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A proposed hybrid VUCA theory and decision making for logistics enterprises in Oman due to uncertainty contemporary factors

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Abstract: The COVID-19 pandemic, the implementation of the industrial revolution 4.0, the recent fuel price crisis, and the vision of the Sultanate of Oman logistics strategy 2040 are forcing the Omani logistics sector to determine its capability in handling these four issues simultaneously. This study proposes a decision-making model for small and medium logistics enterprises in Oman for analysing numerous potential business strategies by considering the uncertainty of contemporary factors. A hybrid of multiple-criteria decision-making methods, namely, the analytic hierarchy process, fuzzy link-based approach and evidential reasoning approach, were used in this study. It was found that the ‘centralised business activities’ business strategy is preferable and more essential to be implemented immediately, mainly due to the geographical market positioning reason. This novel study contributes to developing the decision model for the Logistics Enterprises in Oman as a new measurement when dealing with the uncertainty of external factors of the business environment.

Keywords: operations management; logistics management; decision making; uncertainty supply chain; small-medium enterprises; VUCA theory.

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Biographical notes: Noorul Shaiful Fitri Abdul Rahman has 14 years of professional working experience in both higher education and industry. He published numerous indexed journal articles and conference papers on logistics management, warehousing operations, supply chain studies, Logistics 4.0, maritime operations, shipping and port management, container terminal and risk assessment management. On his papers, he used various multiple criteria decision-making approaches such as Bayesian networks, analytical hierarchy process, fuzzy logic, rule-based reasoning, TOPSIS, risk matrix, broda method, bow-tie, critical path analysis, cause and effect analysis and systematic literature review. He has also previously authored four book units in the logistics and maritime domains, as well as six chapters in a book with well-known publishers Routledge and Springer Nature. In addition, he competed in 26 innovation competitions, winning 17 medals. Finally, he serves as an external reviewer and editorial board member for a number of prestigious ISI and Scopus publications.

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1 Introduction

The government of Oman has highlighted that the logistics sector is a pivotal contributor to economic diversification in Oman. According to the logistics performance index (LPI) of the World Bank, Oman ranked 43 in 2018, while in 2016, it ranked 48, and in 2014, it ranked 59 (World Bank, 2020). Oman managed to improve its LPI ranking by 16 places between 2014 and 2018. SMLEs play a significant role in developing the logistics sector

in Oman. They contributed 23% of the national gross domestic product (GDP) in 2017, and their contribution to the GDP is expected to be more than 30% in 2020 (Kutty, 2017).

Different bodies have defined SMEs; the OECD World Bank (2017) is based on three indicators: total asset value, annual sales, and staff (Berisha and Pula, 2005). However, in the Omani context, two factors were used to differentiate between micro, small and medium businesses. A micro business is characterised by less than five persons and less than OMR25,000 of the annual sales, while a small business has several staff between five and nine, and the annual sales are between OMR25,000 to OMR250,000. Next, a medium-sized business is characterised by many staff between 10 to 99 employees with annual sales between OMR250,000 and OMR1.5 million (Ministry of Commerce and Industry, 2019).

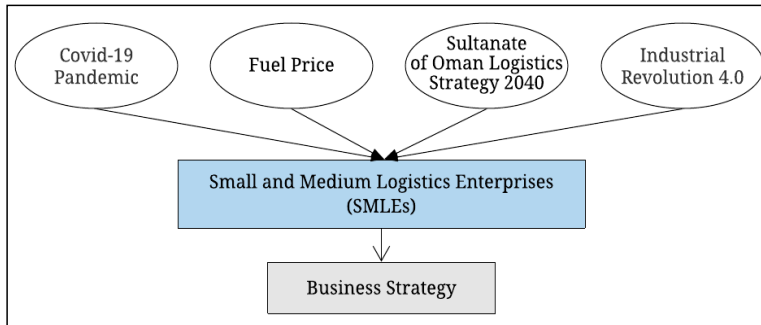
According to the SOLS 2040, SMEs are expected to contribute to the GDP in the future actively. Both public authorities and industry have taken several actions and decisions to assist SMEs. Many foreign firms began to incorporate and integrate with SMEs in Oman to capitalise on these promised opportunities (Pearson, 2021) through partnerships and alliances with Omani SMEs that steadfastly maintained their presence in regional and international logistics markets. The public authority for small and medium enterprise development (Riyada) released a report announcing that by the end of January 2021, the total number of these organisations will be 32,441 (The National Centre for Statistics and Information (NCSI), 2021).

However, starting from the end of December 2019, almost all commercial industries have been facing challenges globally due to a pandemic of the most threatening virus known as the Coronavirus (COVID-19). The government of Oman decided to lock down business activities throughout the country from 17 March 2020 till the end of July 2020, except for essential services such as grocery stores, pharmacies, and medical healthcare (Garda World, 2020). These measures have had a direct impact on SMLEs. Next, the plunge in demands due to COVID-19 has also caused oil prices to crush a two-decade low (Sonnichsen, 2020). As Oman is heavily dependent on the hydrocarbon sector, which contributed 37.1% of its GDP in 2018, low oil prices and a fuel price crisis considerably impact its economy (Times News Service, 2019). The third issue is the implementation of the industrial revolution 4.0 (IR 4.0). The IR 4.0 can bring to the logistics sector in Oman fresh opportunities to increase its competitive edge. However, local practitioners are faced with the challenge of a lack of commitment towards upgrading their technological capabilities, coupled with an over-reliance on a cheap expatriate workforce (Benayoune, 2018; Ministry of Commerce and Industry, 2019). Finally, the last issue comes from a national-level development plan called the SOLS 2040. This strategy is a blueprint that aspires to transform Oman into a top 10 logistics hub in the world by 2040. It was expected to be implemented starting from 2020 (Public Authority for Investment Promotion and Export Development, 2016).

These four issues, which coincided in 2020, put SMLEs in Oman under vast pressure and led the businesses to run in volatile, uncertain, complex, and ambiguous (VUCA) environments due to highly dynamic circumstances and unforeseeable circumstances changes (Matthysen and Harris, 2018). Hence, this begs the question: How can SMLEs navigate through this challenging period and beyond, and what are the potential business strategies that can assist SMLEs to survive during and after this economic downturn? Therefore, the objective of this study is to propose a decision-making model for SMLEs in Oman for analysing numerous potential business strategies by considering the VUCA environments of the SOLS 2040, the IR 4.0, COVID-19 pandemic, and the fuel price

crisis. Based on the VUCA reviews, the COVID-19 pandemic, Fuel price, SOLS 2040 and IR 4.0 can create tremendous challenges for Oman's logistics industry, especially for the SMLEs. Therefore, effective decisions should be made by the rulers and stakeholders to ensure the business strategy that fits for SMLEs to face the issues can be achieved and the benefits can be brought to all. Figure 1 shows a conceptual framework that illustrates the overview of the study background.

Figure 1 Conceptual framework of the study (see online version for colours)



2 Literature review

Previous studies on VUCA confirmed some factors' impacts on logistics and supply chain, and these factors have various sources such as macro-economic and micro-economic factors, demand, and supply (El-Sakty and Osama, 2015). Traditionally, every company has a strategy for every single activity, such as sales and production. Thus, business planning must be integrated and flexible to align with the industry's complexities.

