Assessing the mechanism of barriers towards green finance and public spending in small and medium enterprises from developed countries

Chien, Fengsheng and Ngo, Quang-Thanh and Hsu, Ching-Chi and Chau, Ka Yin and Iram, Robina

22 June 2021

Assessing the mechanism of barriers towards green finance and public spending in small and medium enterprises from developed countries

Fengsheng Chien [1,2] · Quang-Thanh Ngo [3] · Ching-Chi Hsu [1] · Ka Yin Chau [4] · Robina Iram [5]

Abstract
Due to their different abilities to improve financial growth and improve social development, small and medium enterprises (SMEs) have been referred to as the economy's backbone. Small- and medium-sized enterprises are crucial for both high- and low-income nations' financial development. Customers grow more conscious of their purchase choices, preferences, and envi-ronmental consequences. The financial opportunities for SMEs in the United Arab Emirates to use green innovation methods to address potential obstacles for increasing green goods, processes, and management are examined in this paper; as a result, it is critical to reduce clean technology adoption constraints in small- and medium-sized businesses. To identify significant hurdles, sub-barriers, and ways to overcome impediments to green innovation in the United Arab Emirates, we apply an integrated decision process. Following a detailed literature analysis and the assistance of twelve experts, six primary obstacles, twenty-five sub-obstacles, and strategies to reduce the barriers were identified. Primary and sub-barriers were assessed using the FAHP. The (FTOPSIS) approach was used to rank the strategies. Five SMEs in the United Arab Emirates are putting the suggested integrated decision model to the test. "Financial investment levels 0.646 to 11 percent growth level," according to the FAHP, are the most significant hurdles to SMEs adopting green practices. This research demonstrated a considerable beneficial association between SMEs and financial development and funding in the United Arab Emirates. According to this study, using research methodologies to provide green innovation in SMEs is the best strategy to overcome green innovation and adoption hurdles in small and medium firms and increasing their economics.

Keywords SMEs · Barriers · Green innovation · Financial · FAHP · Financial development · United Arab Emirates

Introduction

Small- and medium-sized enterprises support entire towns and, in some cases, generations of families. Small and micro firms, on the other hand, frequently encounter economies of scale that huge enterprises do not. Large enterprises benefit from preferential treatment, volume discounts, and other advantages that come with their scale (Alemzero et al. 2020b) (Sun et al. 2020) (Alemzero et al. 2020a).

✉ Ching-Chi Hsu
chingchi@fzfu.edu.cn

✉ Robina Iram
Mosikhann@yahoo.com; robinamohsin22@yahoo.com

Fengsheng Chien
jianfengsheng@fzfu.edu.cn

Quang-Thanh Ngo
thanhnq@ueh.edu.vn

Ka Yin Chau
gavinchau@cityu.mo

[1] School of Finance and Accounting, Fuzhou University of International Studies and Trade, Fujian 350202, China

[2] Faculty of Business, City University of Macau, Macau, China

[3] School of Government, University of Economics Ho Chi Minh City, Ho Chi Minh City, Vietnam

[4] Faculty of International Tourism and Management, City University of Macau, Macau, China

[5] Jiangsu University, Zhenjiang, China

There are significant barriers to corporate expansion in most markets, except the most flexible and deregulated ones. The study suggests that attention has to be paid to the set of barriers to the growth of small- and medium-sized companies with great job creativity and innovative and new technology. On the other hand, SMEs play an even bigger role in optimizing the economic structure and social stability of developed and developing countries. They are, ironically, having more difficulty expanding and communicating their sustainability efforts to their stakeholders (Han & Trimi 2018).

The results also suggest that as SMEs become globalized, they add more to their domestic economy. SMEs face major obstacles in funding foreign activity, identifying opportunities, and establishing effective contacts in their target markets, so they must resolve the biggest obstacle. SMEs are, meanwhile, overlooked at the national and regional level for their contributes to environmental degradation (Sun et al. 2020). This is demonstrated in literature emphasis on the economic success of small and medium enterprises. Although some policymakers established policies intended to facilitate and encouraging small and medium enterprises' development, growth, and performance, many were intended to help SMEs expand through soft lending and other government subsidies, such as the reduction of poverty, job creation, social development, and social standards of living, in order to boost social and economic development (Chien et al. 2021c) (Chien et al. 2021e).

In terms of competitive terms, the SME market is thought to be inhabited by businesses with significant growth potential. SME productivity gains in developed countries can be achieved to a large degree simply by borrowing technology from the shelf, around the globe (Christopoulos and Tsionas 2004).

How does it contribute to green and inclusive growth for SMEs?

From this section, two takeovers emerge:

1. Material shows that SMEs contribute to inclusive growth through job creation, but literature on employment quality is both less rich and less positive. Evidence is also shown, however, that small- and medium-sized businesses can contribute to inclusive growth by adopting an inclusive business strategy.

2. Eco-innovation, eco-adoption, eco-enterprise, and green enterprise ("three kinds of green SMEs") can contribute to green growth. While the anecdote indicates that greening involves green practices for a large majority of small- and medium-sized enterprises, there is a paucity of data on the share of SMEs in each of the three categories and how this differs by group nation.

To learn how small businesses can encourage green and inclusive growth:

Firstly, if a successful SME industry is an engine for growth, what are its implications for the business performance of SMEs for eco-innovation, eco-enterprise, and eco-adoption?

Secondly, how much are the benefits and costs of greening the labor market being achieved by businesses? In other words, does greening have a good impact on the amount and quality of jobs?

Lastly, though the role of SMEs for inclusive growth in inclusive business models (not including jobs) is not well investigated, it is clear that SMEs have successfully merged green and inclusive business models.

This study is unique. There is a lack of research on the small- and medium-scale enterprises (SMEs) and financial development in the United Arab Emirates that is still understudied. To cover the gap in the literature, (i) the research is the first to identify and identify a number of hurdles to the implementation by the United Arab Emirates of green-based financial innovation and development of SMEs. (ii) This study also provides strategic answers to various hurdles. However, green innovation is quite important, but it is not so much investigated and investigated. In addition, the solution and challenges to the green financial innovation of the SME sector depend heavily on the region or country's context and on the development of the finances. Thus, a particular location or country needs to be worked out. For politicians and researchers, the framework of this research study can be fundamental and useful; their research on this subject can be expanded further.

In conclusion, we've identified six primary barriers and 25 sub-barriers and plan to lower hurdles through the FAHP process, which undoubtedly means that suppliers can improve their green financial innovation, small- and medium-sized enterprises, as well as their financial development implications.

Green finance

Green growth has drawn global attention as an emerging economic growth driver, capable of both environmental and economic development, even before the financial crisis worldwide. In this respect, green financing is used as key role for supporting green growth. Green finance generally is forward-looking, pursuing economic growth, protection for the environment, and the development of the financial industry. Green finance, in particular, is one of the "targeted fundings" because it focuses on green economic activities, for instance, export financing, small- and medium-sized business financing, and IT venture financing. Green finance can be divided into two: (1) funding for green growth and (2) funding for environmental cost prevention.

The previous includes, more specifically, indirect financing in the capital market, including green loans and direct finance

markets, such as the development of the green index and launch of the green fund.

Improving small and medium business access to green finance

Provision of credit to small- and medium-sized enterprises must satisfy both the supply side of the demand and the demand side of the supply. For the demand side, small firms should be prepared for bank loans by having better recordkeeping, making more transparent disclosures, and using stronger business plans. Small- and medium-sized enterprises should be more suitable for bank funding. In addition to checking references, alternative techniques of vetting loan applicants exist on the supply side (Chien et al. 2020). Larger banks may utilize external or internal agency credit rate criteria to help potential borrowers to determine if they are approved for loans. While it may be beneficial for a bank to have a close relationship with their customers, in order to have a safer and more up-to-date corporate database, smaller institutions should favor relationship banking. Smaller market trade policy and unofficial financing also play a role in mitigating the gap in knowledge and making it easier for small business owners to have access to capital (Tiep et al. 2021). Further dividing the study, it is made up of the following subdivisions. Literature review provides an overview of the literature assessment, as well as a discussion of environmentally sustainable innovation challenges in the United Arab Emirates. AHP-TOPSIS framework with fuzzy AHP discusses the study goal and the fundamental methodology applied in this research. Results and discussion explains the findings of the study, and Conclusion and policy implications draws some conclusions about those results

Literature review

According to the existing literature, SMEs are aware of and motivated by these potential cost savings. In terms of eco-innovators and entrepreneurs, according to a 2011 survey on EU entrepreneurs' attitudes toward eco-innovation, 52% of SMEs consider high energy prices to be a very important driver of eco-innovation, while 50% consider expected future increases in energy prices to be a very important driver. This driver's relative importance varies by industry. In the ICT sector, for example, input cost reduction is a key motivator, with SMEs offering innovative solutions to extend the life cycle of ICT equipment, save energy through cloud computing, and reduce e-waste disposal costs (OECD 2013). This conclusion is reflected by the eco-adopter class of SMEs in Europe, with 63% reporting resource efficiency as a cost-cutting measure. Furthermore, more than two-thirds of SMEs say they are happy with their return on resource efficiency investments (OECD 2018). Although similar survey data for SMEs in developing and emerging markets is scarce, a study on eco-innovation in Brazil highlights the "economic requirement for business continuity" as one of the drivers for eco-innovation. The major motivator, however, is the desire to protect Amazonian biodiversity, which is strongly relied on by enterprises in the region, and the long-term sustainability of the needed resources is necessary for long-term commercial sustainability (Aloise & Macke 2017). This shows that incentives for businesses to "become green" may vary by country.

