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Multi-Criteria Decision-Making in SMEs Venture Capital Allocation: Analytic Hierarchy Process and Double Auction Approach

Satria Abadi¹, Muhamad Hariz Muhamad Adnan^{1,2*}, Citrawati Jatiningrum³, Hafizul Fahri Hanafi^{1,2},
Nurul Akhmal Mohd Zulkefli⁴, Deshinta Arrova Dewi⁵

¹ Faculty of Computing and Meta-Technology, Universiti Pendidikan Sultan Idris, 35900, Tanjong Malim, Perak, Malaysia

² Digital Transformation Society, Faculty of Computing and Meta-Technology, Universiti Pendidikan Sultan Idris, 35900, Tanjong Malim, Perak, Malaysia

³ Department Information System, Institut Bakti Nusantra, Lampung, Indonesia

⁴ Computer Science Department, College of Arts and Applied Science, Dhofar University, Salalah, Sultanate of Oman

⁵ Faculty of Data Science and Information Technology, INTI International University, Nilai, Malaysia

ABSTRACT

Small and medium-sized enterprises (SMEs) make a significant contribution to the economy and can reduce the unemployment rate. To improve their success, SMEs often need outside support, such as venture capital or other sources of financing. For governments, private investors, and banks to provide financial support, it is important to identify relevant criteria to evaluate the future success of SMEs. To evaluate SMEs and allocate venture capital effectively, this study proposes a multi-criteria decision-making technique that combines the Analytic Hierarchy Process (AHP) and the double auction method. The double auction approach is used to match SMEs with investors based on their AHP scores and funding needs. The AHP is used to assess the importance of various factors that influence SME success. This study aims to support an effective and informed decision-making process for the distribution of venture capital to SMEs by bringing these two methods together to promote their growth and success.

Keywords:

Multi Criteria Decision Making;
Analytical Hierarchy Process, Double
Auction; Small and Medium Enterprises;
Small Enterprises

1. Introduction

Economic conditions are significantly impacted by the continued decline in employment prospects, especially for people living in poor areas. Many people are currently unemployed for a variety of reasons, including COVID-19. Indeed, the Covid outbreak had a significant impact on many people. Those who were negatively affected by the economic impact of the outbreak, such as the businesses that had to close and the employees they had to lay off because they could not pay their wages. The unemployment rate increased as a result of these layoffs [1]. Many of these people are able to find new jobs because of their solid education and skills, and others have even started their businesses. The new businesses are classified as SMEs or small and medium

* Corresponding author.

E-mail address: mhariz@meta.upsi.edu.my

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enterprises because of the way they operate. Many small and medium enterprises have emerged as a result of corporate layoffs, giving society a chance to survive the recession.

Small and medium-sized enterprises (SMEs) are critical to most economies, especially in emerging markets. They represent the vast majority of businesses worldwide and contribute significantly to the growth of the global economy and job creation. Around 90% of businesses and more than 50% of jobs worldwide are owned by them. In emerging economies, the contribution of formal SMEs to GDP could be as high as 40%. If informal SMEs are taken into account, their number is even higher. Our projections show that 600 million jobs will be needed by 2030 to support the growing global workforce, making SME development a top priority for many governments worldwide. Small and medium-sized enterprises (SMEs) account for 7 out of 10 jobs in emerging economies [2]. However, the second most frequently cited barrier to SME expansion in emerging and developing economies is access to credit [1,2].

Small and medium-sized enterprises (SMEs) have contributed to the financial stability of society and boosted a country's economy. SMEs can help people find jobs and foster innovation and creativity. This is because SMEs are able to quickly adapt to changing market conditions and develop creativity due to their comparatively high employment rate and low need for investment capital. These adaptations can boost competition in the current market [2,3]. Market competitiveness and competitive position will be very helpful to improve market performance and economic conditions. Analyzing the elements that affect the success of the business will help SMEs to make decisions that determine the success of their business while reducing the risk of failure [3,4].

Establishing effective links between SMEs and potential investors or funding sources is an approach that makes it easier for them to obtain funding. Double auction techniques can be used to create a marketplace where investors interested in providing money and SMEs looking for financing can come together and reach agreements based on their preferences and needs [5,6]. As proposed in this study, the combination of the Analytic Hierarchy Process (AHP) and Double Auction techniques can provide an effective and informed decision-making process for the distribution of venture capital to SMEs, promoting their expansion and success.

