	Qualified
Team4	2	2	2	2	2	2	2	Qualified
Team6	4	4	4	4	4	4	4	Qualified
Team7	5	5	5	5	5	5	5	Not qualified

Table 6. Results of the three MCDM approaches for the group of disaster tech (team ranking)

Participant	Committee	Weighting by government agent			Weighting by expert			Competition result
		Weight sum	TOPSIS	SAW	Weight sum	TOPSIS	SAW	
Team10	7	7	7	7	7	7	7	Not qualified
Team11	2	2	2	2	2	1	2	Qualified
Team12	5	5	5	5	5	5	5	Qualified
Team13	4	4	4	4	4	4	4	Qualified
Team14	1	1	1	1	1	2	1	Qualified

Team15	6	6	6	6	6	6	6	Not qualified
Team16	3	3	3	3	3	3	3	Qualified

From the data of evaluation scores, the data of both the dual use tech and the disaster tech groups have proceeded as the research framework in Figure 1. In the result of the dual-use tech group, both of the rankings obtained by the weights of the government agent and the rankings by those of the experts showed the same direction so that Team1 and Team7 were not qualified for the next round when the rankings of each approach and source of weight were compared to find that all the approaches identically ranked the participants of the competition and also coincided with the rankings by the committee.

In the result of the disaster tech group, the rankings obtained by the weights of the government agent identified Team10 and Team15 as the disqualified for the next round, and also the rankings obtained by the weights of the experts identified the same teams. However, the rankings of TOPSIS calculated by the weights of the experts are different from those of the other approaches. The ranking of Team11 is number one and that of Team14 is number two, but the other approaches reverse the rankings of Team11 and Team14, which are consistent with the rankings of the committee. The reason is as follows: the experts weighted criteria 4 and 6 with high scores, 0.15 and 0.18 respectively, and for both of the criteria, Team11 obtained higher scores than Team14. However, the difference in the final scores between the two teams was only 0.002 points. The rankings obtained by the weights of the experts identified Team10 and Team15 as the disqualified for the next round, which is consistent with the result from the rankings obtained by the weights of the government agent.

5. Discussion and limitation

The research question of this paper is which MCDM approach is the most appropriate for the decision-making process of the Thai government agent to select promising technological startup companies to provide funding. To answer the research question, the results of the MCDM approaches were compared with the decisions of the committee in the UAV startup 2019 program to find which MCDM approach can produce results as close as the results in the program. The results of the weight sum method, SAW and TOPSIS for the groups of dual-use tech and disaster tech were consistent with the decisions of the committee. In contrast to the results from the weights of the experts, the result of TOPSIS for the disaster tech group, which was influenced by the weights of the experts, was different from the others. This incident caused the scores of the teams that had different results to be reviewed once more. This action was consistent with the objective of using the weights of the experts as an outsider's opinion or reference to support the committee's decision in this research. These different results influenced the committees to review the teams' performances from the video recorder. If the committee agreed with the outsider's opinion, then they could rely on the results from the weights of experts. However, if the committee confirmed their decision, they could internally discuss and find the consensus for making the final decision.

Though the reliability and accuracy of results are emphasized in this paper, the weights of GISTDA did not have an indicator to identify its reliability. Therefore, the results of the committee might not build trust with other people that their results were accurate. The weights of the experts had more reliability than the weight of the government agent because they were calculated by the pairwise comparison technique. The reliability of the weight could be indicated by the consistency ratio that expressed the consistency of the judgment (Afshari et al., 2010; Opasanon, 2017), and these weights got scored by comparing pairs of criteria which is a reasonable method (Saravisutra, 2016). Basically, inconsistency may lead to vague and incorrect results (Dhochak and Sharma, 2016); therefore, the consistency ratio of the comparative matrix should not exceed 0.1 (Afshari et al., 2010; Opasanon, 2017; Saravisutra, 2016). With this technique, the weights of the experts obtained from their comparative matrices with their ratios were 0.093, 0.085 and 0.092, respectively and these numbers were acceptable. Therefore, the results calculated by using the weights of experts will be more reliable and accurate than the results calculated by the weights of the government agent. In this research, the results from the weights of the experts can be a reference for the committee to express the reliability and accuracy of their results to others such as participants in the program.