Concerning the United Arab Emirates, twenty-four financial and economic barriers have been confirmed. In addition, they are classified into six groups, i.e., marketing barriers (MB), economical barriers (EB), technical barriers (TB), information barriers (IB), political barriers (PB), and management barriers (MAB). A number of available subgroups are shown in Table 1. Similarly, following extensive literature, Table 2 provides a list of ten strategic solutions to these financial and socioeconomic barriers.

A contribution of small- and medium-sized enterprises (SMEs) in financial development

The financing of SMEs will reach a substantial number of small enterprises, most of whom are unable to obtain financial services due to the lack of strong financial intermediaries in the retail industry. Finance sector is necessary for the development of the informal economy and aid in the absorption of money supply through saving, which is accessible for national development as investment capital (African Development Indicators 1997).

SMEs tend to be significantly more variable in growth and profit than large enterprises by their very nature. According to the OECD's 2006 SME Development Policy Brief, funding is required to aid SMEs in setting up and expanding their businesses, developing and investing in new goods and employees, or manufacturing facilities and developing new goods.

SMEs typically complain that the lack of access to funding and the high cost of loans hinder their growth and competitiveness. Recent developments in Latin America and East Asia are proof that SMEs are more likely to be rejected fresh loans in the course of a financial crisis than large companies (World Bank 2000). The significant role played by SMEs in economic development is increasingly recognized. In most nations interest in the role of small- and medium-sized businesses in the development process remains at the forefront of policy discussions (Chien et al. 2021a, 2021b, 2021d). Government attempts to encourage the growth of SMEs have been done at all levels (Feeney and Riding 1997). SMEs may develop, and they can be a countervailing force to countervail against the economic clout of larger firms, both for local and

Table 1 List of all selected barriers

Main barrier	Sub-barriers	Code	Reference
Economical barriers (E_B)	Scarce bank loans	(1)	(Cecere et al. 2018), (Mathiyazhagan et al. 2013)
	Least payoff	(2)	(Govindan et al. 2014), (Matus et al. 2012)
	Very short financial incentives	(3)	(Huang et al. 2020), (Li et al. 2021c), and (Li et al. 2021b)
	The high cost of the green system	(4)	(Hillary 2004)
	Hazardous wastes cost	(5)	(Govindan et al. 2014), (Mathiyazhagan et al. 2013)
Marketing barriers (M_B)	Market out of reach	(1)	(Gupta and Barua 2018a)
	Customers low responsiveness	(2)	(Ashford 1993), (Dhull and Narwal 2016), (Silva et al. 2008)
	Trust issues	(3)	(Govindan et al. 2014), (Mathiyazhagan et al. 2013), (Walker et al. 2008), (Revell and Rutherfoord 2003)
Political barriers (P_B)	Unclear green policies	(1)	(Zhu et al. 2012b), (Runhaar et al. 2008), (Brammer et al. 2012)
	No policy for green technology	(2)	(Blok et al. 2015)
	No policy implementation	(3)	(Zhu et al. 2012b), (Zhu et al. 2012a), (Blok et al. 2015),(Xiong et al. 2021)
	No counseling programs	(4)	(Ashford 1993), (Urban and Naidoo 2012)
Information barriers (I_B)	No information about green products	(1)	(Dhull and Narwal 2016), (Mudgal et al. 2010), (Chen et al. 2006), (Li et al. 2021d)
	Less familiarity with green innovation	(2)	(Runhaar et al. 2008), (Mudgal et al. 2010), (Yuan et al. 2021), (Mangla et al. 2017), (Longoni et al. 2014), (Simpson et al. 2004), (Horbach et al. 2012)
	Less technological information	(3)	(Mangla et al. 2017), (Woolman and Veshagh 2006), (Li et al. 2021a)
	Rare green innovation opportunities	(4)	(Govindan et al. 2014), (Runhaar et al. 2008), (Lv et al. 2021)
Technical barriers (T_B)	Market uncertainty	(1)	(Jinzhou 2011), (Rao and Holt 2005)
	Minimum R&D	(2)	(Lai et al. 2003),
	Complex designing process	(3)	(Perron 2005), (Lin et al. 2020), (Russel 2017)
	Least technologies	(4)	(Del Río et al. 2010)
Management barriers (MA_B)	Short of staff	(1)	(Lin and Ho 2008), (Collins et al. 2007)
	Scarce commitment	(2)	, (Ashford 1993), (Zhu et al. 2012b), (Zhu et al. 2012a),
	Reluctant green practices	(3)	(Ashford 1993), (Zhu et al. 2012a), (Jones et al. 2011), (Lin and Ho 2008)
	No reward systems	(4)	(Madrid-Guijarro et al. 2009), (Zhu et al. 2012b)

international decentralization. More generally speeding up the existing broad economic and socioeconomic goals, including poverty alleviation, as observed in SME development (Cook and Nixson 2000). The OECD research says that SMEs make up roughly 25% of exports from the OECD and 35% of exports from Asia (OECD 1997).

Framework of study

The suggested approach for evaluating waste treatment options has two stages: (1) AHP calculations to determine criterion weights and (2) IVF TOPSIS assessment of alternatives, with the best findings given as an interval rather than a precise perfect solution. To calculate the criterion weights, pairwise comparison matrices are created. The final pairwise comparison matrix may be identified by computing the geometric mean of the values acquired from each assessment. In the second step, the IVF TOPSIS approach may determine the ranking of waste management solutions using the calculated weighting variables (Organization WH 2015). Starting with a hypothesis as to which range would be able to capture the variations represented by the interval might cause problems in determining a precise solution that is closer to the ideal answer. Figure 3 shows a schematic illustration of the suggested approach. When all forms of uncertainty have been adequately considered, iteration may be stopped.

The AHP is a fundamental decision-making strategy, according to Saaty and Vargas (2001). The decision-maker performs basic pairwise comparisons as part of this process, which are subsequently utilized to generate overarching priorities for ranking the choices. The AHP allows for judgment inconsistency and gives a way to increase consistency (Saaty and Vargas 2001).

Table 2 List of strategies

No.	Approaches	Reference
1	Designing research efforts to help SMEs apply green innovation	(Dangelico 2016), (Horbach et al. 2012), (Dangelico 2016)
2	Coordination of awareness-raising and training initiatives in public institutions for green innovation projects in SMEs	(Solazzo et al. 2016), (Mathiyazhagan et al. 2014)
	Environmental management systems are being developed to track SME systems	(Zhu et al. 2012b), (Zhu et al. 2012a), (Somsuk and Laosirihongthong 2017), (Lee et al. 2014), (Johnstone and Hascic 2008)
2	Establishment of a green logistics facility for small- and medium-sized businesses	(Somsuk and Laosirihongthong 2017), (Jabbour et al. 2015), (Kannan et al. 2014), (Zhu et al. 2012a)
5	To reduce environmental degradation, develop successful government green programs	(Govindan et al. 2016), (Kiss et al. 2013), (Arundel and Kemp 2009)
6	Increase the number of green goods research projects	(Govindan et al. 2014), (Govindan et al. 2016),
7	Entrepreneurial education on environment and green systems for SMEs	(Gupta and Barua 2017), (Mathiyazhagan et al. 2014)
8	Preparing human resources for green environmental performance	(Gupta and Barua 2018b), (De Medeiros et al. 2014), (Bliesner et al. 2014), (Hanim Mohamad Zailani et al. 2012), (Corral 2003)
9	Small- and medium-sized businesses (SMEs) should be given government subsidies and incentives to create green goods	
10	All players must be associated with environmental protection and procuring programs	(Somsuk and Laosirihongthong 2017), (Lee et al. 2014), (Eltayeb et al. 2011), (Awasthi et al. 2010), (Zhu et al. 2012a)

The AHP is created using the processes outlined below (Saaty, 1980):

1. Define the issue and establish the goal.
2. For each of the lower levels, use basic pair-wise comparison matrices.
3. Perform a consistency check.
4. Estimate the relative weights of each level's components.

The decision hierarchies may be structured based on a set of criteria stated in the right half. The chosen objectives are at the top of an AHP analysis, followed by certain long-term criteria. Environmental, economic, social, and technological objectives are among the priorities. The breakdown criteria enlarged from these sustainable requirements make up the third level. The relative relevance of the criteria is assessed using Saaty's (1980) nine-point scale (Table 2).

Furthermore, by breaking an issue down logically from the huge to the smaller and smaller, one may relate the little to the huge using basic paired comparison judgments. AHP has been used in a variety of decision-making scenarios. The following are the various stages of AHP:

1. Define the issue and set a goal for it.
2. Create a hierarchy starting at the top (objectives) and working down to the lowest level (criteria) (alternatives).

To discover the best human resource manager for an Indonesian telecoms company, Kusumawardani and Agintiara (2015) employed type 1 fuzzy AHP-TOPSIS. They quantified utilizing triangular fuzzy numbers and utilized a geometric mean algorithm to compute the weights of criterion.

AHP-TOPSIS was merged in some studies with other extended fuzzy sets, like interval 2 fuzzy sets, PFS, intuitionist interval sets, hesitant fuzzy sets, and neutrosophic sets. AHP-TOPSIS was merged by Dogan et al. (2019) with a prevailing intuitionist fluid in which to select a suitable corridor for independent cars from 5 possibilities. Fifteen criteria were used in the decision-making issue. The computed weight was based on Pythagorean fuzzy AHP, and the final ranking was estimated in the decision-making by using Pythagorean fuzzy TOPSIS. In the AHP-TOPSIS type 2 fuzzy sets, Mathew et al. (2020) selected four options based on four criteria for the optimum maintenance approach.