Numerous problems that hinder internal and external business operations often lead to business failure. To reduce the risk of failure, a measure of SME success is created that can be used by the government, banks, and large companies to improve business capital or CSR for small and medium-sized enterprises (SMEs) [4-6].

2. Related Work

In 2023, Pattaya *et al.*, conducted a study on the criteria for credit applications in Turkey. The results showed that among the 26 sub-criteria and the seven main criteria, operational profitability had the highest priority, followed by stability and intelligence with the sub-criteria for debt repayment methods, total revenue, and profitability stability. This study explains how statistical hypothesis testing can be conducted using the priority lists created by the AHP for each criterion. It also combines other expert opinions, including some criteria that have not yet been discovered in the relevant literature [7].

Alward and colleagues investigated how managers think about SMEs and AHP. He concluded that risk criteria take precedence, with probability receiving a weighting value of 52% and consequences receiving a value of 48%. The biggest risk for SMEs is an increase in bank fees, with an average value of 18.8%. However, with an average weighting, low profit or lack of profit was in last place [8,9]. The flexibility of AHP to handle many criteria and options is one of its primary

features. Decision-makers may use AHP to break down a complicated issue into smaller, more manageable components, which can then be reviewed and prioritized [10-13]. This method makes it easy to evaluate and contrast possibilities and choose the best one. AHP, for example, may be used in supplier selection to prioritize variables such as quality, cost, and delivery time and assess alternative providers depending on these criteria [14].

AHP also can include expert views and subjective assessments. AHP enables decision-makers to balance quantitative and qualitative factors based on their relative relevance. When dealing with complicated and ambiguous decision-making processes, such as technology appraisal or knowledge management, this technique is very beneficial [15]. AHP may assist decision-makers in making better informed and accurate choices by combining expert views and subjective assessments [16-19].

AHP also gives an organized approach to decision-making, which may aid in the reduction of bias and the improvement of decision quality. AHP consists of many phases, including describing the decision issue, specifying criteria and alternatives, doing pairwise comparisons, and computing priorities. This organized method helps guarantee that decision-makers analyze and assess all relevant aspects. Decision-makers may prevent typical biases and mistakes in decision-making by utilizing a systematic method, such as confirmation bias or anchoring bias [17]. Nonetheless, there are significant limits to AHP that decision-makers should be aware of. One of the method's key disadvantages is its complexity, which may make it difficult to use and comprehend for non-experts. AHP also requires careful evaluation of pairwise comparisons, which may be time-demanding and error-prone. Moreover, AHP outcomes might be sensitive to changes in the criteria or weighting system, which can influence the final choice. AHP is a popular decision-making tool that enables decision-makers to rank factors in order of priority. AHP is very helpful for dealing with complicated and multi-criteria decision-making difficulties since it breaks the choice down into smaller, more manageable components [18,19]. This method allows decision-makers to evaluate and contrast possibilities and choose the best choice.

AHP's capacity to combine both quantitative and qualitative criteria is one of its strengths. This method allows decision-makers to consider a broad variety of issues, including financial, technological, and social concerns. Decision-makers may make better informed and trustworthy judgments if they examine both objective and subjective factors [18].

AHP may also assist decision-makers in decreasing bias and improving decision quality. AHP pairwise comparisons force decision-makers to examine the relative relevance of several factors, which may assist lessen the influence of biases such as anchoring bias or confirmation bias. AHP's organized method may also assist decision-makers in avoiding frequent mistakes in decision-making, such as missing essential criteria or balancing them incorrectly [19].

Nonetheless, the use of AHP requires careful thought and attention to detail. Pairwise comparisons may be time-consuming and error-prone, and the findings can be affected by changes in the criteria or weighting system. Additionally, AHP necessitates decision-makers' experience and judgment, which might inject subjective biases into the decision-making process [17-19].

Notwithstanding these limitations, AHP is a helpful decision-making tool in a variety of sectors, including engineering, business, and management. AHP has been utilized in supplier selection, renewable energy technology appraisal, and knowledge management, to name a few applications. AHP has also been utilized in healthcare risk assessment and decision-making, such as assessing treatment alternatives for patients [19].