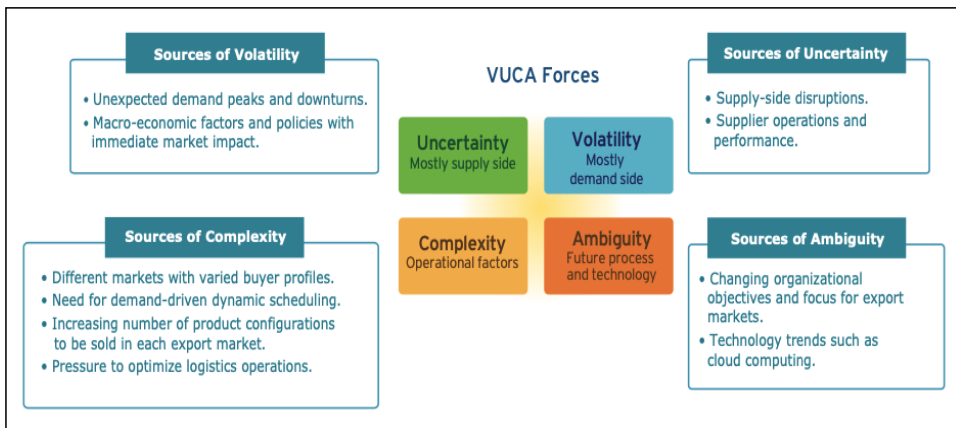
VUCA refers to the complicated and varying business circles that companies and individuals must navigate (Sullivan, 2012). VUCA refers to an enterprise environment constantly shifting in contradictory, drastic, and consistent ways, resulting in challenges (Deaton, 2018). VUCA stands for volatility, confusion, complexity, and ambiguity Figure 2. Many firms face the challenges posed by the climate in terms of the unpredictability of risk (Nenavani and Jain, 2018). The VUCA theory focuses on describing or reflecting complicated and varying business circles that companies and individuals must navigate, which involve the volatility, uncertainty, complexity, and ambiguity conditions of the business environment, ensuring the leadership's readiness (Sullivan, 2012).

Any country exists in a VUCA environment, which means it must adapt to and deal with the reality of changes and uncertainties regularly. In the case of Oman, a VUCA environment is uncertain and complex due to government policies, frequent regulatory changes, and ambiguity caused by various factors such as the SOLS 2040, the IR 4.0, COVID-19 pandemic, and the fuel price crisis. COVID-19 has recently been added to VUCA, and the COVID-19 plague has brought uncertainty about the future and the realisation that the pandemic is far from over. The economic impact of COVID-19 and other factors is massive, and it has the potential to harm the global economy significantly. Many policymakers and analysts predicted that the COVID-19 and other factors would

cause the world, including Oman, to enter a deep recession in 2020 and 2021 (Sohar International, 2020).

Researchers in the logistics sector have conducted several studies about Industry 4.0. For instance, Sharma (2018) highlighted five key impacts of Industry 4.0 on Logistics 4.0: digitalisation, transparency, automation, modularisation, and transportation and distribution. Meanwhile, Skapinyecz et al. (2018) addressed the nature of IR 4.0, its technical conditions, possibilities, and challenges and its effect on intra-corporate and non-corporate logistics systems. They discovered that assessing the reliability and quality of logistics networks is a complicated challenge. (Adonis, 2020; Hofmann and Rüsçh, 2017) mentioned that to accommodate IR 4.0, businesses in the transport and logistics sector globally are facing a rapid shift to new technologies in supply chains driven by software disruptions, where technology is redefining every element of global supply operations from manufacturing to shipping, warehousing, competition, collaboration, and the management of customer expectations.

Figure 2 The VUCA forces on the business environment (see online version for colours)



Source: Cognizant (2012)

A very few studies investigated IR 4.0 as an uncertainty factor and considering fuel price, COVID-19 in one model or framework, most of the previous studies covered the readiness for IR.4.0, IR 4.0 and supply chain or logistics (Ariffin and Ahmad, 2021; Ślusarczyk, 2018; Nick and Pongrácz, 2016). Besides the studies that investigated the application and adoption of IR 4.0 by most of the previous studies (Joubert and Jokonya, 2021; Jayashree et al. 2021; Won and Park, 2020) before and during COVID-19 did not test the impact of IR 4.0 with COVID-19, fuel price and their impact on small business. In addition to IR 4.0, COVID-19 was a newly discovered COVID-19 (World Health Organization, 2020) that can infect many people once it has infected a few (Nishiura et al., 2020). During COVID-19, few studies were conducted on the impact of COVID-19 and IR 4.0 like blockchain. Bhatt et al. (2021) investigated technology convergence assessment in the case of blockchain within the IR 4.0 platform. Also, another study from Kassab and Neto (2021) about digital surveillance technologies to combat COVID-19.

Furthermore, Shariq et al. (2021) tested radio frequency identification (RFID), and internet of things (IoT) enabled healthcare in the COVID-19 scenario. While Dorcheh et al. (2021) discussed the impact of the COVID-19 pandemic using a hybrid

SWOT-QSPM approach in an emerging economy. This study is an example of the new trend of the studies that are looking for a hybrid or mix-methods of problem-solving and decision making in SMEs or large companies; concerning the size of the business SMEs. Only a few studies have been conducted on small and medium enterprises SMEs in America and China. Bartik et al. (2020) highlighted that the current crisis is deeply affected by small businesses, mainly in terms of fragile financial limitations, resulting in many layoffs and shutdowns. Despite the reopening of businesses and the support given to SMEs in China, the supply chain and logistics SMEs are still facing challenges regarding their downstream supply because of the ongoing pandemic and various travel bans (Bouey, 2020).

Another critical issue, fuel price fluctuation, is a phenomenon that appears and fades according to many variables before and after COVID-19. Therefore the effects of the fuel price on small businesses and logistics were addressed from several perspectives before the COVID-19. Reducing national freight logistics costs risk in a high-oil-price environment, Saville (2020) argued that fuel costs are not an issue for the container shipping industry, whereas Yergin (2020) pointed out that low oil prices will be good for the transportation business. Still, the challenge will be to get the demand. Both SMLEs and customers are directly benefitting from this fuel price slump crisis.

3 Methodology

A hybrid decision approaches, including:

- 1 an analytical hierarchy process (AHP)
- 2 a fuzzy link-based method
- 3 an ER approach, was used to propose a decision-making model system to the SMLEs in Oman for analysing various prospective market strategies while taking into account the complexity of contemporary socio-economic and technological considerations.

Figure 3 defines the research framework adopted in this study. This study began with identifying the issues faced by SMLEs in Oman. The evaluation criteria and alternatives were conducted using a brainstorming technique, a literature survey and focus group discussions with experts.

For the data collection process, the qualitative data collection method was used in this study. All necessary data were obtained through questionnaires with the industry experts who participated in the SMLEs industry in Oman. They had over eight years of experience working in the logistics sector and were decision-makers in their respective SMLEs, i.e., managerial positions. In the beginning, there were 30 industry experts selected. However, only ten experts (four senior operations managers, three logistics and procurement managers, and three general managers) have successfully returned a set of surveys with complete information. They are involved in the focus group discussion sessions.

In comparison, eight experts have provided insufficient data, and twelve have not returned any information. This study, therefore, analyses the feedback of only ten expert respondents. The assessment input value transformation process was conducted using a fuzzy link-based technique. Later, the assessment output value of each alternative was

computed using an ER method, and all the potential solutions were ranked in order of preference. Consequently, in this analysis, a combination decision-making approach was used in conjunction with the VUCA theory.

