Identifying and prioritisation entrepreneurial behaviour factors using fuzzy AHP approach

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Abstract: The purpose of this research is to realise how organisations have been sustaining their growth through applying entrepreneurial behaviour factors. Regarding the thematic nature of research model, experts' opinion in oil industry, companies in oil industry have been examined in the current study included: 1) oil pipeline and telecommunication company; 2) oil products distribution company; 3) National Gas Company in Semnan and Khorasan province have been brought for this research as statistic population. The number of experts participating in the study is 30 persons who were interested in improving discussion. The main tools used for gathering the data in this study were company records and questionnaire. In this study, structural factors, underlying factors, behaviour factors sub-criteria were ranked regarding to criteria related to different levels of entrepreneurial behaviour sub-criteria of oil industry by using fuzzy analytic hierarchy process (FAHP). The results obtained from fuzzy AHP method according to the entrepreneurial behaviour factors indicate that structural factors are more important than underlying factors and behaviour factors. According to the structural factors scale, it is concluded that entrepreneur organisation structure is more important than other factors.

Keywords: entrepreneur; entrepreneurship benefits; entrepreneurial behaviour; fuzzy analytic hierarchy process; FAHP.


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1 Introduction

Policies that allow European economies to capitalise on the entrepreneurial potential of individuals from all walks of life, with the dual aim of spurring economic growth and promoting social inclusion. Governments have often looked to stimulate entrepreneurial behaviour amongst particular social groups, such as ethnic minorities, lone parents, and the disabled, to reduce unemployment and to unlock human capital for the benefit of society. Research on entrepreneurship has increasingly drawn attention to the barriers faced by different social groups (Kautonen et al., 2015). Entrepreneurship can be increased through education, especially entrepreneurship education, in particular, the role of entrepreneurship education has been called for as one of the key instruments to increase the entrepreneurial attitudes of people (Usaci, 2015). Entrepreneurship, like every social phenomenon, needs to be provided with a specific environment in order to be up-to-date and to be able to promote itself. Entrepreneurial environment is composed of the factors which are playing an important role in entrepreneurship development (Gnyawali and Fogel, 1994). There is an intricate relationship between environment and company’s development. Three structures are most influential ones on developmental rate of a small business including:

1 improving attitude of company’s manager
2 entrepreneurial attitude of company
3 dynamism of environment in which the company is performing (Wiklund et al., 2009).

Entrepreneurial values support the development of new activities within the firm and the renewal of ongoing business activities that have become stagnant or in need of progress. Entrepreneurial activities have also resulted in important consequences for economic growth and national development worldwide during recent decades (Szyliowicz and Galvin, 2010). Entrepreneurship was an immediate action for providing new goods or services and establishing new business which in turn lead to putting existing goods and services and relationship away within a market. Nowadays, instead of being considered as an event, Entrepreneurship is more considered as a process which is shaped by organisational culture and is seeking to make value by using existent resources through exploring opportunities (Tajeddini, 2010). Although entrepreneurship mostly has been taken as an individual concept; today our point of view about this subject has changed permanently. Entrepreneurship is not only the characteristic of different, brave, talented, and genius individuals but also an institutional concept (Özdemirci, 2011). Entrepreneurship is a process and purposeful activity that combines risk, creativeness, personal success and/or innovation and requires taking financial, moral and social responsibility to setup a new and profitable business idea (Askun and Yıldırım, 2011). New entrepreneurship starts from some novel companies which introduce new services and goods to the competitive market and are known as small and medium enterprises (SMEs). Nowadays, SME’s role in the development of countries all over the world is identified and it is confirmed by the results of studies, researches, and reports presented by media and various press. Entrepreneurship and supporting entrepreneurs is of a discussion which is closely related to SMEs. Issues such as development and job creation have been affected by the relationship between Entrepreneurship with SMEs. SMEs have
played a vital role in any country’s economic health and it is of most importance to support them (Aernoundt, 2004). SMEs are the foundation of the global economy and play a vital role in job creation. The success and vitality of SMEs are recognised as important elements in measuring an economy’s progress and future development. Additionally, entrepreneurship has been the topic of scholarship and research in a variety of academic fields. Entrepreneurship has been viewed as an engine of economic growth and social development. It is not only a driver for economic competition and employment creation, but also an instrument for personal development and solving social problem (Tsai and Kuo, 2011). To engage in entrepreneurial activity, persons need to monitor the environmental changes and to evaluate the effects of changes on their own new business. Inability of an entrepreneur to predict the commercial success leads to environmental uncertainty which in turn is able to prevent him for conducting an entrepreneurial activity (Gold et al., 2001). Organisations need to be adapted to be survived and must remain competitive in a complex; demanding and changing economic environment and therefore should adopt a more entrepreneurial approach to manage decision-making process.