To summarize, the Analytic Hierarchy Process is a valuable decision-making tool that enables experts to rank criteria based on their relative relevance. AHP is a versatile and adaptable strategy that may be used in a variety of complicated decision-making processes. AHP offers a systematic

decision-making technique that includes expert views and subjective assessments. Nevertheless, there are significant drawbacks to AHP, such as complexity, sensitivity to changes in criteria or weighting, and possible inaccuracies in pairwise comparisons. Overall, AHP is a powerful decision-making tool when utilized effectively and with caution [17].

The AHP method for SMEs has been used in numerous studies, but what distinguishes this research from earlier studies is that it was carried out to look for criteria, and the most crucial criteria used to obtain business financing capital [20,21]. Additionally, in this study, researchers also integrated the methods AHP with the Double Auction technique, where the criteria built using AHP with a double auction can provide space for investors to invest in business capital. In order to do this, investors interested in providing money are matched with SMEs looking for funding based on the AHP method's assessment criteria and the financing requirements they have [22,23].

3. Methodology

3.1 Sampling

This study used qualitative and quantitative methods. It was conducted by distributing questionnaires to respondents in two phases. In addition, this study used purposive judgment sampling, in which respondents were selected as experts in their field based on criteria [9,10]. This is shown in Table 1.

Table 1
 Criteria of respondents

	Position	Years Of Service
1	Owners of SMEs	>= 5 years
2	Credit Analyst	>= 5 years
3	Entrepreneurship	>= 5 years

3.2 Data Processing

The research then proceeded and was conducted in three phases, as shown in Figure 1.

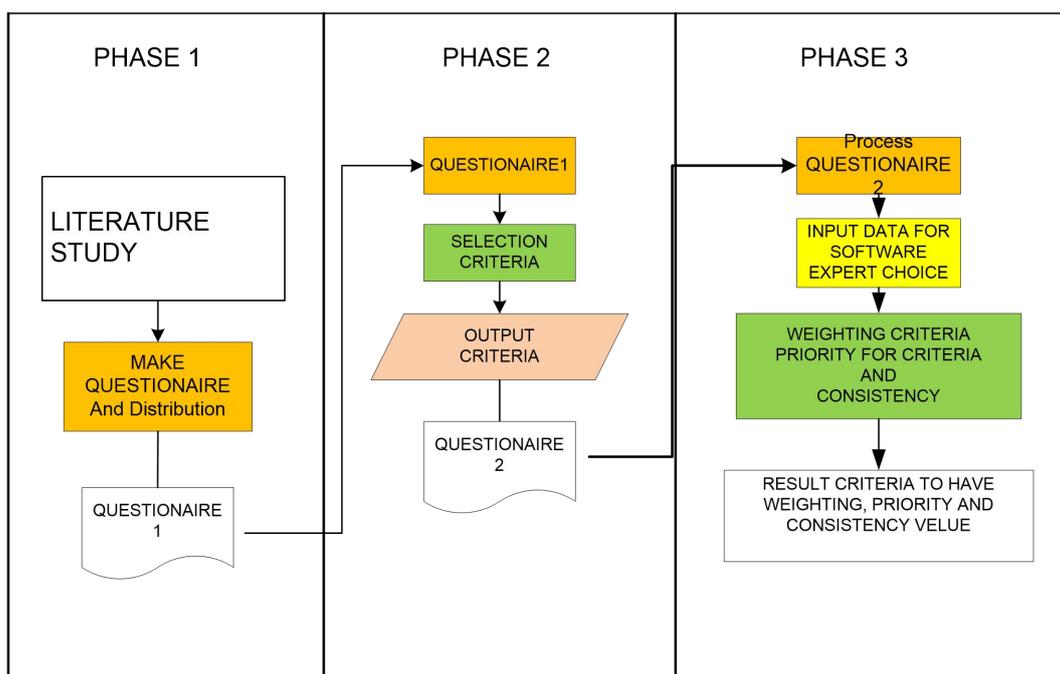


Fig. 1. Research design

This research was conducted in three stages, in the first stage, namely searching for literature to determine the criteria to be used as criteria for measuring SMEs that can receive assistance or business loans from the government or other vendors, after the criteria were obtained from the literature, a questionnaire was created. the first stage is to determine the criteria that are needed to be a measure of providing loans or business assistance by vendors, data processing from the first stage of the questionnaire uses the formula below [11]:

$$75\% X (\sum \text{Respondent X Maximum Score}) \tag{1}$$

The total number of respondents is multiplied by the maximum existing score, then multiplied by 75% then the score results obtained from the criteria, the criteria to be used are criteria whose score values are equivalent to the score results obtained [11,12].