Figure 3 A research framework (see online version for colours)

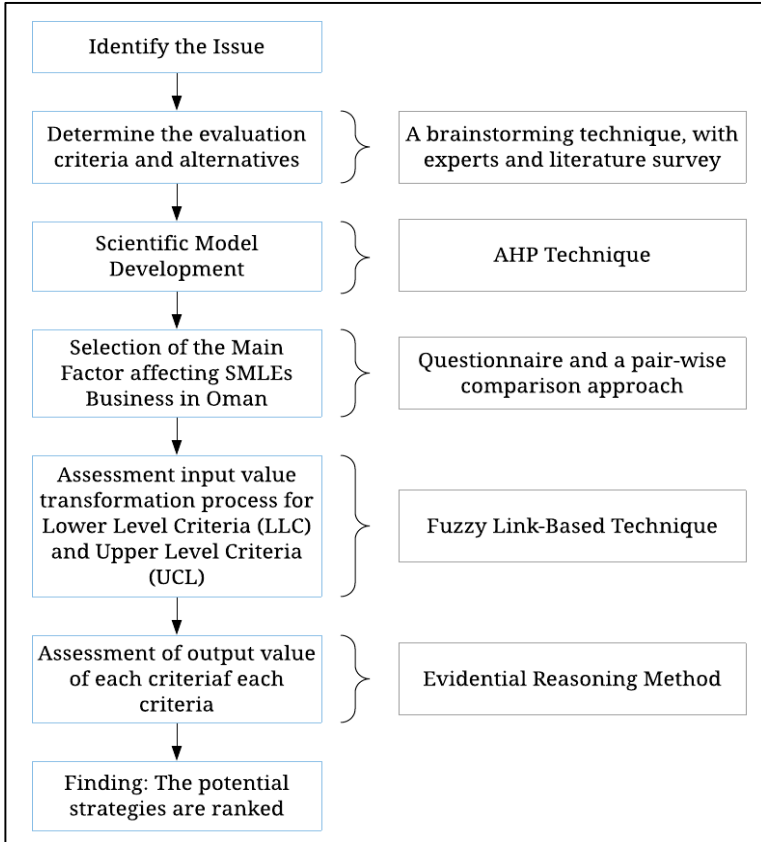


Table 1 The ratio scale of pair-wise comparison

<i>The intensity of the assessment scale</i>	<i>Assessment scale meaning</i>	<i>The intensity of the assessment scale</i>	<i>Assessment scale meaning</i>
1	Equally important	1	Equally unimportant
3	Moderately important	1/3	Moderately unimportant
5	Important	1/5	Unimportant
7	Very important	1/7	Very unimportant
9	Extremely important	1/9	Extremely unimportant
2, 4, 6, and 8	Intermediate values of important	1/2, 1/4, 1/6, and 1/8	Intermediate values of unimportant

Source: Saaty (2008), Abdul Rahman and Ahmad Najib (2017)

3.1 Use of an analytical hierarchy process

An AHP solution is a mathematical framework that allows for the comparison of parameters or alternatives in the pair-wise comparison mode and the interpretation of the weight value depending on the preference (Saaty, 1980, 1990; Abdul Rahman et al., 2019b). By using a ratio scale analysis, a pair-wise comparison matrix of all the parameters was developed. Table 1 depicts the evaluation scale (Saaty, 2001, 2008).

As seen in equation (1), qualified judgments on the pairs of attributes, A_i and A_j , were expressed by a $n \times n$ matrix, A .

$$A = (a_{ij}) = \begin{bmatrix} 1 & a_{12} & \dots & a_{1n} \\ a/a_{12} & 1 & \dots & a_{2n} \\ \cdot & \cdot & \dots & \cdot \\ a/a_{1n} & a/a_{2n} & \dots & 1 \end{bmatrix} \quad (1)$$

where $i, j = 1, 2, 3, \dots, n$ and each a_{ij} represents the value of the attribute A_i in relation to attribute A_j . For an order matrix $n \times (n-1)/2$, comparisons are needed. The weight vector shows the priority of each factor in the pair-wise comparison matrix in terms of its overall contribution to decision-making. Equation (2) is used to measure the weight value.

$$w_k = \frac{1}{n} \sum_{j=1}^n \left(\frac{a_{kj}}{\sum_{i=1}^n a_{ij}} \right) \quad (k = 1, 2, 3, \dots, n) \quad (2)$$

where a_{ij} is an entry value in a row i and column j in a comparison matrix of order n . The consistency ratio (CR) was used to check the weight values obtained from the pair-wise comparison matrix. The following equations were used to calculate the CR value (Saaty, 1990):

$$CR = \frac{CI}{RI} \quad (3)$$

$$CI = \frac{\lambda_{max} - n}{n - 1} \quad (4)$$

$$\lambda_{max} = \frac{\sum_{j=1}^n \frac{\sum_{k=1}^n w_k a_{jk}}{w_j}}{n} \quad (5)$$

where n denotes the number of items to compare, λ_{max} indicates the maximal value of the $n \times n$ comparison matrix, RI indicates the average random index Table 2, and CI denotes the consistency index.

Table 2 The values of the random index (RI)

n	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

The CR is more than 0.10, and the pair-wise comparison consistency is inconsistent. While the CR is 0.10 or less, the pair-wise comparison consistency is appropriate (Saaty, 1980). This AHP approach is the best method to perform this analysis to assess the weight value of each criterion and choose a decision-making model.

3.2 Use of a fuzzy link-based

Various criteria use different measurement scores, which must be organised using the degree of belief for conversion from a fuzzy input to an unclear output value (Yang et al., 2009; Abdul Rahman et al., 2019a). The lower-level criteria's (LLC) input was then converted into the upper-level criterias (ULC) output by completing the transformation process. Concerning Figure 4, the mathematical formulation is as follows (Rahmatdin et al., 2018).

$$u^j = \sum_{i=1}^5 l^i \beta_i^j \tag{6}$$

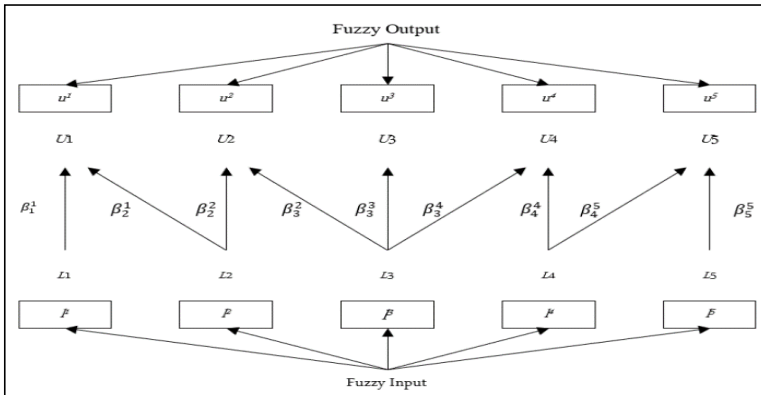
$$\sum_{i=1}^5 l^i \leq 1 \tag{7}$$

$$\sum_{j=1}^5 \beta_1^j = 1, \sum_{j=1}^5 \beta_2^j = 1, \sum_{j=1}^5 \beta_3^j = 1, \sum_{j=1}^5 \beta_4^j = 1, \sum_{j=1}^5 \beta_5^j = 1 \tag{8}$$

where u^j = fuzzy output; l^i = fuzzy input; β_i^j = belief degree value obtained from experts, ($j, i=1, 2, 3, 4$ and 5) and sum of $\sum u^j = 1$; $\sum l^i = 1$.

This study applies this method to convert the raw input data obtained from the experts to the output data using a fuzzy algorithm. Later will be transferred into the ER method to analyse a decision-making model process further.

Figure 4 The transformation process of fuzzy input values into undefined output values



Source: Rahmatdin et al. (2018), Abdul Rahman et al. (2019a)

3.3 Evidential reasoning (ER) approach

This method deals with the multi-criteria decision-making problems under uncertainty based on the D-S theory, and the ER approach was developed in the 1990s. Yang and Singh generated the ER algorithm (1994), later updated by Yang (2001) and further modified by Yang and Xu (2002). This method relies on people's talents, knowledge, and experience to comply with both qualitative and quantitative criteria in belief functions (Riahi, 2010). This method has productively applied many areas of study such as offshore designs, system assessments, container line safety assessments, and crude oil tanker selection. According to Yang and Xu (2002), assume a straightforward two-level hierarchy of attributes, with a general top-level attribute and a fundamental bottom-level attribute. Assume that a known attribute, y is correlated with L basic attributes e_i ($i = 1, 2, \dots, L$). The use of this approach can be demonstrated using a series of mathematical algorithms (Yang and Xu, 2002; Abdul Rahman et al., 2018), as well as being capable of obtaining evaluation performance using mature computational applications, such as the Intelligent Decision System (IDS) (Yang and Xu, 2002; Riahi, 2010).