The fuzzy strategies employed in the literature, notably in the previous 5 years, are shown in the pie chart in Fig. 3. Type 1 fuzzy sets were utilized in 53 percent of the thirty-two studies analyzed, whereas internal valued type 2 fuzzy sets were employed in 16 percent.

MCDM approaches aim to achieve a delicate equilibrium between conflicting criteria or to outrank conflicting criteria. On the basis of these two main categories, aggregation techniques, and outranking approaches, many approaches have been presented. In this paper, we look at aggregation strategies that try to identify a middle ground between opposing requirements. As a result, any MCDM strategy that ignores any of these will do a disservice to the achievement of the overall goal.

AHP-TOPSIS framework with fuzzy AHP

Using Fuzzy AHP and TOPSIS, the total vulnerability index of nodes in the water distributor network may be assessed and ranked. TOPSIS assumes that the best answer has the least

Euclidian distance from the optimal positive solution and the longest Euclidian distance from the ideal negative solution. One of the most significant features of TOPSIS is that it allows trade-offs across criterion so that all criteria share the optimum solution where one criterion's deficit is offset by one's own strength. TOPSIS, on the other hand, has certain drawbacks in that it needs clearly defined criterion weights that are not taken into consideration in the technique. The incorporation of AHP into TOPSIS has been offered as a solution to this issue. This is a partial answer since AHP is subjective on its own since it needs experts to rate the criteria in order of priority (important) and might be prejudiced. This difficulty is solved in this work by using fuzzy AHP, which aids decision-making in the face of competing interests and uncertainty. It also considerably minimizes subjectivity and prejudice. The decision-makers' subjective nature cannot be totally eradicated. However, fuzzy AHP assures that it has no effect on the optimum solution. The combination of fuzzy AHP and TOPSIS assures that each criterion contributes its quota, as well as reducing the decision marker's bias and subjectivity.

Figure 1 interprets the framework of the study.

Various competing criteria and many options must be considered in a variety of real-world strategic choices and difficulties. In general, MCDM techniques incorporate both quantitative and qualitative elements, allowing decision-makers to employ the criteria that influence the selection. As a solution to choice and prioritizing difficulties, a variety of strategies with varying theoretical backgrounds have been presented. According to Mardani et al., the various forms of MCDM techniques in use have witnessed tremendous development in transportation decision-making.

The VIKOR technique, like the TOPSIS technique, is widely used to assess the automobile sector. In order to analyze the service performance of electric car sharing schemes, Xu et al. performed a study. The VIKOR method is taken into account throughout the study's analysis. Similarly, this strategy was utilized to find an alternative material for electric vehicle instrument panels. In the aforementioned research, conventional fuzzy sets or crisp numbers/intervals were utilized.

Fig. 1 The framework of the study

The complexity of everyday concerns in real-life circumstances causes uncertainty and ambiguity in multi-criteria decision-making challenges. With extremely confusing information, the many criterion assessment challenge of assessing dangers associated in self-driving cars has become a difficult challenge.

Each strategy has its own set of limits and drawbacks that policymakers should consider. Alternative rankings may be presented via a variety of MCDM approaches. As a result, for real-world situations, a single methodology may no longer provide the optimum answer. A hybrid model has the potential to significantly increase the impact and dependability of solutions obtained by single models. Hybrid techniques allow you to improve the inadequacies of single models by combining many techniques, each with its own set of strengths and shortcomings. This study presents a unique hybrid model built upon AHP, an ideal solution-similarity order preferred technique for Vlse Kriterijumska Optimizatija I Kompromisno Resenje (TOPSIS) and (VIKOR). The innovative aspect of these techniques is the use of Pythagorean fuzzy sets to better handle the uncertainties associated with real-world situations and get more accurate answers for prioritizing dangers related with self-driving cars.

Gray relational analysis and a fuzzy methodology were used by Xue et al. to prioritize maritime traffic safety impacting elements of autonomous ship navigation.

According to the literature analysis, no research on the prioritizing of hazards associated with autonomous cars has been published. This MCDM issue is a real-world strategic decision dilemma with its own set of assessment criteria and dangers. As a result, another contribution may be the identification of AVs' hazards and particular criteria.

Fuzzy AHP method

The fuzzy analytical hierarchy (AHP) process has proven to be extremely beneficial in many different decision-making criteria in fuzzy scenarios in recent years. The vast volumes of data use a crisp point estimation method for the fuzzy AHP priority derivation such as extension analyzing and nonlinear fuzzy preference programming (FPP). Fuzzy AHP was created to better manage such ambiguous and subjective input data than traditional MCDM algorithms. The fuzzy set theory is used by Fuzzy AHP to assist researchers and decision-makers to convert ambiguous and vague language input information from experts, such as the phrase "a lot more important," into specific decision intervals that are much easier to deal with by decision-makers. This is a vital feature to analyze adequately as project selection becomes increasingly global. This novel study analysis contains the following paths:

Let a matrix be $H = (\ h_{ek}\ )_{n \times m}$. Let a fuzzy number be $F_{ek} = (a_{ek}, b_{ek}, c_{ek})$:

I. Using fuzzy numbers, formulate paired matrices.
II. Use Eq. (1), (2), (3), and (4) to acquire the results of fuzzy synthetic degree value (SEV_e):

$$SEV_e = \sum_{k=1}^{m} F_{ek} \otimes \left[\sum_{e=1}^{n} \sum_{k=1}^{m} F_{ek} \right]^{-1} \tag{1}$$

$$\text{s.t} \sum_{k=1}^{m} F_{ek} = \left(\sum_{k=1}^{m} a_{ek}, \quad \sum_{k=1}^{m} b_{ek}, \quad \sum_{k=1}^{m} c_{ek} \right) \text{for } e = 1, 2, 3, 4, 5, \ldots, n \tag{2}$$

$$\sum_{e=1}^{n} \sum_{k=1}^{m} F_{ek} = \left(\sum_{e=1}^{n} \sum_{k=1}^{m} a_{ek}, \quad \sum_{e=1}^{n} \sum_{k=1}^{m} b_{ek}, \quad \sum_{e=1}^{n} \sum_{k=1}^{m} c_{ek} \right) \tag{3}$$

$$\left[\sum_{e=1}^{n} \sum_{k=1}^{m} F_{ek} \right]^{-1} = \left(\frac{1}{\sum_{e=1}^{n} \sum_{k=1}^{m} c_{ek}}, \quad \frac{1}{\sum_{e=1}^{n} \sum_{k=1}^{m} b_{ek}}, \quad \frac{1}{\sum_{e=1}^{n} \sum_{k=1}^{m} a_{ek}} \right) \tag{4}$$

III. Use Eq. (5) to obtain a degree of possibility $SEV_k = (a_k, b_k, c_k) \geq SEV_e = (a_e, b_e, c_e)$:

$$V\ (SEV_k \geq SEV_e) = (SEV_e \cap SEV_k) = c_{s_k}\ (d) = \begin{cases} 1, \text{if } b_k \geq b_e \\ 0, \text{if } a_e \geq c_k \\ \dfrac{a_e - c_k}{(b_k - c_k) - (b_e - a_e)}, \text{otherwise} \end{cases} \tag{5}$$

where (d) is the intersection between c_{s_k} and c_{s_e} and $(SEV_e \geq SEV_k)$ and $(SEV_k \geq SEV_e)$ values are compared with SEV_e and SEV_k.

IV. Obtain minimum possibility degree $d(e)$ of $(SEV_k \geq SEV_e)$:
where $ek = 1, 2, 3, 4, 5, \ldots, k$.

$$\begin{gathered} (SEV \geq SEV_1, SEV_2, \ldots, SEV_k), \\ \text{for } e = 1, 2, 3, 4, 5, \ldots, k \\ = [(SEV \geq SEV_1) \text{ and } (SEV \geq SEV_2) \text{ and} (SEV \geq SEV_k)] = \min\ (SEV \geq SEV_e) \\ \text{for } e = 1, 2, 3, 4, 5, \ldots, k \end{gathered} \tag{6}$$

Let:

$$d^{'}\ (B_e) = \min\ (SEV_k \geq SEV_e), \text{for } e = 1, 2, 3, 4, 5, \ldots, k$$

Then the weight vector is:

$$W^{'} = \left(d^{'}(H_1), d^{'}(H_2), d^{'}(H_3), \ldots,\ d^{'}(H_n) \right)^T \tag{7}$$

where H_1 ($e = 1, 2, 3, 4, 5, \ldots, n$) signifies n elements:

V. Vector is standardized as follows:

$$W = \left(d(H_1), d(H_2), d^{'}(H_3), \ldots,\ d(H_n) \right)^T \tag{8}$$

where W is a non-fuzzy weight.

FTOPSIS approach

These two methodologyologies (the fuzzy analytical hierarchy process (FAHP) and fuzzy technique for ordering preference by similarity to ideal solution (FTOPSIS)) are applied in this work to present a two-phase model. With the FAHP approach, the FAHP criteria weights are estimated, while with the FTOPSIS approach, the rankings are produced. A thoroughly developed model, containing a wide range of performance measures, both theoretical and practical in nature, is assessed by FAHP techniques to calculate the weight of the criterion.