‘Corporate entrepreneurship’ is a process that enhances the level of activity and hence performance (Burgess, 2013). Although entrepreneurial behaviour of established businesses is viewed as a crucial prerequisite for growth and performance in dynamic environments corporate entrepreneurship (or entrepreneurial behaviour, to introduce the term used widely and interchangeably in this paper) refers to processes in established businesses leading to:

1. innovativeness
2. pro-activeness
3. risk taking.

Hence, by showing an entrepreneurial orientation, businesses enlarge their ability to gain sustainable competitive advantage (Weismeier-Sammer, 2011). Determining structural factors, underlying factors, behaviour factors sub-criteria priorities by considering one level of entrepreneurial behaviour sub-criteria of factors effective on entrepreneurial behaviour success is the research problem.

2 Entrepreneurship, entrepreneur and benefits of entrepreneurship

Currently, entrepreneurship is considered as one of the main driving forces of economy in every modern society which in turn is used as a tool to encounter new competitive insights and changes more quickly (Kraus and Kauranen, 2009). Entrepreneurship is the practice of starting new organisations or revitalising mature organisations, particularly new businesses generally in response to identified opportunities. Entrepreneurship as a mechanism that converts economic knowledge into economic growth (Carlsson et al., 2009). This gradually formed an idea in the literature of entrepreneurship which focuses on organisations, cultures and organisational processes and is entitled ‘entrepreneurship’. According to experts, “entrepreneurship is considered as an instrument for the development and improvement of business, increase in income and interest, pioneering in the development of products, services and novel activities” (Safari et al., 2010). The term ‘entrepreneurship’ encompasses a wide range of definitions. Its definitions include tolerance of ambiguity, new composition of manufacturing resources, abilities of
entrepreneurs to compensate markets shortage through activities complementary for manufacturing resources, ability to deal with imbalance and ability to make legitimate decisions about the coordination of scarce resources. Entrepreneurship is a dynamic process towards increasing the capitals. It is also a process which creates a new element using creativity and is accompanied by using time, resources, risks, and other factors. Entrepreneurship is an endless and fundamental resource in all societies; one which is related to the individual's creativity. It is both cheap and valuable. When entrepreneurship is accepted as a profession by many of the society members, society develops so fast. That is, entrepreneurship affects individuals’ social and economic development directly. According to experts, ‘human resources’ are the most important factors among those which affect work and production (Ghasemi et al., 2011).

Entrepreneurship is the practice of starting new organisations or revitalising mature organisations, particularly new businesses generally in response to identified opportunities. Entrepreneurship is often a difficult undertaking (Shahhosseini et al., 2011). An entrepreneur is an individual who establishes and manages a business for the principles of profit and growth. Entrepreneurs known as taking at least moderator level of risks such as: economic, social, carrier, psychological and health risks (Deniz et al., 2011). Briefly, we can classify the definitions in two categories; i-who is the entrepreneur? As a particular person or as the product of a particular environment, ii-or what does the entrepreneur do?; as the performer of a particular role in society, or as a specific input to the economy, events and processes (Dincer et al., 2011). Entrepreneurship is a dominant factor in the economy; researchers have examined a number of factors that may explain entrepreneurial activity, though a good deal of recent research has tended to focus on the characteristics of the business and industrial environment or the characteristics of the entrepreneurial opportunity itself. Our understanding of entrepreneurship will not be complete unless we understand the motivation of the individuals involved. Recent research suggests that motivational traits and creativity are important factors in entrepreneurial activity and success. Research on the motivational traits of entrepreneurs seems especially promising for helping to identify those individuals that might be best suited for identifying and exploiting entrepreneurial opportunities in the market place (Deniz et al., 2011). Although, there are different interpretations about the role of entrepreneur but it is known as function used for exploring available opportunities in market. Such operations are often associated with the allocation of productive inputs. Therefore, there is a relationship between entrepreneur with productivity and initiative (Zheng et al., 2009). Entrepreneur is an innovative person that performs five functions:

1. manufacturing a new product with new quality
2. creating a new manufacturing procedure
3. opening a new market
4. capturing a new delivery resource
5. setting up a new organisation or enterprise (Zeqiri, 2010).