This ER approach is useful in achieving the study's goal. It allows us to propose a decision-making model to SMLEs in Oman for short-term business solutions when faced with the literature's uncertainty factors.

4 Findings

Step 1 Set up a goal and decision-making criteria

The fuel price crisis, IR 4.0, COVID-19 pandemic and the SOLS 2040 vision are four contemporary factors that have placed SMLEs under much pressure at the start of the year 2020. The details of these four factors have been discussed in the literature review in Section 2. Thus, these factors have raised the question: How can SMLEs navigate this challenging period and beyond while dealing with uncertainty? Consequently, the purpose of this analysis was to analyse the uncertainty and evaluate a possible solution for SMLEs in Oman by taking these four contemporary factors into account.

Step 2 Suggestions for potential business strategies

A combination of literature surveys and expert respondents' opinions, seven potential solutions have been recommended,

- 1 managing employees and operating expenses
- 2 outsourcing business strategy
- 3 mergers and acquisitions (M&A) strategy
- 4 centralised business activities
- 5 investing in work-from-home technology
- 6 logistic blockchain strategy
- 7 selling any business assets.

Table 3 Potential solutions for SMLEs in Oman based on experts' opinions

<i>Potential business strategy</i>	<i>Expert voting (out of 10 experts)</i>	<i>Remarks</i>	<i>Suggestion</i>
Managing employees and operating expenses (OPEX)	10	<ul style="list-style-type: none"> • urgent to be implemented • immediate action required • within/internal SMLEs' control 	Immediate action
Centralised business strategy	8	<ul style="list-style-type: none"> • urgent to be implemented • immediate action required • within/internal SMLEs' control • possibly to reduce OPEX 	Immediate action
Mergers and acquisitions (M&A)	7	<ul style="list-style-type: none"> • possible to be implemented. • to survive the business operation for long term • within/internal SMLEs' control • discussion between two or more SMLEs • urgent to be implemented 	Immediate action
Logistics blockchain strategy	6	<ul style="list-style-type: none"> • high investment, but for long-term and business benefits. • SMLEs are supporting IR 4.0 and Logistics 4.0. • this is an opportunity to improve SMLEs business networking between industry, government, investors, etc. 	Immediate action
Outsourcing business strategy	5	<ul style="list-style-type: none"> • possibly to be implemented. • challenging to get it done because many businesses are also affected. • all SMLEs in Oman are in a similar condition. 	Delete and not suitable for now
Investing in work-from-home technology	4	<ul style="list-style-type: none"> • not all business operations can be carried out from home. • more investment is required if more than 20 staff work from home. • only a temporary solution, but the investment is high. • The issue with the internet coverage problem in villages, rural areas, and some places in urban areas. 	Delete and not suitable for now
Selling any business assets	2	<ul style="list-style-type: none"> • good strategy, but it shows the financial strength of the SMLEs and the business image. • it is not a good time to sell out because most SMLEs companies are thinking about surviving a business operation rather than investing in something else. 	Delete and not suitable for now

However, the experts suggested that these potential business strategies should be prioritised by taking the element 'immediate action' into account. The justification of each possible business strategy is summarised in Table 3.

After the filtration process with the cut-off point 6 and above, all the expert respondents finally agreed to carry out this research with only four potential business strategies as follows;

- 1 managing employees and operating expenses (OPEX)
- 2 centralised business strategy
- 3 M&A
- 4 logistics blockchain strategy.

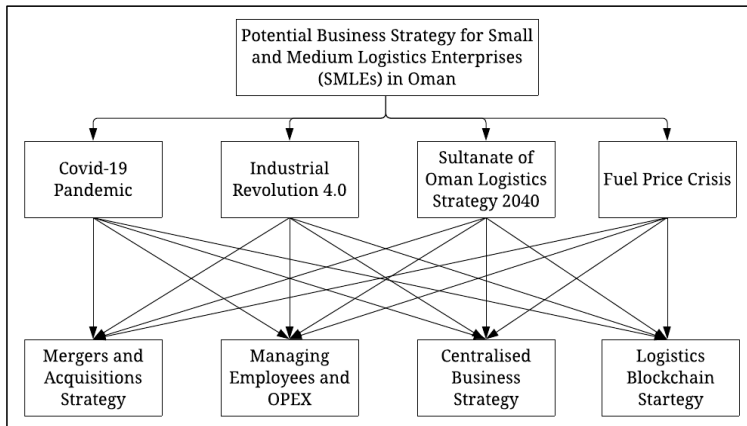
Therefore, a decision-making model will be proposed based on these four business solutions, which, particularly for a short-term period and urgently to be implemented.

Step 3 Build a decision-making model

As seen in Figure 5, an empirical model was created by integrating all of the data from Steps 1 and 2, which had three levels of information:

- 1 the goal (at the top)
- 2 the uncertainty factors (middle)
- 3 alternative business solutions that needed to be applied immediately.

Figure 5 The decision model for analysing the small and medium logistics enterprises in Oman



Step 4 Data collection process

A scale of ratios was used for the pair-wise comparisons indicated in Table 1. An example of the four main criteria, a 4x4 pair-wise comparison matrix was established to obtain its weight value. The *A(CISF)* matrix was used to express a qualified opinion on the relative matter of the COVID-19 (C), the Industrial Revolution 4.0 (I), the SOLS

2040 (S), and the fuel price crisis (F). When calculating the average score of the pair-wise comparison, the ten experts marked the priority values indicated in Table 4 using the priority of the ‘COVID-19’ criterion to the ‘Industrial Revolution 4.0’ criterion as an example.

Consequently, the total rating rate was $3 (R1) + 3 (R2) + 4 (R3) + 3 (R4) + 4 (R5) + 3 (R6) + 4 (R7) + 4 (R8) + 5 (R9) + 5 (R10) = 38$. Using equation (2), the average rating value of the ‘COVID-19’ importance to the ‘Industrial Revolution 4.0’ criterion was $38 \div 10 = 3.8$ (See Table 5). The same method was used to measure all of the qualitative data mentioned previously for constructing a pair-wise comparison matrix.

Table 4 The priority value between the criteria given by experts

Importance criteria			Respondents									
			R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
COVID-19	vs.	IR 4.0	3	3	4	3	4	3	4	4	5	5
COVID-19	vs.	SOLS 2040	3	3	3	3	3	3	3	3	5	4
COVID-19	vs.	Fuel price crisis	3	4	4	3	3	3	4	3	4	3
IR 4.0	vs.	SOLS 2040	1	1	2	1	1/2	1	1	1/3	1	1
IR 4.0	vs.	Fuel price crisis	1	1	2	1	1/2	2	1	1/3	1	1
SOLS 2040	vs.	Fuel price crisis	1	1	2	1	1/2	1	1	1/3	1/3	1

Table 5 Pair-wise comparison matrix for the main criteria

		COVID-19	IR 4.0	SOLS 2040	Fuel price crisis
A(CISF)=	COVID-19	1	3.8	3.3	3.4
	IR 4.0	1/3.8	1	0.9833	1.0833
	SOLS 2040	1/3.3	1/0.9833	1	0.9167
	Fuel price crisis	1/3.4	1/1.0833	1/0.9167	1
	SUM	1.8603	6.7401	6.3742	6.4000

Step 5 Using the AHP process, calculate the weight value for each criterion

To calculate the weight of all parameters, a pair-wise measurement technique was used. The *A(CISF)* performance ratio rate was estimated in Table 6.

The weight values for all of the main criteria were determined using equation (2). For example, the ‘COVID-19’ was calculated as follows:

$$w_{Covid-19} = \frac{0.5376 + 0.5638 + 0.5177 + 0.5313}{4} = 0.5376$$

where the criterion ‘COVID-19’ was considered to have a weight value of 0.5376. All of the other main criteria were also weighted using the same formula, and the results are summarised in Table 7.