The TOPSIS approach was firstly developed in 1981 (90) by Hwang and Yoon. The TOPSIS approach is built on the basis of a common notion or relationship that could be beneficial or harmful in order to arrive at a satisfactory solution. A more advanced kind of TOPSIS (fuzzy-based TOPSIS) is utilized in this experiment, and TOPSIS iterations and outcomes are proven to be more trustworthy and consistent with this method. With the set theory of Fuzzy, we can try to get all the undefined and uncomplete information that is available in the fuzzy environment (91). While other methods for ranking and evaluating linguistic factors are far more difficult, this strategy is more beneficial. The triangular fuzzy numbers (TFNs) were employed in this research to determine the possibilities available for each criterion.

The following measures display TFN-based linguistic variables shown in Table 3:

Step I. Let A=(a 1,a 2,a 3) and B=(b 1,b 2,b 3) be the 2 fuzzy numbers; then the mathematical connection is:

$$\widetilde{A} + \widetilde{B} = (a_1, a_2, a_3) + (b_1, b_2, b_3) = (a_1 + b_1, a_2 + b_2, a_3 + b_3) \tag{9}$$

$$\widetilde{A} \times \widetilde{B} = (a_1, a_2, a_3) \times (b_1, b_2, b_3) = (a_1 b_1, a_2 b_2, a_3 b_3) \quad (10)$$

Step II. Let $\widetilde{A}_e = (a_{e1}, a_{e2}, a_{e3})$ be a T.F.Ns for $e \in I$. The standardized fuzzy sum of each $\widetilde{A}_e$ is then displayed as:

$$\widetilde{R} = [r_{ek}]_{m \times n} \quad (11)$$

where $e = 1, 2, 3, \ldots, m$ and $k = 1, 2, 3, \ldots, n$

Advantage considerations: The fuzzy standardization methodology is considered as a proactive objective function, i.e.,

$$r_{ek} = \left(\frac{a_{1ek}}{a^*_{3k}}, \frac{a_{2ek}}{a^*_{3k}}, \frac{a_{3ek}}{a^*_{3k}} \right) \quad (12)$$

where $a^*_{3k} = \max a_{3ek}$, is it a benefit type criterion?

As the negative optimal solution (i.e., costs criteria), the fuzzy normalization method is adopted:

$$r_{ek} = \left(\frac{a^-_{1k}}{a_{3ek}}, \frac{a^-_{1k}}{a_{2ek}}, \frac{a^-_{1k}}{a_{1ek}} \right) \quad (13)$$

$a^-_{1k} = men\ a_{1ek}$ Is cost type measures.

Step III. The fuzzy measured normalized based on the decision hypothesis.

$$\widetilde{V} = [v_{ek}]_{m \times n} \quad (14)$$

$e = 1, 2, 3, \ldots, m$ and $k = 1, 2, 3, \ldots, n$

Here, $v_{ek} = r_{ek} \times w_k$.

Step IV. Calculate the difference between the fuzzy ideal (d^+_e) and fuzzy negative ($d^-_e The$) ideal solutions:

$$d^*_e = \left(v^*_1, v^*_2, v^*_3, \ldots, v^*_n \right) \quad (15)$$

where $V^*_k = (1, 1, 1)\ k = 1, 2, 3, \ldots, n.$

$$d^-_e = \left(v^-_1, v^-_2, v^-_3, \ldots, v^-_n \right) \quad (16)$$

where $V^-_k = (0, 0, 0)\ k = 1, 2, 3, \ldots, n.$

Table 3 TFN-based linguistic variables

No.	Responsive linguistics	TFNs
1	Too low (TL)	(1,2,3)
2	Low (L)	(2,3,4)
3	Moderate low (ML)	(3,4,5)
4	Moderate (M)	(4,5,6)
5	Standard (S)	(5,6,7)
6	Moderate standard (MS)	(6,7,8)
7	Better (B)	(7,8,9)

Here, the distance between $\widetilde{A} = (a_1, a_2, a_3)$ and $\widetilde{B} = (a_1, a_2, a_3)$ is presented as:

$$d\left(\widetilde{A}, \widetilde{B}\right) = \sqrt{\frac{1}{3}\left[(a_1 - b_1)^2 + (a_2 - b_2)^2 + (a_3 - b_3)^2\right]} \quad (17)$$

Step V. Develop the closeness constant (CC_e) of each alternate:

$$CC_e = \frac{d^-_e}{d^*_e + d^-_e} \quad (18)$$

Step VI. Calculate the appropriate equivalents and select them. It will provide equivalent ratings of the best and worst ways to use the FTOPSIS process phases.

Data

Secondary data was collected from publications and the World Bank. The evaluation of the SME sector's performance regarding financing is the first element of the report, using the MCDM methods including (FAHP) and (FTOPSIS) techniques to examine the data. The findings are divided into sections as shown below.

Results and discussion

The idea of CE was established by Pearce and Turner (1989) in the literature to explain economic and environmental issues. Industrial ecology promotes resource conservation, waste reduction, and the use of environmentally friendly technology (Andersen 1997, 1999).

Because of the depletion of natural resources and the relevance of social concerns, sustainability has become a need in business policies and plans (Luthra and Mangla 2018). Stakeholders are pressuring businesses to combine supply chain strategies with sustainability concepts in order to improve environmental, social, and economic performance by allowing material management and information to interact (Luthra et al., 2018).

The triple bottom line approach is reflected in the content of SSCM, which includes environmental, social, and economic advantages (Carter and Rogers 2008). It tries to reduce resource use and negative environmental impacts, as well as trash generation (Sarkis et al. 2011).

From there, this research focuses on a challenge in the CE, namely the site selection challenge for e-waste collection centers in long-term supply chains. The goal of this research is to use the relationship between CE and sustainability to tackle the challenge of selecting a sustainable site for a collection

center. As a result, criteria based on the triple bottom line method are included in the criterion list.

Fuzzy AHP and Fuzzy TOPSIS were utilized in the study to evaluate hurdles to sustainable practice services in SMEs using a hybrid analysis approach. Various techniques for overcoming the challenges to SME ecologically responsible financial and business activities sustainable design have been offered in this study. The United Arab Emirates is doing a similar initiative in which green business activities are introduced to SMEs. The United Arab Emirates possesses oil reserves of roughly 266.4 billion barrels, which account for around 22% of worldwide funds. The GDP of the United Arab Emirates is around US$795.58 billion, and the country's economy is mostly based on oil and natural gas production.

It generated 617,500 jobs, or 10.4% of total employment, including indirectly supported jobs, and 317,500 jobs, or 5.4 percent of total employment, directly.

In the coming decades, it is probable that the importance of tourism for the economy of the UAE would rise more. The investment in the tourist sector in the next 10 years will increase annually to AED 74.5 billion ($ 20,3 billion) of travel and tourism in 2027, which represents 11.2 percent of the nation's overall investment. The cost of recreational expenses is expected to climb by 4.8 percent per year in 2027 to 191.5 billion AED (52 billion dollars), while business expenses to AED 49.2 billion (13.4 billion dollars) would likely increase annually by 4 percent Tourism and Economy 2017). Dubai plans to attract 20 million international tourists on its own by 2020 (UAE Government).

Fuzzy AHP results

The main barrier results have been discovered by the fuzzy AHP program illustrated in Fig. 2. Expert evaluation and research have identified six main barriers to green product creation. The absence of technical skills has a negative effect on the green innovation initiatives of the firm. The company or organization, which has extensive R&D, funding, and long-term development, has revolutionary green goods. The long-term viability of any SME hinges on its opportunity to access the environment. Technological scarcity and a dynamic green technology market are types of economic obstacles (Pinget et al. 2015). Long-term economic, environmental, and social feasibility are all factors in environmental research and development according to Fig. 2. We analyze income, R&D, environmental harm, the market for green technology for SMEs, and well-being.

This research examines the challenge of selecting a collecting location in a sustainable supply chain. Assembling is the initial step in the reverse production and logistics systems offers several benefits in terms of economics, social issues, and the environment. Figure 2 states the priority weights given to the selected barriers. The conclusions of this study are expanded upon with management ramifications, which are backed up by previous research. The deployment of smart cars has the potential to reduce transportation costs, which has been identified as the most significant factor for a long-term collection center site solution.

Furthermore, autonomous vehicles allow businesses to save money on labor, optimize time, and offer safe transportation for e-waste collection. This aligns with Hasan et al.'s (2020) findings, which found that autonomous automobiles address environmental problems via creative and safe transportation. Additionally, by using big data management, collecting expenses may be reduced. Smart planning allows for long-term solutions by lowering e-waste collection expenses. This aligns with the views of Babar and Arif (2017), who advocated for smart planning using big data management to account for budgetary constraints.

The lowest land cost, investment cost, and personnel cost are the primary reasons why this is the greatest option among all. Because it has the greatest link to a city, Gaziemir is the second-best option. Furthermore, Gaziemir's personnel has the greatest level of education and qualification of any of the options.

Finally, as compared to other options, Gaziemir provides tax benefits since the industrial free zone has reduced tax rates. In the decision-making process, transportation costs and distances, as well as collection costs, are more important than tax rates.

The following consequences may be generated for policymakers' viewpoints.

Extended producer responsibility-related regulations should be enforced by governments to reduce the quantity of electronic waste. Organizations have complete or partial responsibility for end-of-life items under this law. Government incentives may also be granted to electronics manufacturer groups in order to enhance product design based on EPR concerns.