Entrepreneurship is a process of discovering, evaluating, and exploring opportunities to produce goods and services in future. Decisions about the new composition of resources are made by entrepreneur based on the evaluation of information and available
knowledge. Innovation is one of the essential aspects of entrepreneurship which is simplified by business knowledge. Development of new product improves both profitability and development of the national economy which in turn are associated with development of organisational knowledge (Lee and Wiliams, 2007). Entrepreneurs are able to produce wealth through discovering opportunities and then extending competitive advantages to explore these opportunities (Tanţău, 2008). Entrepreneurship is a process which is created by novelty. In particular, entrepreneurship means to mix resources in new ways, to introduce productivity in the form of products and services, processes, managerial or structural techniques which in turn may be used as source of value (Ireland and Webb, 2009). The main result of entrepreneurship is to achieve long-term results. It means an organisation which is able to be adapted by variable situations and to be survived. This is of most importance in today’s unstable and sophisticated world. World economic system makes competition more difficult than before. Productive organisations are better equipped than old ones for competition. They are able to react quickly and effectively against external changes. Environmental changes are originated from different sources including: competitors, costumers, providers, new technologies, governmental institutions, political institutes, and the entire community. Every section of an organisation need to be able to react appropriately against emerging different factors implementing changes in an organisation. In addition to long-term results (adaptability and survival) two other benefits assumed for entrepreneurship are as follow.

First, the relationship between organisation and costumers will be improved. Since customers are one of the most important sources of information, more attention will be paid to their needs, interests, and opinions. Having happier and generally better costumers are desirable results.

Second, the organisation is a better place to work. Thus, this will be a reason for pleasure, motivation, and encouragement for more work. This also helps us to improve the morality in relationship existed among the members of an organisation. Although the organisation’s products and services are primarily focused on entrepreneurship, but employee pays more attention to their working process. Entrepreneurship helps us to enhance the relationship with the external individuals which in turn lead organisation to take more responsibility in the society (Cornwall and Baron, 1990).

2.1 Entrepreneurial behaviour

Established definitions of entrepreneurial behaviour within existing firms are typically restricted to discrete entrepreneurial events such as the creation of new organisations, new ventures new entry, or new product development. While important, narrowly defined notions of grand entrepreneurship remain inapplicable to various entrepreneurial phenomena occurring in large established firms. Entrepreneurial behaviour within an existing traditional organisation as a set of activities and practices by which individuals at multiple levels autonomously generate and use innovative resource combinations to identify and pursue opportunities. While innovation, autonomy and opportunities are defining elements of entrepreneurship general (Mair, 2002). Creative and novel behaviours are the lifeblood of entrepreneurship (Tang, 2016). Entrepreneurial behaviour is transitory. Moreover, estimates of the number of people who engage in entrepreneurial behaviour range from 20% of the population to over 50% Since a large and diverse group of people engage in the transitory process of entrepreneurship, it is improbable that entrepreneurship can be explained solely by reference to a characteristic of certain people.
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independent of the situations in which they find themselves. Therefore, when we argue that some people and not others engage in entrepreneurial behaviour. We are describing the tendency of certain people to respond to the situational cues of opportunities not a stable characteristic that differentiates some people from others across all situations (Shane and Venkataraman, 2000). The relationship between entrepreneurial behaviour and performance in large organisations has been assessed differently across time. During the 1980s, argued that it was difficult for people to act entrepreneurially in bureaucratic organisational structures. During this same time period, others suggested that for companies of any size, entrepreneurial behaviour was possible, should be encouraged, and could be expected to enhance firm performance. A significant change in the general perception of the value of entrepreneurial behaviour as a predictor of firm performance took place throughout the 1990s. This was a time during which companies were redefining their businesses, thinking about how to most effectively use human resources, and learning how to compete in the global economy (Kuratko et al., 2005). In short, this was a time during which “…some of the world’s best-known companies had to endure painful transformation to become more entrepreneurial. These companies had to endure years of reorganization, downsizing, and restructuring. These changes altered the identity or culture of these firms, infusing a new entrepreneurial spirit throughout their operations … change, innovations, and entrepreneurship became highly regarded words that describe what successful companies must do to survive” [Zahra et al., (1999), p.5]. Entrepreneurial behaviour continues to be seen as an important path to competitive advantage and improved performance in firms of all types and sizes. Some believe that firms failing to effectively use entrepreneurial actions in the fast-paced and complex global economy reduce the probability of successful competition in their chosen markets. Entrepreneurial behaviour does not occur in a vacuum; rather, it takes place within the context of the organisation’s full array of actions. Establishing an internal environment in large, established organisations that serves as an antecedent to entrepreneurial behaviour is challenging and requires appropriate decisions and actions. In its broadest conception, entrepreneurial behaviour is a comprehensive term that captures all actions taken by a firm’s members that relate to the discovery, evaluation, and exploitation of entrepreneurial opportunities. Defined by newness, entrepreneurial actions involve the firm and its members with the use of new resources, interactions with new customers, involvements with new markets and/or with new combinations of its existing resource portfolio, customer base, and served markets. Thus, entrepreneurial actions are the conduit through which corporate entrepreneurship is practiced in established organisations. By extension, the entrepreneurial behaviour of middle-level managers is fundamentally defined by these individuals’ behaviours that relate to the discovery, evaluation, and exploitation of entrepreneurial opportunities. Still, while this conceptualisation may be technically accurate, as a practical matter, it is not particularly informative. Specific actions are not implied by the words discover, evaluate, or exploit (Kuratko et al., 2005).