Table 6 The main criteria performance ratio

COVID-19	$1 \div 1.8603 = 0.5376$	$3.8 \div 6.7401 = 0.5638$	$3.3 \div 6.3742 = 0.5177$	$3.4 \div 6.4000 = 0.5313$
IR 4.0	$1/3.8 \div 1.8603 = 0.1415$	$1 \div 6.7401 = 0.1484$	$0.9833 \div 6.3742 = 0.1543$	$1.0833 \div 6.4000 = 0.1693$
SOLS 2040	$1/3.3 \div 1.8603 = 0.1629$	$1/0.9833 \div 6.7401 = 0.1509$	$1 \div 6.3742 = 0.1569$	$0.9167 \div 6.4000 = 0.1432$
Fuel price crisis	$1/3.4 \div 1.8603 = 0.1581$	$1/1.0833 \div 6.7401 = 0.1370$	$1/0.9167 \div 6.3742 = 0.1711$	$1 \div 6.4000 = 0.1563$

Table 7 The weighted average value of the evaluation criteria

								Total	Weight value
COVID-19	0.5376	+	0.5638	+	0.5177	+	0.5313	+	$2.1504 \div 4 = 0.5376$
IR 4.0	0.1415	+	0.1484	+	0.1543	+	0.1693	+	$0.6135 \div 4 = 0.1534$
SOLS 2040	0.1629	+	0.1509	+	0.1569	+	0.1432	+	$0.6139 \div 4 = 0.1535$
Fuel price crisis	0.1581	+	0.1370	+	0.1711	+	0.1563	+	$0.6225 \div 4 = 0.1556$

The pair-wise comparison’s CR was then calculated. To start, each value in the pair-wise comparison matrix’s column Table 5 was multiplied by each criterion’s weight value Table 7 as follows:

	<i>COVID-19</i>		<i>IR 4.0</i>		<i>SOLS 2040</i>		<i>Fuel price crisis</i>			
0.5376	1	+	0.1534	3.8	+	0.1535	3.3	+	0.1556	3.4
	1/3.8			1			0.9833			1.0833
	1/3.3			1/0.9833			1			0.9167
	1/3.4			1/1.0833			1/0.9167			1

As a consequence, Table 8 provides a summary of the calculations.

Table 8 The total value of the calculation

									TOTAL
COVID-19	0.5376	+	0.5829	+	0.5066	+	0.5290		= 2.1516
IR 4.0	0.1415	+	0.1534	+	0.1509	+	0.1686		= 0.6144
SOLS 2040	0.1629	+	0.1560	+	0.1535	+	0.1426		= 0.6150
Fuel price crisis	0.1581	+	0.1416	+	0.1675	+	0.1556		= 0.6228

Next, the $\frac{\sum_{k=1}^n w_k a_{jk}}{w_i}$ value as indicates in equation (5) was calculated by dividing the total value of each main criterion mentioned in Table 8 with the weight value of the corresponding main criteria, as follows:

$$\frac{2.1516}{0.5376} = 4.0022; \frac{0.6144}{0.1534} = 4.0052; \frac{0.6150}{0.1535} = 4.0065; \frac{0.6228}{0.1556} = 4.0026$$

The λ_{max} value was computed as follows:

$$\lambda_{max} = \frac{4.0022 + 4.0052 + 4.0065 + 4.0026}{4} = 4.0041$$

Using equation (4), the *CI* value was calculated as follows:

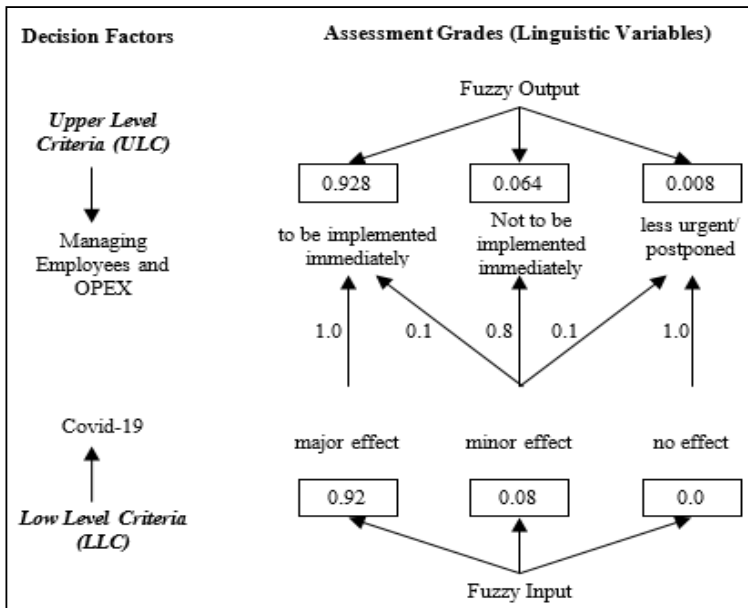
$$CI = \frac{4.0041 - 4}{4 - 1} = 0.0014$$

Equation (3) was then used to determine the *CR*. Since this analysis had four parameters, the *RI* is known to be 0.9000 Table 2, and the *CR* value of the main criteria was calculated as follows:

$$CR = \frac{0.0014}{0.9000} = 0.0016$$

The main criteria had a *CR* value of 0.0016. Since the *CR* value was less than 0.10, the degree of consistency in the pair-wise comparison was acceptable (refer to Section 3.1).

Figure 6 The procedure of converting fuzzy input values LLC to fuzzy output values ULC in relation to the alternative ‘managing employees and OPEX’



Step 6 Applying the fuzzy link-based structure to convert lower-level criteria (LLC) to upper-level criteria (ULC)

First, the assessment grades for both the main criteria and alternatives were determined by incorporating expert opinions through a discussion process, as shown in Table 9.

Table 9 The criteria and alternative assessment grades

<i>Criteria</i>	<i>Assessment grades</i>		
COVID-19	no effect	minor effect	major effect
IR 4.0	no effect	minor effect	major effect
SOLS 2040	no effect	minor effect	major effect
Fuel price crisis	no effect	minor effect	major effect
<i>Alternative</i>			
The potential strategy for small and medium logistics enterprises in Oman	to be implemented immediately	not to be implemented immediately	less urgent/postponed

After consulting with the ten experts, the fuzzy input values for each criterion concerning all the alternatives were given. For example, consider the requirements ‘COVID-19’ LLC in relation to the alternative ‘managing employees and OPEX’, the average fuzzy input values from experts were {(no effect, 0.00), (minor effect, 0.08), (major effect, 0.92)} Table 10.

The rest of the fuzzy input values of the other criteria are summarised in Table 11.

The method of converting fuzzy input values LLC to fuzzy output values ULC was carried out. To define the mapping procedure, equations (6), (7) and (8) were used to derive the fuzzy output values for the assessment grades of the criterion ‘COVID-19’ LLC in relation to the alternative ‘managing employees and OPEX’ (ULC) as follows:

To be implemented immediately	=	$(0.92 \times 1.0) + (0.08 \times 0.1)$	= 0.928
Not to be implemented immediately	=	(0.08×0.8)	= 0.064
Less urgent/postponed	=	$(0.0 \times 0.1) + (0.08 \times 0.1)$	= 0.008
<i>1.000</i>			

Figure 6 depicts the linguistic variable used for the assessment of grades of fuzzy input and fuzzy output. Thus, the fuzzy output values of the criterion ‘COVID-19’ LLC in relation to the alternative ‘managing employees and OPEX’ ULC by applying the rule-based principle were {(to be implemented immediately, 0.928), (not to be implemented immediately, 0.064), (less urgent/postponed, 0.008)}. The same technique was used to convert all of the fuzzy input values of the parameters LLC to the fuzzy output values ULC of the respective alternatives. Table 12 lists the fuzzy output values of the parameters in comparison to all other options.