Governments and local governments should adopt a set of guidelines to aid in the collecting of e-waste. This is consistent with Kumar et al.'s (2020) findings, which say that

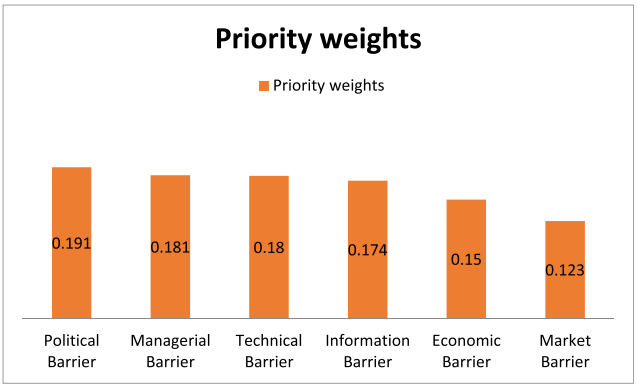

Fig. 2 Ranking of barriers

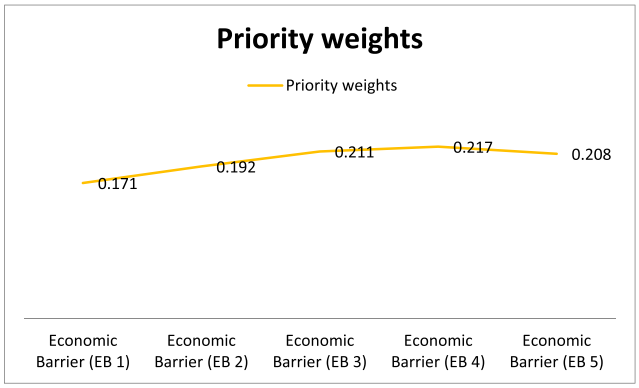

Fig. 3 Economic barriers (EB)

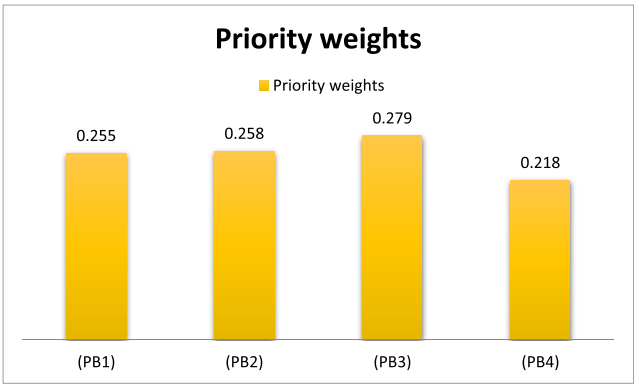

Fig. 5 Political barriers (PB)

policymakers should design laws based on long-term concerns.

The placement of collecting centers may also be regulated by policymakers. The suggested framework may be used to evaluate the performance of current collection centers as well as to open new collection centers.

Fuzzy AHP sub-barrier results

Environmental research funding (R&D) is used to determine long-term economic, environmental, and social feasibility. We examine income, research and development, ecological impact, market insufficiency, and welfare when evaluating green products. MB1, with a weight of 0.212, and lack of knowledge and comprehension (MB3), with a weight of 0.390, were recognized as important sub-barriers from the MB perspective (as shown in Fig. 4).

This reveals a significant restriction to green innovation in the United Arab Emirates because of a government update policy (PB2), which weighs about 0.390. According to Fig. 5, the second major obstacle is the lack of training and consultation programs, whereas environmental policies (PB3) and the inadequate training and consultation programs (PB4) constitute the less essential sub-barriers. Green innovation is anticipated from the government. The categorization of sub-obstacles surrounding political barriers is shown in Fig. 5 (PB). For long-term economic, environmental, and social viability, environmental research and development (R&D) is required. In the case of green technology, income, R&D, environmental harm, and political restrictions all pertain to financial development.

According to Fig. 6, the results suggest that a critical 0.0000 weight substrate is a lack of technical data (IB3), which is associated with a negative attitude (IB1), economic repercussions, environmental, and social feasibility. For economics, insufficient information (IB2) and incapacity apply to income, R&D, environmental harm, and political hurdles (IB4). Green innovations are unable to transform small- and medium-sized businesses into sustainable innovation activities due to a lack of technical skills. At the same time, neither employers nor contractors are aware of long-term regulations and procedures. As a result, it is unable to identify environmental viewpoints.

Figure 7 depicts the categorization of knowledge barriers into sub-barriers (IB).

The 0.271-weight shortfall in R&D capabilities (TB2) has been defined as the main sub-barrier to green development in SME innovation in this technical barrier forecast (as illustrated in Fig. 7). Simultaneously, small- and medium-sized firms (TB1) are described as technological and market uncertainties. Because the United Arab Emirates is a poor country with

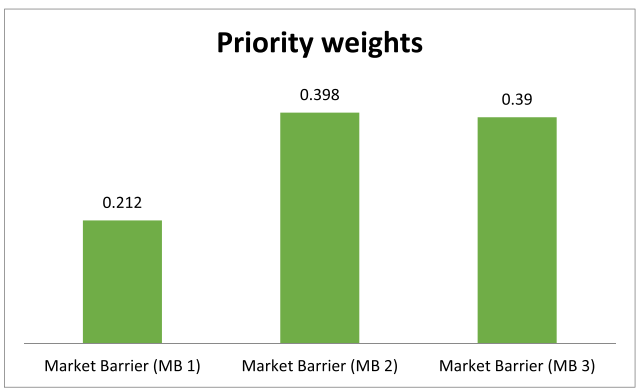

Fig. 4 Market barriers (MB)

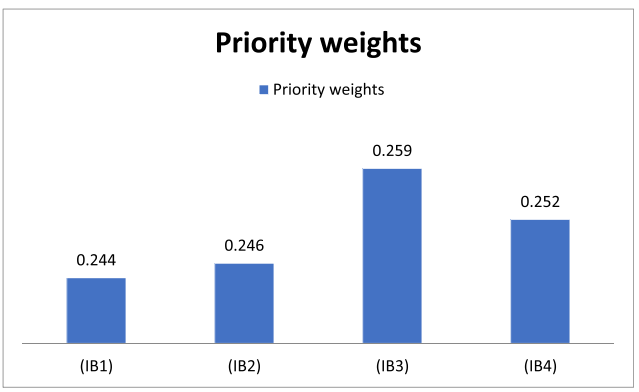

Fig. 6 Information barriers (IB)

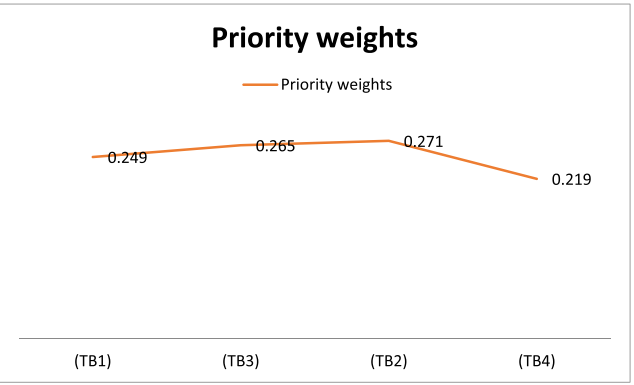

Fig. 7 Ranking and sub-barrier weights

limited technology resources, the government will have to make significant efforts to integrate green light.

Resistance to sustainable ways (MAB3), which has a weight of 0.290, is already recognized as a considerably more widespread green technology barrier among SMEs (as shown in Fig. 8). The remaining issues were categorized as a lack of participation (MAB2), inadequate resources (MAB1), and a lack of incentive systems (MAB1) (MAB4).

The cumulative performance of the sub-carriers

In this part, the weights of twenty-five sub-carriers were measured, regardless of their size. The ultimate ranking of these wide barriers is presented in Fig. 3. The research showed that the 0.0527 environmental policy (PB3) is the most effective barrier, followed by 0.0518 weighted devotion (MAB2) and 0.0507 green procurement (MAB3) in Fig. 8.

The following sub-barriers have been identified in Table 4: In the United Arab Emirates, green innovation is being delayed by what is known as the sub-barriers for SMEs.

FTOPSIS

This research presented a number of techniques for overcoming the primary barriers to green innovation in SMEs in the United Arab Emirates. The Soft TOPSIS method is used to describe and rank green engineering methods in this way. With the TFN level, this process research generated a fluid evaluation matrix.