2.2 Conceptual model

In present study, conceptual models (Figure 1 and shown in Appendix B) introduced by Sarabi et al. (2012), Kavosi and Rahmati (2011) and Gharakhani (2012), were used. Level 2 including structural factors, underlying factors, behaviour factors criteria is used
from Sarabi et al. (2012), Kavosi and Rahmati (2011), Gharakhani (2012), and level 3 including sub-scale for structural factors, underlying factors, behaviour factors levels. Structural factors sub-criteria including entrepreneur organisation structure, entrepreneur organisation strategy, financial system, performance evaluation system, information system, research and development system, reward system, and human resource development were extracted from Sarabi et al. (2012), Kavosi and Rahmati (2011) and Gharakhani (2012), underlying factors sub-criteria including political factors/government, communication, uncertainty/changes, sub-structure, availability to resource, technology, market, and complexity from Sarabi et al. (2012) and Kavosi and Rahmati (2011), behaviour factors sub-criteria including organisational culture, management support, risk taking, manager characteristics, employee’s characteristics, employee empowerment, team spirit, entrepreneur organisation leadership style, creativity and innovation, self-efficacy, foresight, and previous experience from Sarabi et al. (2012), Kavosi and Rahmati (2011) and Gharakhani (2012).

3 Research methodology

In our case study, we use fuzzy AHP technique to choose the best entrepreneurial behaviour factors to develop and improve its competitive advantages at oil industry. This research is of a functional and descriptive-survey type. The fuzzy analytic hierarchy process (FAHP) using Chang’s (1996) extent analysis technique is used as the main statistical method of this study. Firstly, in the questionnaire, experts in oil industry in Iran were asked to compare and state their opinions on the different components of the conceptual model. According to the subjective nature of research model and experts opinion, expert specialists of three Iranian companies in oil industry were selected as expert. Companies in oil industry have been examined in current study included:

1. oil pipeline and telecommunication company
2. oil products distribution company
3. National Gas Company in Semnan and Khorasan province have been brought for this research as statistic population, the significance of each intended option is determined by experts in this stage.

We sent a questionnaire to a group comprising 40 senior experts on April 2015 and received the feedback in May 2015. Of the 40 questions, 30 were used in this study. In this research, bosses and managers had more than 20 years experience and at least bachelor in above-mentioned companies. The main tools used for gathering the data in this study were company records and questionnaire. Experts were asked to express their own ideas about the comparison performed among the elements of conceptual model. In order to get experts’ ideas with respect to the verbal expression in FAHP method, verbal expression listed in Table 1 (Appendix C) were used.

3.1 FAHP method

Despite its wide range of application, the conventional AHP approach may not be able to fully reflect the style of human thinking. One reason is that decision makers usually feel more confident to give interval judgements rather than to express their judgements in the
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form of single numeric values. As a result, fuzzy AHP and its extensions are developed to solve alternative selection and justification problems. Although fuzzy AHP requires tedious computations, it is capable of capturing a human’s appraisal of ambiguity when complex multi-attribute decision making problems are considered. Chang (1996) developed a fuzzy extent analysis for AHP, which has similar steps to those of Saaty’s crisp AHP. However, his approach is relatively easier in computation than the other fuzzy AHP approaches. In this paper, we made use of Chang’s fuzzy extent analysis for AHP.

Let \( O = \{o_1, o_2, \ldots, o_n\} \) be an object set, and \( U = \{g_1, g_2, \ldots, g_m\} \) be a goal set. According to the Chang’s extent analysis, the objects are considered one by one and the analysis is carried out for each of the possible goals, \( g_i \). Therefore, \( m \) extent analysis values for each object are obtained and shown as follows:

\[
M_1^1, M_2^1, \ldots, M_m^1, 1, 2, \ldots, n
\]

where \( M_j^i \) (\( j = 1, 2, \ldots, m \)) are all triangular fuzzy numbers. The membership function of the triangular fuzzy number is denoted by \( M(x) \). The definitions of the triangular fuzzy number and the fuzzy algebraic operations for fuzzy triangular numbers are given in Appendix A. The steps of the Chang’s extent analysis can be summarised as follows:

Step 1 The value of fuzzy synthetic extent with respect to the \( i^{th} \) object is defined as:

\[
S_i = \sum_{j=1}^{m} M_j^i \times \left[ \sum_{i=1}^{n} \sum_{j=1}^{m} M_j^i \right]^{-1}
\]  

(1)

where \( \times \) denotes the extended multiplication of two fuzzy numbers. In order to obtain \( \sum_{j=1}^{m} M_j^i \), we perform the addition of extent analysis values for a particular matrix such that,

\[
\sum_{j=1}^{m} M_j^i = \left( \sum_{i=1}^{n} l_i, \sum_{i=1}^{n} m_i, \sum_{i=1}^{n} u_i \right)
\]  

(2)

And to obtain \( \left[ \sum_{i=1}^{n} \sum_{j=1}^{m} M_j^i \right]^{-1} \) we perform the fuzzy addition operation of \( M_j^i \) (\( i = 1, 2, \ldots, m \)) values such that,

\[
\sum_{i=1}^{n} \sum_{j=1}^{m} M_j^i = \left( \sum_{i=1}^{n} l_i, \sum_{i=1}^{n} m_i, \sum_{i=1}^{n} u_i \right)
\]  

(3)

Then, the inverse of the vector is computed as,

\[
\left[ \sum_{i=1}^{n} \sum_{j=1}^{m} M_j^i \right]^{-1} = \left( \frac{1}{\sum_{i=1}^{n} u_i}, \frac{1}{\sum_{i=1}^{n} m_i}, \frac{1}{\sum_{i=1}^{n} l_i} \right)
\]

(4)

where \( \forall u_i, m_i, l_i > 0 \)

Finally, to obtain the \( S_j \) in equation (1), we perform the following multiplication:
Step 2 The degree of possibility $M_2 = (l_2, m_2, u_2) > M_1 = (l_1, m_1, u_1)$ of is defined and shown in Appendix B

\[ V(M_2 \geq M_1) = \sup_{x \in X} \left[ \min \left( M_1(x), M_2(x) \right) \right] \]  

(6)

This can be equivalently expressed as,

\[ V(M_2 \geq M_1) = \text{hgt}(M_1 \cap M_2) = M_2(d) \]

(7)

Figure 2 illustrates $V(M_2 \geq M_1)$, for the case $m_2 < l_1 < u_2 < m_1$, where $d$ is the abscissa value corresponding to the highest crossover point $D$ between $M_1$ and $M_2$. To compare $M_1$ and $M_2$, we need both values $V(M_1 \geq M_2)$ and $V(M_2 \geq M_1)$.

Step 3 The degree of possibility for a convex fuzzy number to be greater than $k$ convex fuzzy numbers $M_i (i = 1, 2, \ldots, k)$ is defined as

\[ V(M \geq M_1, M_2, ..., M_K) = \min V(M \geq M_i), \quad i = 1, 2, ..., k. \]

Step 4 Finally, $W = (\min V(S_i \geq S_k) \min V(S_i \geq S_k), \ldots, \min V(S_n \geq S_n))^T$ is the weight vector for $k = 1, \ldots, n$ (Erensal et al., 2006).

3.2 Aggregation of group decisions

Fuzzy pairwise comparisons can be combined by the use of the following algorithm (Chang et al., 2009):

\[ lij = \min (lij), \quad m_{ij} = \left( \prod_{k=1}^{K} m_{ijk} \right)^{1/2}, \quad u_{ij} = \max (uij) \]

(8)

where $(lij, m_{ij}, u_{ij})$ are the fuzzy evaluations of sample members’ $k (k = 1, 2, \ldots, K)$. However, min and max operations are not appropriate if the sample has a wide range of upper and lower bandwidths, in other words, if evaluations are inhomogeneous. We have to consider that if only one or few decision makers deliver extreme $lij$ and/or $uij$ the whole span of fuzzy numbers $(lij, m_{ij}, u_{ij})$ gets huge. Due to the required number of multiplication and addition operations, the aggregated fuzzy weights can even exceed the 0-1 borders or become irrational (Mikhailov, 2003), which is of course, unsatisfactory. Therefore, we decided to use the geometric mean also for $lij$ and $uij$ which delivers satisfying fuzzy group weightings. Geometric mean operations are commonly used within the application of the AHP for aggregating group decisions (Davies, 1994):
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\[
lij = \left( \prod_{k=1}^{k} \frac{1}{lijk} \right)^{1/n}, \quad ij = \left( \prod_{k=1}^{k} \frac{1}{mijk} \right)^{1/n}, \quad uij = \left( \prod_{k=1}^{k} \frac{1}{lijk} \right)^{1/n}
\]  \hspace{1cm} (9)