Table 11 The values of fuzzy input for all criteria in relation to the alternatives

		<i>Assessment grades</i>		
		<i>No effect</i>	<i>Minor effect</i>	<i>Major effect</i>
Mergers and acquisitions strategy	COVID-19		0.07	0.93
	IR 4.0	0.85	0.15	
	SOLS 2040	0.69	0.31	
	Fuel price crisis	1.00		
Managing employees and OPEX	COVID-19		0.08	0.92
	IR 4.0	0.80	0.20	
	SOLS 2040	0.90	0.10	
	Fuel price crisis	0.91	0.09	
Centralised business activities	COVID-19		0.10	0.9
	IR 4.0	0.64	0.36	
	SOLS 2040	0.94	0.06	
	Fuel price crisis	0.66	0.34	
Logistics blockchain strategy	COVID-19	0.25	0.55	0.20
	IR 4.0	0.22	0.30	0.48
	SOLS 2040	0.54	0.46	
	Fuel price crisis	0.72	0.28	

Table 12 The fuzzy output values of the criteria in relation to all alternatives

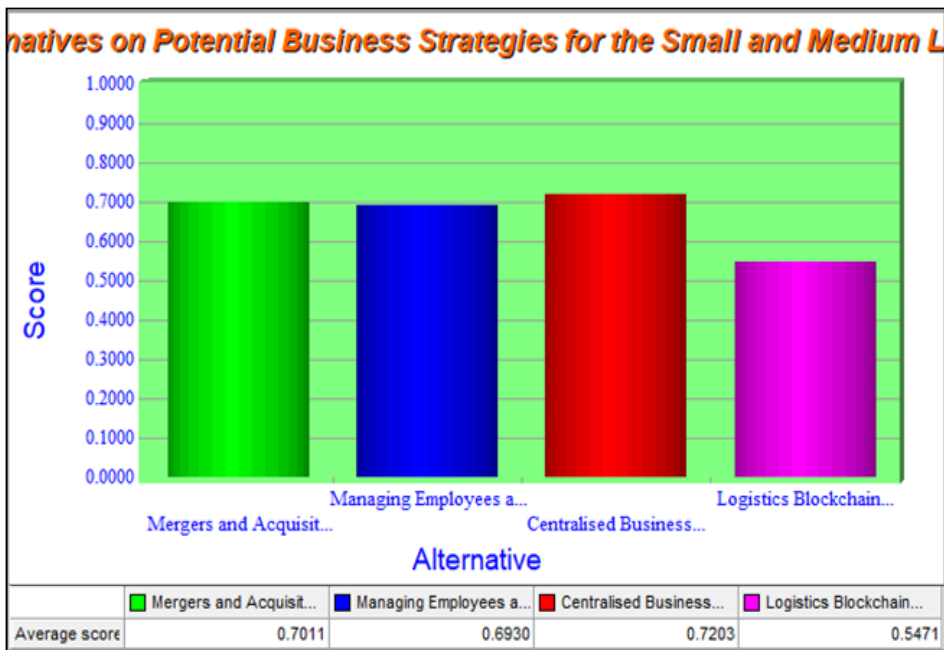
<i>Fuzzy output value/belief degree</i>		<i>Assessment grades</i>		
		<i>to be implemented immediately</i>	<i>not to be implemented immediately</i>	<i>less urgent/postponed</i>
Mergers and acquisitions strategy	COVID-19	0.937	0.056	0.007
	IR 4.0	0.015	0.120	0.865
	SOLS 2040	0.031	0.248	0.721
	Fuel price crisis			1.000
Managing employees and OPEX	COVID-19	0.928	0.064	0.008
	IR 4.0	0.020	0.160	0.820
	SOLS 2040	0.010	0.080	0.910
	Fuel price crisis	0.009	0.072	0.919
Centralised business activities	COVID-19	0.910	0.080	0.010
	IR 4.0	0.036	0.288	0.676
	SOLS 2040	0.006	0.048	0.946
	Fuel price crisis	0.034	0.272	0.694
Logistics blockchain strategy	COVID-19	0.255	0.440	0.305
	IR 4.0	0.510	0.240	0.250
	SOLS 2040	0.046	0.368	0.586
	Fuel price crisis	0.028	0.224	0.748

Step 7 Use the evidential reasoning method and the intelligent decision system (IDS) software tool to calculate the alternatives

Next, the ER approach was used to conduct a synthesis. Based on the analysis inputs data of Table 7 (the weight values) and Table 12 (the belief values of fuzzy output), it then was transferred into the IDS software, which will carry out the calculations and propose a decision model of the numerous potential business solutions to the SMLEs in Oman.

After considering the four contemporary uncertainty factors (as described in Section 2) faced by SMLEs in Oman, the overall assessment was summarised in Figure 7 by showing the average scores with respect to all the alternatives. For instance, the business strategies which scored more than 70% are ‘centralised business activities’ (72.03%) and ‘M&A Strategy’ (70.11%), then followed by ‘managing employees and OPEX’ (69.30%) and the business strategy which lowest percentage is ‘logistics blockchain strategy’ (54.71%). Also, it was shown that during this critical year of 2020, the business strategy, ‘logistics blockchain strategy’, was the least urgent strategy for Oman’s SMLEs.

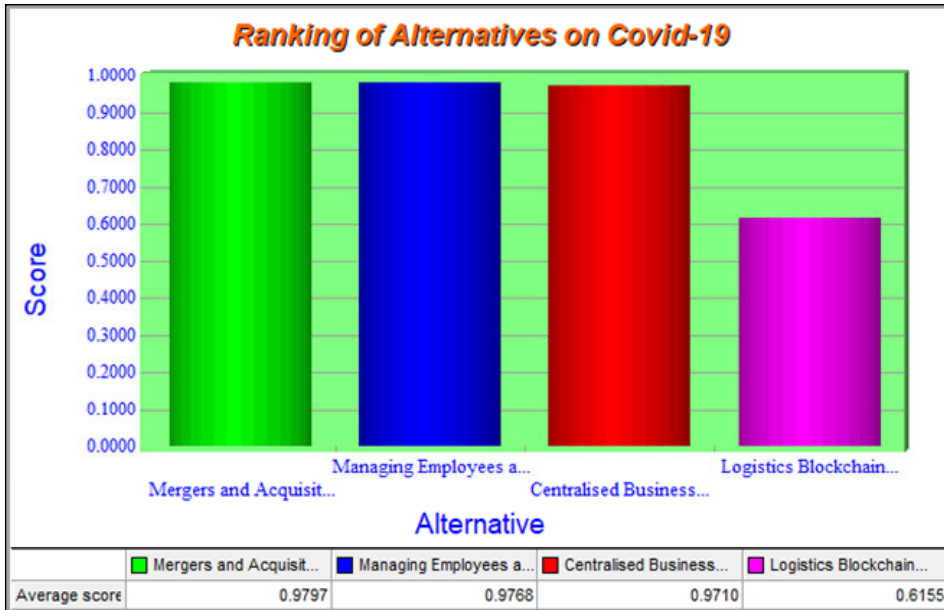
Figure 7 Overall score for a potential business strategy on small and medium logistics enterprises in Oman (see online version for colours)



The ‘centralised business activities’ business strategy is preferable and more important to be implemented immediately. In another sense, by implementing this ‘centralised business activities’ business strategy, indirectly the SMLEs companies are incorporating with the ‘managing employees and OPEX’ business strategy as well. For instance, if SMLEs have two and more business distribution centres (DC) within Oman. However, during this challenging time, there is less business demand and operations at almost all DCs. The ‘centralised business activities’ business strategy is the best synergistic strategy

for reducing operating costs, managing employees, and eliminating unnecessary expenses. In addition, it enables the SMLEs companies to increase the degree of control over activities and harmonisation, and create standardised logistics processes to achieve cost control at its maximum, improve efficiency, and improve customer experience.