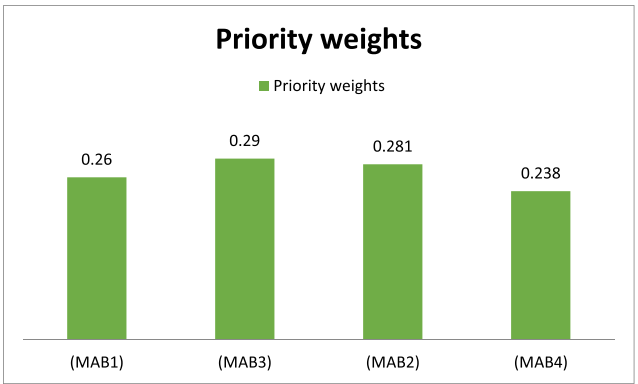

Fig. 8 Ranking and weight of sub-barriers concerning the managerial barriers

The following are the ways for overcoming hurdles in green innovation exercises:

According to Table 5. S1, 1st place: Establishment of renewable technology research activities in SMEs S1 was the top priority to address the major obstacles to green innovation development in small- and medium-sized enterprises in the United Arab Emirates. 2nd position: Transforming green product manufacturing R&D standards (S6). The S6 has been the second most popular method for small- and medium-sized businesses to address renewable innovation hurdles. Development of effective government green policies on mitigating the deterioration of the environment (S5): third place. The S5 was selected as the third best way to overcome obstacles to green innovation by small- and medium-sized firms. Development of SME monitoring environmental management systems (S3): 4th position. The S3 was the fourth significant development and overcoming green innovation obstacles for SME. The fifth place is to establish a SME ecologistics center (S4). The PS4 is the sixth most important technique to overcoming green innovation obstacles for SMEs. The government would give incentives and possibilities for SMEs to make green items (S9): 6th place. The S9 is listed as the sixth most important approach for SMEs in the United Arab Emirates to embrace green innovation techniques. The 7th place for including all participants in resource preservation and procurement activities (S10). The S10 approach for breaking down obstacles to green innovation came in eighth place. SME sustainability training and renewable procurement (S7): 8th rated. In the United Arab Emirates, SMEs ranked S7 sixth in significance for green innovation development. For overcoming challenges in developing green innovation practices, S8 was regarded as the least important approach. Every one of the dynamic characteristics that contribute to SME performance in a downturn is linked to actions that might help or hurt survival chances. There is no doubt that the growing economic forces of SMEs have a significant influence on both financial and nonfinancial indices in terms of economic quality. Furthermore, competitive forces play a key role in enhancing the United Arab Emirates' economic efficiency.

Discussion

In OPEC's economic strategy, the United Arab Emirates is the world's top generator of GDP of 684 billion dollars and 16% of the world's oil reserves. According to *Forbes* magazine, oil products represent 87% of expenditure revenue, 42% of overall GDP, and 90% of all exports. According to the IMF, in 2019, the budget deficit of the United Arab Emirates would

Table 4 Weight and average sub-barriers

Barriers	Barrier weight	Sub-barriers	Priority weights	Global sub-barrier weight	Ranking
Economic barriers	0.151	H21. Bank loans are inaccessible	0.17	0.0295	24
		Less pay	0.193	0.0327	22
		Lack of subventions and opportunities	0.21	0.0359	20
		High costs of a green program	0.216	0.0368	19
		High costs of disposing of hazardous waste	0.202	0.0357	21
Market complications	0.124	Incapable of market access	0.216	0.0258	23
		Lack of response from customers	0.396	0.0484	6
		Untrustworthy	0.391	0.0476	8
Political challenges	0.192	Broad green approaches	0.255	0.0499	7
		Implementation of green policy	0.258	0.0503	4
		Lack of government policy on green technology upgrades	0.279	0.0543	1
		Lack of educational services and outsourcing	0.218	0.0418	16
Information obstruction	0.174	Lack of general understanding	0.244	0.0423	14
		Lack of perspective	0.246	0.0424	13
		Lack of information on infrastructure	0.259	0.0445	10
		Knowledge deficit	0.252	0.0432	12
Technical barrier	0.185	Uncertainty over technology and the market	0.249	0.0398	11
		Deficiency of research and development capacity	0.265	0.0434	5
		Nonexistence of research and development capability	0.271	0.0416	9
		No technologies	0.219	0.0347	17
Managerial hurdles	0.182	Human capital deficit	0.26	0.0355	18
		Engagement difference	0.29	0.0517	2
		Unwillingness to adjustment to green exercises	0.281	0.059	3
		Few remuneration schemes	0.238	0.0416	15

Source: author findings

fall by 7.8% due to lower oil prices, although the level of non-oil exports would increase by 2.6%. These numbers are both shocking and disturbing but reveal the vulnerability of the economy because of its reliance on oil exports. The main reason for choosing the United Arab Emirates is to see how the government responded to the 2014 oil price crisis; will the

Table 5 Approaches for lessening barriers to in SMEs

Code	Approach	(d_a^+)	(d_a^-)	*CCi*	Rank
S1	Developing research exercises for implementing green innovation in SMEs	0	13.7843	1	1
S2	Establishing knowledge-raising and training activities at public agencies to raise awareness of green technologies among SMEs	12.4739	1.292	0.0939	9
S3	Develop environmental management systems for SME monitoring	5.2914	8.5194	0.6169	3
S4	Establishment of green logistics facilities for SMEs	7.3449	6.4403	0.4672	5
S5	Government-led implementation of ambitious green policies to minimize environmental degradation	5.2037	8.6026	0.6231	4
S6	Strengthen research and development (R&D) activities for renewable goods	1.9161	11.8882	0.8612	2
S7	Education people in business in sustainability practices and renewable procurement for SMEs	11.8829	1.9131	0.1387	8
S8	Training of human resources to green innovation	13.2332	0.5574	0.0404	10
S9	The State will offer discounts and opportunities for green goods to SMEs	9.4487	4.3623	0.3159	6
S10	Involving all players in and purchasing sustainable protection programs	10.599	3.2115	0.2325	7

Source: author findings

UAE government rearrange its economic dynamics? In view of the United Arab Emirates Government's developing financial challenges, we seek to offer significant ways to monitor the economic deterioration process. The current study, on the other hand, adds to the existing literature in a number of ways: Initially, this is the very first paper to analyze the effects of non-petroleum exports on the industry of the United Arab Emirates on the basis of its principles and notions. One likely cause is from the fact that the United Arab Emirates' economy is nearly entirely focused on oil, causing environmental damage and impeding overall financial development.

According to these data, advances in green technology tend to have an impact on overall factor efficiency, which may be explained in three ways. To begin, businesses engage in green technology development strategies that are guided by the benefit maximization concept.

When the globe faces severe environmental concerns such as climate fluctuation and ozone depletion, both end-users and corporate customers raise environmental issues. As a result, green engineering activities among suppliers have improved. Previous research has shown that this kind of effort may assist increase product and business efficiency. By analyzing organizational customers' data, we determined that suppliers' green improvement actions often result in favorable relationship outcomes.

As a result, we aimed to identify customer and partnership factors influencing the beneficial benefits of supplier green innovation. The results of a green innovation supplier were considered to have at least four elements. First, the connection will improve if customers take part in the invention phase of the supplier. Second, tight informal connections are likely to gain more from green innovation programs for suppliers as suppliers and customers share the same thinking and ideals and exchange more info.

Conclusion and policy implications

The backbone of the economy is often praised as small- and medium-sized firms. There is broad agreement on their important contribution to green economic growth.

SMEs make upwards of 55% of GDP and therefore more than 65% of total jobs in the high-income countries. In low-income nations, over 60% of GDP and more than 70% of the total work opportunities are in excess of 95%, whereas in middle-income countries, small- and medium-sized enterprises contribute about 70% of the overall employment level. Moreover, in terms of its commitment to GDP, the working age and fare improvement, the SME segment is the basis of Pakistan's economy. Access related to the economy is a vital driver in establishing the SME division, therefore stimulating the country's economic growth.

A number of nations are actively transforming their SMEs and implementing green engineering operations in order to overcome the hurdle.

To support the present analysis study researchers, hybrid choices, such as AHP with fuzzy approaches and TOPSIS with fuzzy approaches, were recommended to resolve the analysis gap. This may help identify and analyze the major roadblocks to green innovation uptake, as well as provide strategies for overcoming them. With the support of the previous literature analysis and five highly trained and experienced specialists, the researchers proposed the format of this research study for SMEs in the United Arab Emirates. In this investigation, the main six impediments were identified.

The AHP approach was used to identify the principal obstacles and sub-barriers. Political barriers (PB) are the most significant impediments, according to the findings. The soft TOPSIS method was then used to rank several techniques for overcoming such challenges.

This is a thorough examination, and there are certain flaws in the study that may be investigated more in the future. This research was carried out at green innovation SMEs in the United Arab Emirates. This study will also aid in the comparison of small- and medium-sized businesses in the United Arab Emirates to those in other nations. Furthermore, the application of effective technological innovation in SMEs in each country faces its own set of hurdles. Finally, this study will be used to evaluate green innovation techniques and major roadblocks in the market for small- and medium-sized businesses. More research on this topic may be done in a larger perspective.

Policy implications

In particular, where the system impedes adequate financial provision for terms and conditions suited to the development stage of the SME industry, governments need to play an important role in helping the SME sector:

- Government action to promote small- and medium-sized enterprises should be carefully targeted to make a banking system function efficiently and encourage the sector to take an active role in SME financing. Banking systems should, whenever necessary, be modified according to market principles.
- Governments also should increase their awareness of the range of funding possibilities available from officials, private investors, and banks, among businesses. In poor nations, microcredit and microfinancing systems play an essential role, and efforts should be made to improve their efficiency and dissemination.
- Policymakers must also ensure that the tax system will not disadvantage small- and medium-sized enterprises unintentionally. They should also assess the legal, fiscal, and

regulatory framework to ensure that it stimulates venture capital development. Diverse forms of institutional saving should be encouraged at the same time but flexibly governed by national policy.

On the basis of the detailed analytical investigation, the research provides three useful conclusions. To continue, politicians and economists should focus on reducing the United Arab Emirates' economic reliance on oil and petroleum products. On the other hand, promoting non-oil exports may contribute to the attainment of the desired goals and benefit the world. Renewable infrastructure initiatives will assist in reducing our reliance on fossil fuels while still protecting the environment. Additionally, aggressive measures addressing the entire energy balance will aid in industrial and institutional transformation, ultimately especially for long economic success.

Availability of data and materials The data that support the findings of this study are openly available on request.