4 Research finding

In order to compare entrepreneurial behaviour factors (structural factors, underlying factors, and behaviour factors), weight of each of these elements is shown in Table 2 and shown in Appendix C. According to the responses given by decision maker group listed in Table 2 and shown in Appendix C, we concluded that the entrepreneurial behaviour factors are ranked in such a way that structural factors is the highest and then underlying factors and behaviour factors are at the next rank, respectively. There are three paired comparative tables for level 2 including structural factors, underlying factors, behaviour factors sub-criteria which are ordered regarding to structural factors, underlying factors, behaviour factors criteria. The final results and findings obtained from each sub-criteria weights related to each element in oil industry are presented in Tables 3 to 5 and shown in Appendix C. Comparing eight indexes used for to structural factors sub-criteria with respect to Table 3, it is known that entrepreneur organisation structure is the first priority and human resource development, reward system, entrepreneur organisation strategy, financial system, performance evaluation system, information system, research and development system are next ones. Comparing eight indexes used for underlying factors sub-criteria with respect to underlying factors, it is known from Table 4 that the political factors/government is first priority and sub- structure, communication, availability to resource, technology, uncertainty/changes, complexity and market are next ones. Comparing 12 indexes used for behaviour factors sub-criteria regarding to behaviour factors it is known from Table 5 that organisational culture is first priority and management support, risk taking, manager characteristics, employee’s characteristics, employee empowerment, team spirit, foresight, self-efficacy, previous experience, creativity and innovation, entrepreneur organisation leadership style are next priorities.

5 Conclusions

In present study, the relationship between entrepreneurial behaviour factors (structural factors, underlying factors and behaviour factors) with structural factors, underlying factors, behaviour factors sub-criteria were studied in order to increase the level of success in entrepreneurship. The results obtained from fuzzy AHP method according to the entrepreneurial behaviour factors indicate that structural factors are more important than underlying factors and behaviour factors. According to the structural factors scale, it is concluded that entrepreneur organisation structure is more important than other factors.

5.1 Comparative analysis

Comparing present results with Sarabi et al.’s (2012) study, regarding to entrepreneurial behaviour, it is realised that structural factors is at the first priority in both studies. Comparing present results with Sarabi et al.’s (2012) study with respect to the structural factors in studies, entrepreneur organisation structure is the first priority and human
resource development, reward system, entrepreneur organisation strategy, financial system, performance evaluation system, information system, research and development system are important, respectively. Comparing present results with Sarabi et al.’s (2012) study with respect to the underlying factors in both studies, political factors/government is at the first priority and sub-structure, communication, availability to resource, technology, uncertainty/changes, complexity and market are the next priorities. Comparing present results with Sarabi et al.’s (2012) study with respect to the behaviour factors in both study, organisational culture is at the first priority and management support, risk taking, manager characteristics, employee’s characteristics, employee empowerment, team spirit are the next priorities.

5.2 Limitations and suggestions for future research

The main objective of this research was Identifying and prioritisation entrepreneurial behaviour factors at oil industry in Iran. This study still has unavoidable limitations. The research sample was relatively small. However, we are confident that the samples used in this research were truly representative of the population. This study may serve as a useful reference for the oil industry located in other countries which have the same conditions as the Iranian oil industry. Further studies may thus include samples from different countries and oil industry of different sizes to reach greater universalisation. This research referred to the entrepreneurial behaviour indices to construct the hierarchy of relationships. We developed various weighted entrepreneurial behaviour indices by utilising the questionnaire analysis performed by senior education experts. Because of the number of entrepreneurial behaviour indices, we suggest that future research be conducted using the weighted entrepreneurial behaviour indices obtained from this research. These studies may add a fuzzy theory in this paper. Hence, we collected the information in the empirical segment of this study through the entrepreneurial behaviour of oil industry. Future research may add other evaluation indices into the entrepreneurial behaviour mechanism presented in this research. Besides, future research is encouraged to utilise the latest entrepreneurial behaviour factors information to investigate the potential change of oil industry. Since FAHP method questions contained in the questionnaire are plentiful, this research suggests more surveys be carried out through face to face interviews so that the researcher(s) can provide the interviewees with explanation when necessary while they are filling the questionnaire and this way ensure the reliability of the questionnaire. entrepreneurial behaviour factors indices of oil industry can provide further references for decision makers to formulate effective strategies. Lastly, because globalisation creates competition among oil industry, future research is recommended taking other country oil industry into consideration.