After the criteria are obtained from the results of the data processing, then the second stage is entered, namely, the selected criteria will be made into a second-stage questionnaire with the paired linked scale method to see the most important criteria for each other to be used as a measure that can be an assessment criterion for awarding assistance for SMEs, at this stage the criteria that are processed from the results of the second questionnaire are measured using the Analytical Hierarchy Process (AHP) method using the formula below [10]:

$$R = [(1+R_1) (1+R_2) (1+R_3) \dots (1+R_n)]^{1/n} - 1 \tag{2}$$

Where:

$$R_1 \dots R_n = \text{result of respondent 1 for respondent n} \tag{3}$$

From AHP processing can be analyzed using Expert Choice software to determine the inconsistency value and weight of each of these criteria, then from the results of the weighting of these criteria it will be found that the greatest value of each criterion, the highest value or criterion weight will be the size of the assessment criteria is very important to determine the provision of business assistance funds by the vendor [10,11].

3.3 Criteria

Criteria from other references as the basis for measurement, including determining the recipient SME help, number of customers, total employees, experience, network business, business capital, income, production, culture business, promotion, location, influence external, structure organizations [20-23].

4. Double Auction Integration

In a market, buyers and sellers submit their bids and demands simultaneously, using a method known as a double auction [24-26]. This strategy allows eager buyers and sellers to be matched according to their preferred prices, facilitating the optimal allocation of resources. The double auction can be used in the context of SMEs and venture capital to link financing. It matches SMEs seeking financing with investors interested in contributing capital, depending on their AHP values

and desired financing parameters [27,28]. Figure 2 shows the double auction market for SMEs and investors.

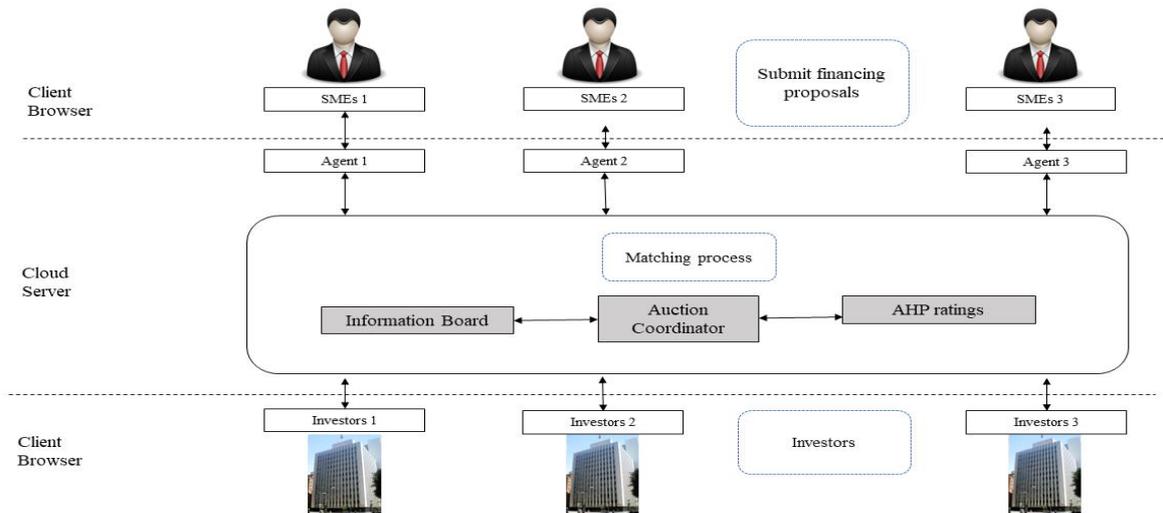


Fig. 2. Chart Criteria

4.1 Setting up the Double Auction Market

The following steps are proposed for a double auction market for SMEs and investors.