Author contribution **Fengsheng Chien:** conceptualization, data curation, methodology, writing—original draft. **Quang-Thanh, Ngo:** data curation, visualization. **Ching-Chi Hsu:** visualization, supervision, editing. **Ka Yin Chau:** review and editing. **Robina Iram:** writing—review and editing—and software. **Fengsheng Chien**: editing and reviewing.

Funding This research is partly funded by University of Economics Ho Chi Minh City, Vietnam.

Declarations

Ethics approval and consent to participate N/A

Consent for publication We do not have any individual person's data in any form.

Competing interests The authors declare no competing interests.

References

African Development Indicators (1997) Africa region findings & Good practice infobriefs; No. 111. World Bank, Washington, DC. © World Bank

Alemzero DA, Iqbal N, Iqbal S, Mohsin M, Chukwuma NJ, Shah BA (2020a) Assessing the perceived impact of exploration and production of hydrocarbons on households perspective of environmental regulation in Ghana. Environ Sci Pollut Res 28:5359–5371. https://doi.org/10.1007/s11356-020-10880-3

Alemzero DA, Sun H, Mohsin M, Iqbal N, Nadeem M, Vo XV (2020b) Assessing energy security in Africa based on multi-dimensional approach of principal composite analysis. Environ Sci Pollut Res 28:2158–2171. https://doi.org/10.1007/s11356-020-10554-0

Andersen O (1997) Internationalization and market entry mode: A review of theories and conceptual frameworks. MIR: Management International Review, pp 27–42

Andersen TF, Madsen M, Jørgensen J, Mellemkjoer L, Olsen JH (1999) The Danish National Hospital Register. A valuable source of data for modern health sciences. Dan Med Bull 46(3):263–268

Aloise PG, Macke J (2017) Eco-innovations in developing countries: The case of Manaus Free Trade Zone (Brazil). J Clean Prod 168:30–38

Arundel AV, Kemp R (2009) Measuring eco-innovation

Ashford NA (1993) Understanding technological responses of industrial firms to environmental problems: implications for government policy (chapter)

Awasthi A, Chauhan SS, Goyal SK (2010) A fuzzy multicriteria approach for evaluating environmental performance of suppliers. Int J Prod Econ 126:370–378

Babar M, Arif F (2017) Smart urban planning using Big Data analytics to contend with the interoperability in Internet of Things. Future Gener Comput Syst 77:65–76

Bliesner A, Liedtke C, Rohn H (2014) Resource efficiency and culture—workplace training for small and medium-sized enterprises. Sci Total Environ 481:645–648

Blok V, Long TB, Gaziulusoy AI, Ciliz N, Lozano R, Huisingh D, Csutora M, Boks C (2015) From best practices to bridges for a more sustainable future: advances and challenges in the transition to global sustainable production and consumption: introduction to the ERSCP stream of the Special volume. J Clean Prod 108:19–30

Brammer S, Hoejmose S, Marchant K (2012) Environmental management in SME s in the UK: practices, pressures and perceived benefits. Bus Strateg Environ 21:423–434

Carter CR, Rogers DS (2008) A framework of sustainable supply chain management: moving toward new theory. Int J Phys Distrib Logist Manag

Cecere G, Corrocher N, Mancusi ML (2018) Financial constraints and public funding of eco-innovation: empirical evidence from European SMEs. Small Bus Econ:1–18

Chen Y-S, Lai S-B, Wen C-T (2006) The influence of green innovation performance on corporate advantage in Taiwan. J Bus Ethics 67:331–339

Chien F, Wang CN, Nguyen VT, Nguyen VT, Chau KY (2020) An evaluation model of quantitative and qualitative fuzzy multicriteria decision-making approach for hydroelectric plant location selection. Energies. 13. https://doi.org/10.3390/en13112783

Chien F, Anwar A, Hsu CC, Sharif A, Razzaq A, Sinha A (2021a) The role of information and communication technology in encountering environmental degradation: proposing an SDG framework for the BRICS countries. Technol Soc 65:101587. https://doi.org/10.1016/j.techsoc.2021.101587

Chien F, Chau KY, Ady SU, Zhang YQ, Tran QH, Aldeehani TM (2021b) Does the combining effects of energy and consideration of financial development lead to environmental burden: social perspective of energy finance? Environ Sci Pollut Res. https://doi.org/10.1007/s11356-021-13423-6

Chien F, Pantamee AA, Hussain MS et al (2021c) Nexus between financial innovation and bankruptcy: evidence from information, communication and technology (ict) sector. Singap Econ Rev:1–22. https://doi.org/10.1142/S0217590821500181

Chien FS, Kamran HW, Albashar G, Iqbal W (2021d) Dynamic planning, conversion, and management strategy of different renewable energy sources: a sustainable solution for severe energy crises in emerging economies. Int J Hydrog Energy 46:7745–7758. https://doi.org/10.1016/j.ijhydene.2020.12.004

Chien FS, Sadiq M, Kamran HW, Nawaz MA, Hussain MS, Raza M (2021e) Co-movement of energy prices and stock market return: environmental wavelet nexus of COVID-19 pandemic from the USA, Europe, and China. Environ Sci Pollut Res 1–15. https://doi.org/10.1007/s11356-021-12938-2

Christopoulos DK, Tsionas EG (2004) Financial development and economic growth: evidence from panel unit root and cointegration tests. J Dev Econ 73:55–74

Collins E, Lawrence S, Pavlovich K, Ryan C (2007) Business networks and the uptake of sustainability practices: the case of New Zealand. J Clean Prod 15:729–740
Cook P, Nixson F (2000) Finance and small and medium-sized enterprise development. Institute for Development Policy and Management, University of Manchester, Manchester
Corral Á (2003) Local distributions and rate fluctuations in a unified scaling law for earthquakes. Phys Rev E 68(3)
Dangelico RM (2016) Green product innovation: where we are and where we are going. Bus Strateg Environ 25:560–576
De Medeiros JF, Ribeiro JLD, Cortimiglia MN (2014) Success factors for environmentally sustainable product innovation: a systematic literature review. J Clean Prod 65:76–86
Del Río P, Carrillo-Hermosilla J, Könnölä T (2010) Policy strategies to promote eco-innovation: an integrated framework. J Ind Ecol 14: 541–557
Dhull S, Narwal M (2016) Drivers and barriers in green supply chain management adaptation: a state-of-art review. Uncertain Supply Chain Manag 4:61–76
Dogan E, Taspinar N, Gokmenoglu KK (2018) Determinants of ecological footprint in MINT countries. Energy Environ 30(6):1065–1086
Eltayeb TK, Zailani S, Ramayah T (2011) Green supply chain initiatives among certified companies in Malaysia and environmental sustainability: investigating the outcomes. Resour Conserv Recycl 55:495–506
Feeney LS, Riding AL (1997) Business owners' fundamental tradeoff: Finance and the vicious circle of growth and control. Canadian Business Owner, November
Govindan K, Kaliyan M, Kannan D, Haq AN (2014) Barriers analysis for green supply chain management implementation in Indian industries using analytic hierarchy process. Int J Prod Econ 147:555–568
Govindan K, Muduli K, Devika K, Barve A (2016) Investigation of the influential strength of factors on adoption of green supply chain management practices: an Indian mining scenario. Resour Conserv Recycl 107:185–194
Gupta H, Barua MK (2017) Supplier selection among SMEs on the basis of their green innovation ability using BWM and fuzzy TOPSIS. J Clean Prod 152:242–258
Gupta H, Barua MK (2018a) A framework to overcome barriers to green innovation in SMEs using BWM and Fuzzy TOPSIS. Sci Total Environ 633:122–139
Gupta H, Barua MK (2018b) A grey DEMATEL-based approach for modeling enablers of green innovation in manufacturing organizations. Environ Sci Pollut Res 25:9556–9578
Han H, Trimi S (2018) A fuzzy TOPSIS method for performance evaluation of reverse logistics in social commerce platforms. Expert Syst Appl 103:133–145. https://doi.org/10.1016/j.eswa.2018.03.003
Hanim Mohamad Zailani S, Eltayeb TK, Hsu C-C, Choon Tan K (2012) The impact of external institutional drivers and internal strategy on environmental performance. Int J Oper Prod Manag 32:721–745
Hasan A, Paray BA, Hussain A, Qadir FA, Attar F, Aziz FM et al (2020) A review on the cleavage priming of the spike protein on coronavirus by angiotensin-converting enzyme-2 and furin. J Biomol Struct Dyn:1–9
Hillary R (2004) Environmental management systems and the smaller enterprise. J Clean Prod 12:561–569
Horbach J, Rammer C, Rennings K (2012) Determinants of eco-innovations by type of environmental impact—the role of regulatory push/pull, technology push and market pull. Ecol Econ 78:112–122
Huang SZ, Chau KY, Chien F, Shen H (2020) The impact of startups' dual learning on their green innovation capability: the effects of business executives' environmental awareness and environmental regulations. Sustain. 12. https://doi.org/10.3390/su12166526
Jabbour CJC, Jugend D, de Sousa Jabbour ABL et al (2015) Green product development and performance of Brazilian firms: measuring the role of human and technical aspects. J Clean Prod 87:442–451
Jinzhou W (2011) Discussion on the relationship between green technological innovation and system innovation. Energy Procedia 5:2352–2357
Johnstone N, Hascic I (2008) Preliminary indicators of eco-innovation in selected environmental areas. ENV/EPOC/WPNEP (2008) 7, OECD, Paris
Jones P, Hillier D, Comfort D (2011) Shopping for tomorrow: promoting sustainable consumption within food stores. Br Food J 113:935–948
Kannan D, de Sousa Jabbour ABL, Jabbour CJC (2014) Selecting green suppliers based on GSCM practices: using fuzzy TOPSIS applied to a Brazilian electronics company. Eur J Oper Res 233:432–447
Kiss B, Manchón CG, Neij L (2013) The role of policy instruments in supporting the development of mineral wool insulation in Germany, Sweden and the United Kingdom. J Clean Prod 48:187–199
Kumar VCS, Mukherjee S, Harne PS, Subedi A, Ganapathy MK, Patthipati VS, Sapkota B (2020) Novelty in the gut: a systematic review and metaanalysis of the gastrointestinal manifestations of COVID-19. BMJ Open Gastroenterol 7(1):e000417
Kusumawardani RP, Agintiara M (2015) Application of fuzzy AHP-TOPSIS method for decision making in human resource manager selection process. Procedia Comput Sci 72:638–646
Lai SB, Wen CT, Chen YS (2003) The exploration of the relationship between the environmental pressure and the corporate competitive advantage. In: Proceedings of the CSMOT Academic Conference, National Chiao Tung University, Hsin-Chu, Taiwan
Lee V-H, Ooi K-B, Chong AY-L, Seow C (2014) Creating technological innovation via green supply chain management: an empirical analysis. Expert Syst Appl 41:6983–6994
Li J, Hu Z, Shi V, Wang Q (2021a) Manufacturer's encroachment strategy with substitutable green products. Int J Prod Econ 235:108102. https://doi.org/10.1016/j.ijpe.2021.108102
Li W, Chien F, Hsu CC, Zhang YQ, Nawaz MA, Iqbal S, Mohsin M (2021b) Nexus between energy poverty and energy efficiency: estimating the long-run dynamics. Res Policy 72:102063. https://doi.org/10.1016/j.resourpol.2021.102063
Li W, Chien F, Kamran HW, Aldeehani TM, Sadiq M, Nguyen VC, Taghizadeh-Hesary F (2021c) The nexus between COVID-19 fear and stock market volatility. Econ Res Istraživanja:1–22. https://doi.org/10.1080/1331677x.2021.1914125
Li Y, Wang S, Xu T, Li J, Zhang Y, Xu T, Yang J (2021d) Novel designs for the reliability and safety of supercritical water oxidation process for sludge treatment. Process Saf Environ Prot 149:385–398. https://doi.org/10.1016/j.psep.2020.10.049
Lin C-Y, Ho Y-H (2008) An empirical study on logistics service providers' intention to adopt green innovations. J Technol Manag Innov 3:17–26
Lin CP, Xian J, Li B, Huang H (2020) Transformational leadership and employees' thriving at work: the mediating roles of challenge-hindrance stressors. Front Psychol 11. https://doi.org/10.3389/fpsyg.2020.01400
Longoni A, Golini R, Cagliano R (2014) The role of new forms of work organization in developing sustainability strategies in operations. Int J Prod Econ 147:147–160
Luthra S, Mangla SK (2018) Evaluating challenges to Industry 4.0 initiatives for supply chain sustainability in emerging economies. Process Saf Environ Prot 117:168–179
Lv X, Liu Y, Xu S, Li Q (2021) Welcoming host, cozy house? The impact of service attitude on sensory experience. Int J Hosp Manag 95: 102949. https://doi.org/10.1016/j.ijhm.2021.102949
Madrid-Guijarro A, Garcia D, Van Auken H (2009) Barriers to innovation among Spanish manufacturing SMEs. J Small Bus Manag 47: 465–488
Mangla SK, Govindan K, Luthra S (2017) Prioritizing the barriers to achieve sustainable consumption and production trends in supply