References


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Appendix A

The illustration of membership function

The definition of the triangular fuzzy number and the operational laws of triangular fuzzy numbers

The membership function $M(x): R \rightarrow [0, 1]$ of the triangular fuzzy number $M = (l, m, u)$ defined on $R$ is equal to

$$M(x) = \begin{cases} \frac{x}{m-l} - \frac{1}{m-l}, & x \in [l, m] \\ \frac{x}{m-u} - \frac{u}{m-u}, & x \in [m, u] \\ 0, & \text{otherwise} \end{cases}$$

where $l \leq m \leq u$ and, $l$ and $u$ are respectively lower and bound values of the support of $M[1]$. According to extension principle given two triangular fuzzy numbers $M_1 = (l_1, m_1, u_1)$ and $M_2 = (l_2, m_2, u_2)$:

1. the extended addition is defined as $M_1 + M_2 = (l_1 + l_2, m_1 + m_2, u_1 + u_2)$
2. the extended multiplication is defined as $M_1 \times M_2 = (l_1l_2, m_1m_2, u_1u_2)$
3. the inverse of triangular fuzzy number $M_1 = (l_1, m_1, u_1)$ is defined as

$$M_1^{-1} \approx \left( \frac{1}{u_1}, \frac{1}{m_1}, \frac{1}{l_1} \right).$$
Appendix B

Figure

Figure 1 Conceptual model

Level 1

Level 2

Structural factors

Underlying factors

Behaviour factors

Level 3

Entrepreneur organisation structure

Entrepreneur organisation strategy

Financial system

Performance evaluation system

Information system

Research and development system

Reward system

Human resource development

Political factors/government

Communication

Uncertainty/changes

Sub-structure

Availability to resource

Technology

Market

Complexity

Organisational culture

Management support

Risk taking

Manager characteristics

Employee’s characteristics

Employee empowerment

Team spirit

Entrepreneur organisation leadership style

Creativity and innovation

Self-efficacy

Foresight

Previous experience

Note: Hierarchical model of entrepreneurial behaviour.

Figure 2 The degree of possibility of $M_1 \geq M_2$
Appendix C

Table

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Verbal concepts in fuzzy scale spectrum</th>
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<tbody>
<tr>
<td><strong>Verbal scale</strong></td>
<td><strong>Triangle fuzzy numbers</strong></td>
</tr>
<tr>
<td>Equal significant</td>
<td>(1, 1, 1)</td>
</tr>
<tr>
<td>A little more significant</td>
<td>(1, 3, 5)</td>
</tr>
<tr>
<td>More significant</td>
<td>(3, 5, 7)</td>
</tr>
<tr>
<td>Many more significant</td>
<td>(5, 7, 9)</td>
</tr>
<tr>
<td>Extremely significant</td>
<td>(7, 9, 11)</td>
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<thead>
<tr>
<th>Table 2</th>
<th>Normalised final weights of entrepreneurial behaviour factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behaviour factors</td>
<td>Underlying factors</td>
</tr>
<tr>
<td>w</td>
<td>0.028</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Normalised final weights related to structural factors sub-criteria according to the structural factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial system</td>
<td>Research and development system</td>
</tr>
<tr>
<td>w</td>
<td>0.125</td>
</tr>
<tr>
<td>Reward system</td>
<td>Entrepreneur organisation strategy</td>
</tr>
<tr>
<td>w</td>
<td>0.149</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 4</th>
<th>Normalised final weights related to underlying factors sub-criteria according to the underlying factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Political factors/government</td>
<td>Substructure</td>
</tr>
<tr>
<td>W</td>
<td>0.241</td>
</tr>
<tr>
<td>Technology</td>
<td>Uncertainty/changes</td>
</tr>
<tr>
<td>W</td>
<td>0.108</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 5</th>
<th>Normalised final weights related to behaviour factors sub-criteria according to the behaviour factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foresight</td>
<td>Manager characteristics</td>
</tr>
<tr>
<td>W</td>
<td>0.068</td>
</tr>
<tr>
<td>Management support</td>
<td>Team spirit</td>
</tr>
<tr>
<td>W</td>
<td>0.111</td>
</tr>
<tr>
<td>Entrepreneur organisation leadership style</td>
<td>Creativity and innovation</td>
</tr>
<tr>
<td></td>
<td>0.053</td>
</tr>
</tbody>
</table>
The rules applied for the fuzzy AHP

After unifying the elites’ opinions, by using the geometry mean, Table A1 has attained.

**Table A1**   Unifying the elites’ opinions

<table>
<thead>
<tr>
<th>Behaviour factors</th>
<th>Behaviour factors</th>
<th>Behaviour factors</th>
<th>Underlying factors</th>
<th>Underlying factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behaviour factors</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>0.306</td>
</tr>
<tr>
<td>Underlying factors</td>
<td>1.442</td>
<td>2.466</td>
<td>3.271</td>
<td>1.000</td>
</tr>
<tr>
<td>Structural factors</td>
<td>2.466</td>
<td>4.718</td>
<td>6.804</td>
<td>0.306</td>
</tr>
</tbody>
</table>

**Fuzzy AHP computation**

For the first step of the analysis, the pair-wise comparison matrix for the main attributes is built (see Table A2).