- a) Create a website platform: set up an online platform where investors can view SMEs' financing requests, including their AHP ratings and required investment amounts, and where SMEs can submit their financing requests.
- b) SMEs and investors register on the website by providing the required information, such as their contact details, a brief description of their business (if an SME), and their preferred investment strategies (for investors).
- c) Funding Proposal Submission: Small and medium-sized enterprises (SMEs) submit their financing proposals, highlighting their AHP rating, financing needs, and any other details that are important to potential investors.
- d) Investor Offers: After reviewing the submitted financing proposals, investors submit their offers, indicating the amount of money they are willing to invest and other relevant terms such as equity participation, interest rate, or repayment schedule.

4.2 Matching Process

The following criteria can be used to match buyers and sellers in a double auction market:

- a) Investors may give preference to SMEs with higher AHP ratings because these companies are perceived to have a higher chance of success.
- b) Amount of financing: The investor's offer and the SME's required amount of financing should be considered when determining a match.
- c) Investment terms: To ensure compatibility between the SME's needs and the investor's preferences, the platform should also consider the investment terms, such as the equity portion, interest rate, and repayment schedule.

- d) A time-sensitive financing need or the investor's preferences may lead the platform to prefer matching in certain circumstances.

4.3 Market Clearing and Allocation

After the matching process is completed, the platform closes the transactions. Investors receive their desired equity, debt, or other types of investment in the SMEs, and the SMEs receive their funding. By enabling the matching of investors and SMEs based on their preferences and requirements, the double auction technique ensures an efficient allocation of resources, promoting the expansion and success of SMEs.

5. Results

5.1 Result of Criteria for SMEs

From the questionnaire, 10 criteria were selected as shown in Table 2. Of the 12 criteria provided, 2 criteria were not selected: external influences, and organizational structure. This was because the value of the two criteria was less than 38 which was calculated according to formula 1. Therefore, the investigator calculated all the respondents' answers. The number of answers for each criterion must have a minimum overall score of 75% of the maximum total, which is $75\% \times 50$ (10 respondents \times Score 5) = 37.5 or ≈ 38 . This weighted value is a logical weighted value because this value can represent the choice of respondents.

Table 2

Obtained criteria

NO	Criteria
1	Number of Customer
2	Number of Employee
3	Experience
4	Network Business / Relationship
5	Business Capital
6	Income
7	Production
8	Culture Business
9	Promotion
10	Location

5.2 Weighting Criteria for SMEs

The results from questionnaire using the Analytical Hierarchy Process (AHP) using the average formula geometry are shown in Table 3.

Table 3

The weighting of Criteria for SMEs

No	Criteria	Weighting
1	Number of Customer	0.076
2	Number of Employee	0.068
3	Experience	0.115
4	Network Business / Relationship	0.090
5	Business Capital	0.110
6	Income	0.190
7	Production	0.103

8	Culture Business	0.101
9	Promotion	0.102
10	Location	0.041

From the table, the weightage is illustrated in Figure 3. Based on the figure, the income criterion has the outermost point, while the innermost point is the location.