In the part of the results of each approach, there was a different result from the TOPSIS approach for the disaster group that was influenced by the weights of experts. With the advantages of the TOPSIS approach, it finds the best alternative by identifying the position of the best solution which should be the closest to the positive ideal solution and the farthest from the negative ideal solution (Hwang and Masud, 2012; Parida and Sahoo, 2013; Saravisutra, 2016). In contrast, the SAW approach is typically considered and emphasized on positive and negative criteria (Afshari et al., 2010; Hwang and Masud, 2012; Melia, 2016) that is a rough calculation when it is compared with TOPSIS (Saravisutra, 2016). Furthermore, the disadvantage of the SAW approach is it usually produces exaggerated results (Saravisutra, 2016). With the above reasons, the SAW approach is the most appropriate for starters who would like to use rough calculation for problems in MCDM. While the problem of the government agency's investment decision requires highly accurate approaches, TOPSIS is the most appropriate MCDM approach for this problem.

From the observation of research in the competition, all the criteria in this competition were required quality scores, not crisp numbers that were used to evaluate participants. The research found that most criteria were difficult to be scored as a crisp number or cardinal score. Decision-makers might score the same criteria differently. Some decision-makers scored a low number while another decision-maker scored a high number for the same criterion. This difference in scoring can influence decision-makers to evaluate alternatives inefficiently (Hashemi et al., 2017). Therefore, the linguistic variable should be used to evaluate startup companies that are matched to quality data, which is vague and subjective (Afful-Dadzie et al., 2015; Hashemi et al., 2017; Parida and Sahoo, 2013; Saghafian and Hejazi, 2005). The linguistic variable can support decision-makers to improve their evaluation alternatives more efficiently. As the criteria of the government agent, the weights of those criteria were scored as a non-preemptive type in which the weighting value of each criterion is related to the importance of that criterion. However, the weights which are scored by non-preemptive cannot indicate or measure the reliability of the weight. In contrast, the weights obtained by the pairwise method can measure the reliability by using the consistency ratio. In academic research, the weights from this technique are as acceptable as weights scored as non-preemptive type. Finally, this research was studied in the context of GISTDA's decision-making process in the UAV startup 2019 program and particularly scoped to the competition in the conceptual idea stage. Therefore, weights used for numeric analysis do not cover weights used in the decision-making process for the selection of technology startup companies to be funded, which is the final stage of this program.

6. Summary

In developing countries, the government typically supports funding technological SMEs or startup companies through government agencies. The funds from this source become an important capital for technological startup companies in the seed stage because the startup companies raise funds more easily from this source than others such as venture capitalists, angel investors, or banks. The government agencies do not expect high return on investment, but they expect the funded venture can survive and grow in the business world as well as generate incomes to drive the economy of the country. However, government agencies cannot sufficiently provide funding to all startup companies in the country because the number of startup companies is increasing, and budgets supported by the government are limited each year. Therefore, government agencies should improve their decision-making process to select appropriate startup companies for their investment more efficiently.

This paper has proposed 3 MCDM approaches, which are the weight sum method, SAW, and TOPSIS to find which one can solve the problem of the government agency's decision-making process and has results to resemble the committee's decision. From the experiment with GISTDA's data and criteria in the competition of the conceptual idea stage, all MCDM approaches could rank the participants as the same as the committee's rankings. However, when the weights of the experts were used in this experiment, the results of TOPSIS for the disaster tech group differed from the results of the other approaches and the committee's results because each criterion systematically weighted by the experts could check the consistency of weighting. In contrast, as the weight of each criterion of the agency originated in their experiences, the reliability of the weights could not be measured. Therefore, these weights of the government agency probably have vagueness and inaccuracy in decision results. To ensure the committee's decision is reliable, the results of the MCDM approach from the weights of experts will be the reference of committee's decision results to express the reliability and accuracy of their decision. In terms of application, TOPSIS is the most appropriate method for the problem of the government agency's decision-making process because of TOPSIS selects the best alternative that is the closest to the positive ideal solution and the farthest from the negative ideal solution. While SAW is typically used by starters for the rough calculation, it generally produces exaggerated results. Finally, this research has experimented with GISTDA's context and the approaches used in this research may produce different results from those in this paper in other contexts. Therefore, other MCDM approaches should be considered to apply to the context appropriately.

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