Figure 8 Ranking of alternatives on COVID-19 scenario (see online version for colours)



This major decision to be implemented immediately is also supported by the geographical factor in Oman, which currently has a total population of 5,126,990 people within a total land area is 309,500 square kilometres (Km²) (Worldometer, 2020). Furthermore, Oman has a population density of 16 people per Km², while 87% are concentrated in the urban area (4,442,970 people) which most centralised populations are located at Muscat, Sohar and Salalah. Also, it is considered as the geographical market positioning reason.

4.1 Discussion – ranking of business strategy with respect to the criteria

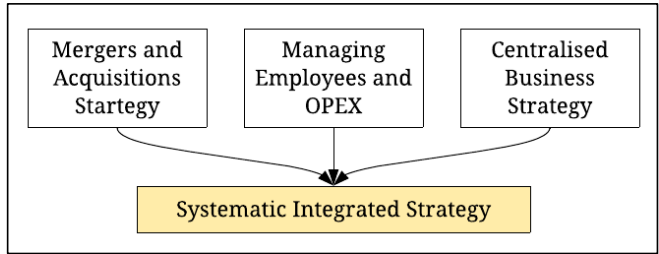
This section presents the results of the analyses obtained from the IDS software on the ranking of business strategies with respect to the criterion. The first analysis delivered a scenario on the impact of the critical period of the ‘COVID-19’. The results showed that three out of four strategies were reasonably practical for immediate implementation in 2020, as shown in Figure 8. The highest recommended strategy by the respondents was the alternative, ‘M&A strategy’, with a degree of belief of 0.9797 @ 97.97%, followed by the alternative, ‘managing employees and OPEX’ in second place with a degree of belief amounted for 0.9768 @ 97.68%. The third recommended strategy was the alternative, ‘centralised business activities’, with a degree of belief generated for 0.9710 @ 97.10%. The least recommended approach was the alternative, ‘logistics blockchain strategy’, with a degree of belief accounted for 0.6155 @ 61.55%. The results showed

that SMLEs in Oman had been affected significantly by the COVID-19 pandemic and should choose to implement the top three strategies immediately.

As the degrees of belief of the alternatives, namely, ‘M&A strategy’, ‘managing employees and OPEX’ and ‘centralised business activities’, were almost similar at around 97%. Therefore, the systematic, integrated business strategy was simultaneously recommended for immediate implementation with respect to the criterion, ‘COVID-19’ situation. To obtain the optimum solution to mitigate the COVID-19 crisis, this study constructed a systematic, integrated strategy that combined and applied the three solutions simultaneously. Figure 9 represents the systematic, integrated strategy combining of three alternatives as a strategy in the COVID-19 scenario. During this pandemic crisis, Oman’s SMLEs should benefit from a ‘M&A Strategy’ through business synergies between SMLEs with SMLEs or SMLEs with large companies.

Moreover, synergies with large companies are beneficial due to their stable capital and greater specialisation. This was followed by the ‘managing employees and OPEX’ strategy, which defined how well SMLEs can manage and restructuring the utilisation of the existing firm’s primary resources (labour and cost) in dealing with market changes due to this pandemic. The final strategy in facing the COVID-19 pandemic is for SMLEs in Oman to switch to centralised business activities instead of using conventional practices.

Figure 9 A systematic, integrated strategy on COVID-19 scenario (see online version for colours)

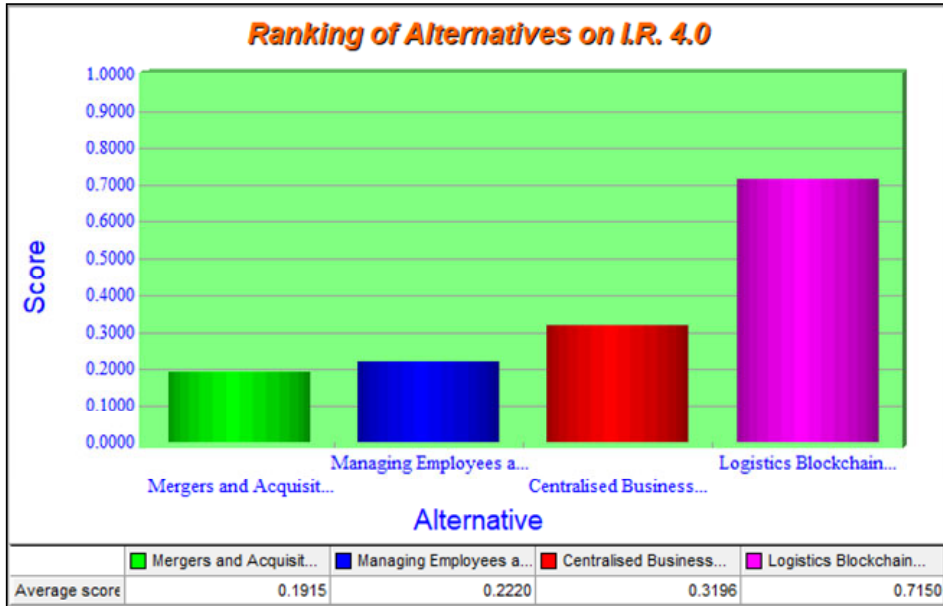


Next, the international pressure from the current IR 4.0 has not considerably impacted Oman’s SMLEs. Although most of the respondents were aware of the global directive of IR 4.0, this criterion is not a priority of the logistics sector for 2020. Figure 10 shows the ranking of alternatives on IR 4.0. Therefore, for the criterion ‘IR 4.0’, the respondents selected as its strategy the alternative, ‘logistics blockchain strategy’, with a degree of belief accounted for 0.7150 @ 71.50%. This strategy has to do with artificial intelligence, robotics, the internet of Things, and other relevant technology. Therefore, the respondents recommended that this alternative be ‘less urgent/postponed’ and ‘not to be implemented immediately’.

Figure 11 describes the degree of belief values of the alternative to the criterion, ‘SOLS 2040’. The alternative, ‘logistics blockchain strategy’, had the highest degree of belief of 0.3806 @ 38.06%. In second place was the alternative, ‘M&A strategy’, with a degree of belief generated for 0.2891 @ 28.91%, followed by the alternative, ‘managing employees and OPEX’, in third place with a degree of belief made up of 0.1610 @ 16.10%. Finally, the alternative, ‘centralised business activities’, had the lowest degree of belief amounted to 0.1366 @ 13.66%. The figures directly showed that in the opinion of

the respondents, the vision of the SOLS 2040 requires support from a ‘logistics blockchain strategy’ and ‘M&A strategy’. The SOLS 2040 vision needs the IoT and a blockchain system that links the entire logistics sector in Oman onto one host/platform. Also, to achieve this SOLS 2040 vision, SMLEs must combine their businesses through the ‘M&A strategy’ to become one big logistics company. This is because SMLEs cannot afford the huge investments required in a logistics blockchain system far behind the business screen. Thus, small and medium logistics businesses must move into big/stable logistics companies via the alternative of ‘M&A strategy’.

Figure 10 Ranking of alternatives on IR 4.0 scenario (see online version for colours)



Meanwhile, Figure 12 depicts the ranking of alternatives on fuel price crisis. For the ‘fuel price crisis’ criterion, the highest degree of belief value comprised of 0.3074 @ 30.74% was associated with the ‘centralised business activities’ alternative, followed by the ‘logistics blockchain strategy’ alternative with a degree of belief represented of 0.2708 @ 27.08%. The ‘managing employees and OPEX’ alternative was ranked third with a degree of belief that amounted to 0.1549 @ 15.49%. In comparison, the ‘M&A strategy’ alternative was ranked last with a degree of belief scored at only 0.1000 @ 10.00%. Although the fuel price crisis is being debated at the national level, some small and medium logistics companies have shown that their business has not been affected. Instead, the crisis has positively impacted their logistics companies as the fuel cost has been automatically reduced. According to the respondents, the fuel cost was around 35%–50% of the company’s total expenses. As such, a ‘centralised business activities’ alternative is recommended for this scenario that helps to optimise the business strategy.