Grafic Criteria for SMEs Receive Capital

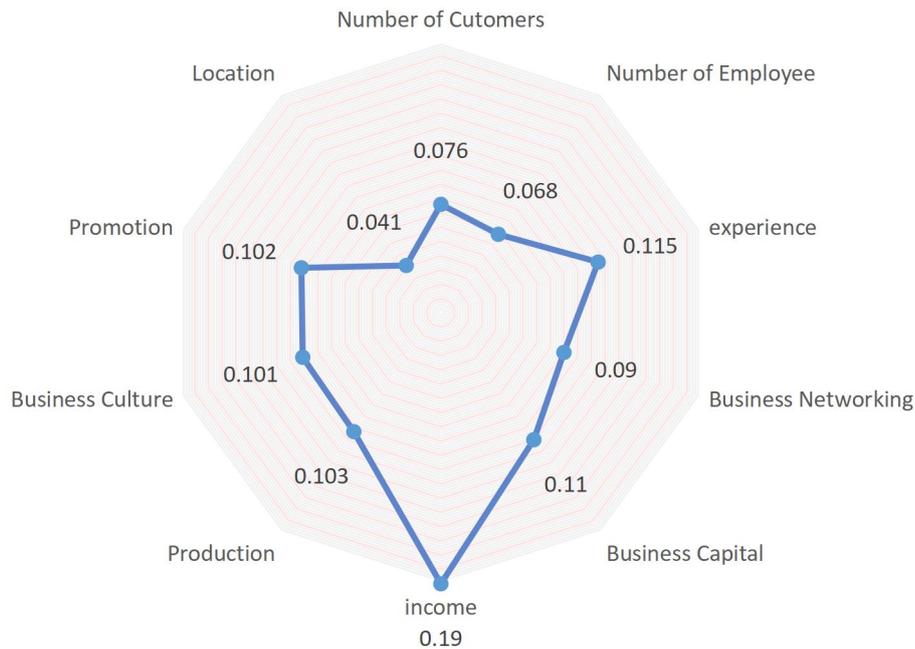


Fig. 3. Chart Criteria

5.3 Ranking of Criteria for SMEs

Data processing using the expert choice allowed for charting the ranking criteria of SMEs from the most important to the least important, as shown in Figure 4. The income criteria have the most important value, namely 0.190, while the experience criterion has a value of 0.115. For business capital criteria it has a value of 0.110, for production criteria, it has a value of 0.103, for promotion criteria it has a value of 0.102, and the business culture criteria have a value of 0.101. From the criteria shown, the value is not significantly different. However, for the income criterion, there is a very significant difference from the other criteria, this shows that the income criterion is the criterion with the highest weighting value. the income criterion is also the most important, and this criterion is because this criterion will become the focal point for donors to provide business capital or business loans for SMEs.

Model Name: OUTPUT MULTI CRITERIA

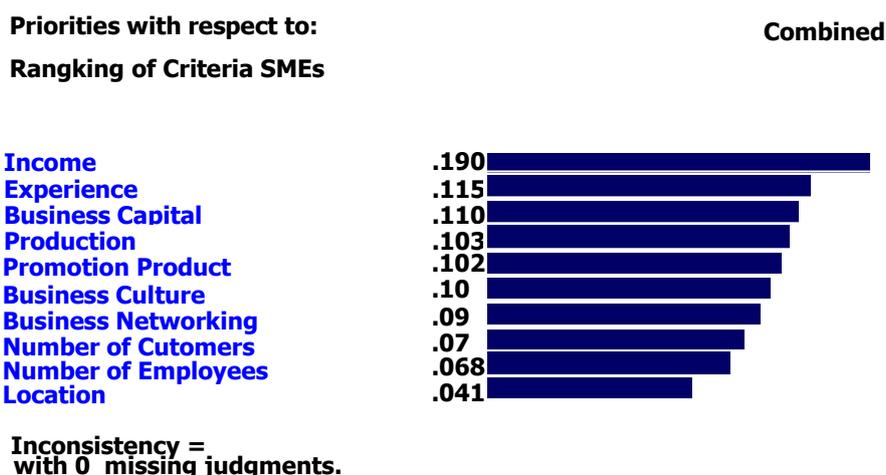


Fig. 4. Ranking of Criteria SMEs

6. Conclusion

The study highlights the importance of successfully allocating venture capital to SMEs by combining the Analytic Hierarchy Process (AHP) and the double auction process. Income is found to be the most important factor in this decision-making process, determining whether SMEs are eligible for grants or loans. Given the widespread use of technology, which allows companies to be accessible from anywhere, the location criterion is of the least importance. With this integrated strategy, stakeholders such as governments, for-profit companies, and banks can make more informed decisions when it comes to financial support for SMEs, thereby promoting their expansion and prosperity.