chains using fuzzy analytical hierarchy process. J Clean Prod 151: 509–525
Mathew D, Giles JR, Baxter AE, Oldridge DA, Greenplate AR, Wu JE et al (2020) Deep immune profiling of COVID-19 patients reveals distinct immunotypes with therapeutic implications. Science 369(6508)
Mathiyazhagan K, Govindan K, NoorulHaq A, Geng Y (2013) An ISM approach for the barrier analysis in implementing green supply chain management. J Clean Prod 47:283–297
Mathiyazhagan K, Govindan K, Noorul Haq A (2014) Pressure analysis for green supply chain management implementation in Indian industries using analytic hierarchy process. Int J Prod Res 52:188–202
Matus KJM, Xiao X, Zimmerman JB (2012) Green chemistry and green engineering in China: drivers, policies and barriers to innovation. J Clean Prod 32:193–203
Mudgal RK, Shankar R, Talib P, Raj T (2010) Modelling the barriers of green supply chain practices: an Indian perspective. Int J Logist Syst Manag 7:81–107
OECD Economic Studies (1997) https://doi.org/10.1787/16097491
OECD (2013) Economic Surveys 2013. https://doi.org/10.1787/19990820
OECD (2018) Economic Surveys 2018. https://doi.org/10.1787/19990820
Organization WH (2015) Trends in maternal mortality: 1990-2015: estimates from WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division. World Health Organization
Perron GM (2005) Barriers to environmental performance improvements in Canadian SMEs. Dalhousie Univ Canada
Pinget A, Bocquet R, Mothe C (2015) Barriers to environmental innovation in SMEs: Empirical evidence from French firms. M@ n@ gement 18(2):132–155
Rao P, Holt D (2005) Do green supply chains lead to competitiveness and economic performance? Int J Oper Prod Manag 25:898–916
Revell A, Rutherfoord R (2003) UK environmental policy and the small firm: broadening the focus. Bus Strateg Environ 12:26–35
Runhaar H, Tigchelaar C, Vermeulen WJV (2008) Environmental leaders: making a difference. A typology of environmental leaders and recommendations for a differentiated policy approach. Bus Strateg Environ 17:160–178
Russel T (2017) Greener purchasing: opportunities and innovations. Routledge
Saaty TL, Vargas LG (1980) Hierarchical analysis of behavior in competition: Prediction in chess. Behav Sci 25(3):180–191
Saaty TL, Vargas LG (2001) The decision by the US congress on China's trade status: a multicriteria analysis. In: Models, methods, concepts & applications of the analytic hierarchy process. Springer, Boston, MA, pp 305–317
Sarkis J, Zhu Q, Lai KH (2011) An organizational theoretic review of green supply chain management literature. Int J Prod Econ 130(1): 1–15
Silva MJ, Leitao J, Raposo M (2008) Barriers to innovation faced by manufacturing firms in Portugal: how to overcome it for fostering business excellence? Int J Bus Excell 1:92–105
Simpson M, Taylor N, Barker K (2004) Environmental responsibility in SMEs: does it deliver competitive advantage? Bus Strateg Environ 13:156–171
Solazzo R, Donati M, Tomasi L, Arfini F (2016) How effective is greening policy in reducing GHG emissions from agriculture? Evidence from Italy. Sci Total Environ 573:1115–1124
Somsuk N, Laosirihongthong T (2017) Prioritization of applicable drivers for green supply chain management implementation toward sustainability in Thailand. Int J Sustain Dev World Ecol 24:175–191
Sun H, Pofoura AK, Adjei Mensah I, Li L, Mohsin M (2020) The role of environmental entrepreneurship for sustainable development: evidence from 35 countries in Sub-Saharan Africa. Sci Total Environ 741:140132. https://doi.org/10.1016/j.scitotenv.2020.140132
Tiep NC, Wang M, Mohsin M, Kamran HW, Yazdi FA (2021) An assessment of power sector reforms and utility performance to strengthen consumer self-confidence towards private investment. Econ Anal Policy 69:676–689. https://doi.org/10.1016/j.eap.2021.01.005
Tourism and economy (2017). https://doi.org/https://u.ae/en/information-and-services/visiting-and-exploring-the-uae/travel-and-tourism
Turner TJ, Pearce LB, Goldin SM (1989) A superfusion system designed to measure release of radiolabeled neurotransmitters on a subsecond time scale. Anal Biochem 178(1):8–16
Urban B, Naidoo R (2012) Business sustainability: empirical evidence on operational skills in SMEs in South Africa. J Small Bus Enterp Dev 19:146–163
Walker H, Di Sisto L, McBain D (2008) Drivers and barriers to environmental supply chain management practices: lessons from the public and private sectors. J Purch Supply Manag 14:69–85
Woolman T, Veshagh A (2006) Designing support for manufacturing SMEs approaching ecodesign and cleaner production—learning from UK survey results. In: 13th CIRP conference on life cycle engineering, Leuven
World Bank (1998) https://doi.org/worldbank.org/handle/10986/9896
World Bank (2000) World Development Report 2000/2001. https://doi.org/http://hdl.handle.net/10986/11856
Xiong Z, Xiao N, Xu F, Zhang X, Xu Q, Zhang K, Ye C (2021) An Equivalent exchange based data forwarding incentive scheme for socially aware networks. J Signal Process Syst 93:249–263. https://doi.org/10.1007/s11265-020-01610-6
Yuan H, Wang Z, Shi Y, Hao J (2021) A dissipative structure theory-based investigation of a construction and demolition waste minimization system in China. J Environ Plan Manag:1–27. https://doi.org/10.1080/09640568.2021.1889484
Zhu Q, Sarkis J, Lai K (2012a) Green supply chain management innovation diffusion and its relationship to organizational improvement: an ecological modernization perspective. J Eng Technol Manag 29: 168–185
Zhu Y, Wittmann X, Peng MW (2012b) Institution-based barriers to innovation in SMEs in China. Asia Pac J Manag 29:1131–1142