Figure 11 Ranking of alternatives on SOLS 2040 scenario (see online version for colours)

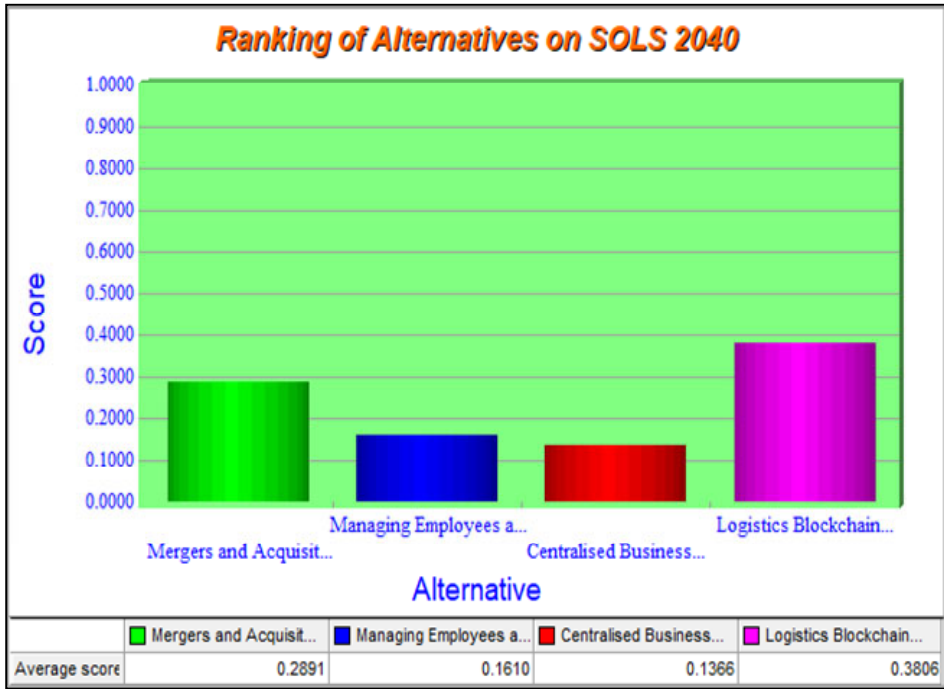
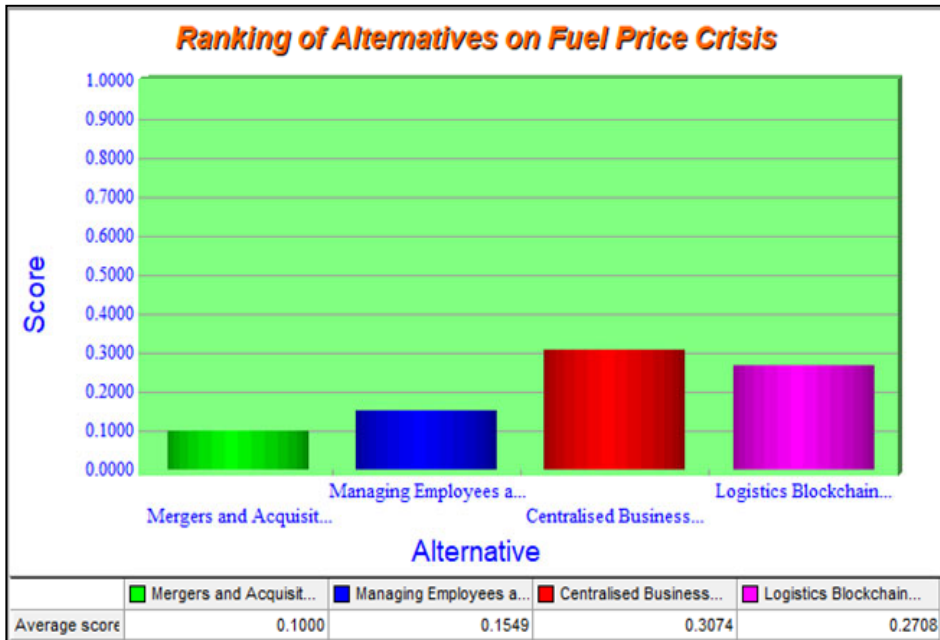


Figure 12 Ranking of alternatives on fuel price crisis scenario (see online version for colours)



5 Managerial and practical contributions

The contribution of this analysis was a proposed systematic, holistic business strategy model to battle COVID-19 in 2021, which was in conjunction with the need for SMLEs to sustain the logistics sector in Oman. The government of Oman could assist SMLEs financially by offering low-interest government loans and tax reductions. These benefits would help them successfully sustain and transform their businesses, which is vital for their economy. Also, this study contributes to social development directly by creating more employment opportunities for the residents, particularly to sustain the SMLEs business activity in Oman.

In addition, this research contributes to the comprehensive analysis of the literature, especially in the study of SMLEs in Oman. The presentation of emerging uncertainty on contemporary factors and decision-making models, in particular, is the main theoretical contribution of this study to the Oman SMLEs. However, any additional variables can be conveniently added to the proposed research model if new external variables are triggered. It undoubtedly leads to the update of a new study finding; however, the underlying philosophy remains.

Furthermore, the study's reliability demonstrates that this research theory is transferable to stakeholders and industry societies such as SMLEs in Oman and other logistics companies worldwide. The theoretical model can also be extended to other research fields such as container terminal efficiency, warehousing, any supply chain business, organisation, management, and others to enhance understanding of research knowledge. Although this study's practical value applies to organisational and managerial needs, it is advantageous in responding to the emerging uncertainty of external factors in the business logistic context.

6 Conclusions

Numerous alternative market models for SMLEs in Oman have been systematically developed using a hybrid decision management paradigm called AHP, fuzzy link-based, and ER approaches. The logistics industry in Oman is a thriving industry that has helped the country establish itself as a regional logistics centre and a gateway to the Gulf Cooperation Council. As a result, this study emphasised how SMLEs in Oman could model their business strategies in the short term to address problems caused by uncertainty factors, for instance, the SOLS 2040, IR 4.0, the COVID-19 crisis and the fuel price crisis. Furthermore, the findings of this study revealed that each pressure indicator necessitated the introduction of various business strategy alternatives, especially for the year 2021/2022.

The novel proposed business strategy framework analysis reflecting the criteria significantly impacted Oman's SMLEs to determine which strategy should be implemented immediately, based on the current pressures in 2020/2021. This study model and findings are applicable internationally, subject to changes in contemporary factors and national vision/goals.

The limitation of this study is that only a selected number of experts volunteered to participate in this study. As a result, ten experts with vast experience in the logistics SMEs in Oman engaged in the survey. They focused group discussion sessions on examining the most crucial uncertainty factors that have emerged in the SMLEs'

day-to-day business activities in Oman over the last two years, 2019-2020. These were due to the complexity of the research scopes, where only the qualified experts were the selected targeted respondents for this research. Hence, by taking the rule of thumb suggested by Nunnally (1978) and Boateng et al. (2018), the ideal/ sufficient number of respondents for a complex and resources limited research can be at least 10 participants for each scale item (ratio of 10:1). In this regard, the total of 10 experts used in this study is acceptable, and enough since this research is a case study for demonstrating the decision analysis model calculation process and the findings are not intended for generalisation purposes. Nevertheless, this research work can serve as a baseline for future research in which the approaches can be transferred or adopted, where appropriate, to a comparable test case to evaluate and make the decisions on the uncertain conditions. In addition, future study results might also be compared to this research for benchmarking and improvement in all areas.

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