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References

- [1] Wordbank. (2019). Small and Medium Enterprises (SMEs) Finance. [Online]. Available: <https://www.worldbank.org/en/topic/smefinance>
- [2] Cueto, Lavinia Javier, April Faith Deleon Frisnedi, Reynaldo Baculio Collera, Kenneth Ian Talosig Batac, and Casper Boongaling Agaton. "Digital innovations in MSMEs during economic disruptions: experiences and challenges of young entrepreneurs." *Administrative Sciences* 12, no. 1 (2022): 8. <https://doi.org/10.3390/admsci12010008>
- [3] Masood, Tariq, and Paul Sonntag. "Industry 4.0: Adoption challenges and benefits for SMEs." *Computers in industry* 121 (2020): 103261. <https://doi.org/10.1016/j.compind.2020.103261>
- [4] Roy, Pranith K., and Krishnendu Shaw. "A credit scoring model for SMEs using AHP and TOPSIS." *International Journal of Finance & Economics* 28, no. 1 (2023): 372-391. <https://doi.org/10.1002/ijfe.2425>
- [5] Yulianingsih, Yulianingsih. "FAKTOR-FAKTOR YANG MEMPENGARUHI KEBERHASILAN UMKM MELALUI PENDEKATAN FAKTOR INTERNAL DAN FAKTOR EKSTERNAL DIKOTA BOGOR." *Jurnal Sosial Humaniora* 12, no. 1 (2021): 98-108.
- [6] Diansari, Rani Eka, and Rendy Rahmantio. "Faktor keberhasilan usaha pada UMKM industri sandang dan kulit di Kecamatan Wirobrajan Kota Yogyakarta." *Journal of Business and Information Systems (e-ISSN: 2685-2543)* 2, no. 1 (2020): 55-62. <https://doi.org/10.36067/jbis.v2i1.60>
- [7] Pekkaya, Mehmet, and Volkan Zilifli. "A Preliminary Study on Generating Criteria Priorities Series via AHP for Decision Process of Commercial Credit Applications in Turkey." *International Journal of Information Technology*

- & *Decision Making* 22, no. 06 (2023): 1843-1866. <https://doi.org/10.1142/S0219622022500894>
- [8] Alrawad, Mahmaod, Abdalwali Lutfi, Mohammed Amin Almaiah, Adi Alsyounf, Akif Lutfi Al-Khasawneh, Hussin Mostafa Arafa, Nazar Ali Ahmed, Ahmad M. AboAlkhair, and Magdy Tork. "Managers' perception and attitude toward financial risks associated with SMEs: Analytic hierarchy process approach." *Journal of Risk and Financial Management* 16, no. 2 (2023): 86. <https://doi.org/10.3390/jrfm16020086>
- [9] Ramdani, Boumediene, Siddhartha Raja, and Marina Kayumova. "Digital innovation in SMEs: a systematic review, synthesis and research agenda." *Information Technology for Development* 28, no. 1 (2022): 56-80. <https://doi.org/10.1080/02681102.2021.1893148>
- [10] Kusumadewi, Sri, Sri Hartati, Agus Harjoko, and Retantyo Wardoyo. "Fuzzy multi-attribute decision making (fuzzy madm)." *Yogyakarta: Graha Ilmu* 74 (2006).
- [11] Feridani, Elena. "Perancangan Metode Pembobotan Kriteria Pemilihan Pemasok Dengan Metode Analytic Hierarchy Process (AHP) dan Fuzzy AHP.(Studi Kasus Pemilihan Pemasok Jasa Pemeliharaan Fasilitas Off Shore di PT. X)." *Jakarta: Fakultas Teknik Industri Universitas Indonesia* (2005).
- [12] Abadi, Satria, Setyawan Widyarto, and Nur Syufizah Ahmad Shukor. "Customer and stakeholder perspective using analytical hierarchy process method for evaluation performance of higher education." *International Journal of Supply Chain Management* 8, no. 3 (2019): 1057-1064.
- [13] Sevinç, Ali, Şeyda Gür, and Tamer Eren. "Analysis of the difficulties of SMEs in industry 4.0 applications by analytical hierarchy process and analytical network process." *Processes* 6, no. 12 (2018): 264. <https://doi.org/10.3390/pr6120264>
- [14] Aulia, Rahmat, Azharsyah Ibrahim, and Ismail Rasyid Ridla Tarigan. "Operasionalisasi Lembaga Keuangan Baru Dan Dampaknya Terhadap Pertumbuhan Usaha Mikro." *JIHBIZ: Global Journal of Islamic Banking and Finance* 2, no. 1 (2020): 57-81. <https://doi.org/10.22373/jihbiz.v2i1.8579>
- [15] AlBar, Adnan Mustafa, and Md Rakibul Hoque. "Factors affecting the adoption of information and communication technology in small and medium enterprises: A perspective from rural Saudi Arabia." *Information Technology for Development* 25, no. 4 (2019): 715-738. <https://doi.org/10.1080/02681102.2017.1390437>
- [16] Cebi, Selcuk, Fatma Kutlu Gündoğdu, and Cengiz Kahraman. "Consideration of reciprocal judgments through Decomposed Fuzzy Analytical Hierarchy Process: A case study in the pharmaceutical industry." *Applied Soft Computing* 134 (2023): 110000. <https://doi.org/10.1016/j.asoc.2021.110000>
- [17] Issa, Usama, Fam Saeed, Yehia Miky, Muwaffaq Alqurashi, and Emad Osman. "Hybrid AHP-fuzzy TOPSIS approach for selecting deep excavation support system." *Buildings* 12, no. 3 (2022): 295. <https://doi.org/10.3390/buildings12030295>
- [18] Adnan, Muhamad Hariz Muhamad. "An Overview of Current Multi-Attribute Techniques in Double Auction Frameworks." *Turkish Journal of Computer and Mathematics Education (TURCOMAT)* 12, no. 3 (2021): 877-883. <https://doi.org/10.17762/turcomat.v12i3.798>
- [19] Mastura, Mastura, Mutia Sumarni, and Zulfa Eliza. "Peranan infomasi akuntansi terhadap keberhasilan UMKM di Kota Langsa." *J-EBIS (Jurnal Ekonomi dan Bisnis Islam)* (2019): 20-33. <https://doi.org/10.32505/v4i1.1248>
- [20] Bala, Hillol, and Xuan Feng. "Success of small and medium enterprises in Myanmar: Role of technological, organizational, and environmental factors." *Journal of Global Information Technology Management* 22, no. 2 (2019): 100-119. <https://doi.org/10.1080/1097198X.2019.1603511>
- [21] Musaad O, Almalki Sultan, Zhang Zhuo, Zafar Ali Siyal, Ghulam Muhammad Shaikh, Syed Ahsan Ali Shah, Yasir Ahmed Solangi, and Almalki Otaibi Musaad O. "An integrated multi-criteria decision support framework for the selection of suppliers in small and medium enterprises based on green innovation ability." *Processes* 8, no. 4 (2020): 418. <https://doi.org/10.3390/PR8040418>
- [22] Müller, Julian Marius, Oana Buliga, and Kai-Ingo Voigt. "Fortune favors the prepared: How SMEs approach business model innovations in Industry 4.0." *Technological forecasting and social change* 132 (2018): 2-17. <https://doi.org/10.1016/j.techfore.2017.12.019>
- [23] Enjolras, Manon, Mauricio Camargo, and Christophe Schmitt. "Evaluating innovation and export capabilities of SMEs: toward a multi-criteria decision-making methodology." *Journal of technology management & innovation* 15, no. 3 (2020): 17-32. <https://doi.org/10.4067/S0718-27242020000300017>
- [24] Grošelj, Petra, and Gregor Dolinar. "Group AHP framework based on geometric standard deviation and interval group pairwise comparisons." *Information Sciences* 626 (2023): 370-389. <https://doi.org/10.1016/j.ins.2023.01.034>
- [25] Adnan, M. H., M. F. Hassan, I. A. Aziz, O. Nurika, and M. S. Husain. "Modified ISR hyper-heuristic for tuning automatic genetic clustering chromosome size." In *IOP Conference Series: Materials Science and Engineering*, vol. 932, no. 1, p. 012065. IOP Publishing, 2020. <https://doi.org/10.1088/1757-899X/932/1/012065>
- [26] Adnan, Muhamad Hariz Muhamad, Mohd Fadzil Hassan, and Nurul Akhmal Mohd Zulkefli. "A framework of

- heterogeneous cloud service and multi attributes negotiation using double auction." *International Journal* 9, no. 3 (2020). <https://doi.org/10.30534/ijatcse/2020/220932020>
- [27] Roslan, Nur Widad, Normaliza Abd Rahim, Nur Maisarah Roslan, and Siti Nur Aliaa Roslan. "Students' presupposition towards incooperating AI (Artificial Intelligence) technology in virtual and face-to-face classes." *International Journal of Advanced Research in Future Ready Learning and Education* 27, no. 1 (2022): 16-19.
- [28] Abd Rahman, Haliza, Zarina Mohd Khalid, Noraslinda Mohamed Ismail, Nur Arina Bazilah Kamisan, Siti Mariam Norrulashikin, Siti Rohani Mohd Nor, Ani Shabri, and Muhammad Fauzee Hamdan. "Statistical analysis on students' evaluation and students' final exam marks in undergraduate mathematical courses at universiti teknologi malaysia." *International Journal of Advanced Research in Future Ready Learning and Education* 27, no. 1 (2022): 1-8.