**Table A2** The pair-wise comparison matrix

<table>
<thead>
<tr>
<th>Behaviour factors</th>
<th>Behaviour factors</th>
<th>Behaviour factors</th>
<th>Underlying factors</th>
<th>Underlying factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behaviour factors</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>0.306</td>
</tr>
<tr>
<td>Underlying factors</td>
<td>1.442</td>
<td>2.466</td>
<td>3.271</td>
<td>1.000</td>
</tr>
<tr>
<td>Structural factors</td>
<td>2.466</td>
<td>4.718</td>
<td>6.804</td>
<td>0.306</td>
</tr>
<tr>
<td>Behaviour factors</td>
<td>0.693</td>
<td>0.147</td>
<td>0.212</td>
<td>0.405</td>
</tr>
<tr>
<td>Underlying factors</td>
<td>1.000</td>
<td>1.442</td>
<td>2.466</td>
<td>3.271</td>
</tr>
<tr>
<td>Structural factors</td>
<td>0.693</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
</tr>
</tbody>
</table>

For the second level, the values of fuzzy synthetic extents with respect to the main attributes are calculated as below:
Identifying and prioritisation entrepreneurial behaviour factors

\[
\left[ \sum_{i=1}^{n} \sum_{j=1}^{m} M_{ij}^{g} \right]^{-1} = \left( \frac{1}{\sum_{l=1}^{n} u_{l}}, \frac{1}{\sum_{l=1}^{n} m_{l}}, \frac{1}{\sum_{l=1}^{n} l_{l}} \right)
\]

\[
\sum_{j=1}^{m} \sum_{i=1}^{n} M_{ij} = \left( \sum_{i=1}^{n} l_{i}, \sum_{i=1}^{n} m_{i}, \sum_{i=1}^{n} u_{i} \right)
\]

\[
\sum_{j=1}^{m} \sum_{i=1}^{n} M_{ij} = (9.109, 13.673, 18.138)
\]

\[
\left[ \sum_{j=1}^{m} \sum_{i=1}^{n} M_{ij}^{g} \right]^{-1} = (0.055, 0.073, 0.110)
\]

\[
S_{k} = \sum_{j=1}^{m} M_{ij} \otimes \left[ \sum_{i=1}^{n} \sum_{j=1}^{m} M_{ij} \right]^{-1}
\]

<table>
<thead>
<tr>
<th></th>
<th>( \sum_{i=1}^{n} \sum_{j=1}^{m} M_{ij} )</th>
<th>[ \sum_{i=1}^{n} \sum_{j=1}^{m} M_{ij}^{g} ]^{-1}</th>
<th>( S_{k} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behaviour factors</td>
<td>1.453 1.617 2.099</td>
<td>0.055 0.073 0.110</td>
<td>0.079 0.118 0.231</td>
</tr>
<tr>
<td>Underlying factors</td>
<td>3.884 5.932 7.542</td>
<td>0.055 0.073 0.110</td>
<td>0.212 0.433 0.830</td>
</tr>
<tr>
<td>Structural factors</td>
<td>3.772 6.123 8.497</td>
<td>0.055 0.073 0.110</td>
<td>0.206 0.447 0.935</td>
</tr>
</tbody>
</table>

The degrees of possibility are calculated as below:

\[ V(S \text{ Behaviour factors} \geq S \text{ Underlying factors}) = 0.056 \]

\[ V(S \text{ Behaviour factors} \geq S \text{ Structural factors}) = 0.070 \]

\[ V(S \text{ Underlying factors} \geq S \text{ Behaviour factors}) = 1.000 \]

\[ V(S \text{ Underlying factors} \geq S \text{ Structural factors}) = 0.978 \]

\[ V(S \text{ Structural factors} \geq S \text{ Behaviour factors}) = 1.000 \]

\[ V(S \text{ Structural factors} \geq S \text{ Underlying factors}) = 1.000 \]

For each pair-wise comparison, the minimum of the degrees of possibility is found as below:

\[ \text{Min } V(S \text{ Behaviour factors} \geq S_{i}) = 0.056 \]
Min $V(S \text{ Underlying factors } \geq S_i) = 0.978$

Min $V(S \text{ Structural factors } \geq S_i) = 1.000$

These values yield the following weights vector:

$$W = (0.056, 0.978, 1.000)^T$$

Via normalisation, the importance weights of the main attributes are calculated as follows:

$$W = (0.028, 0.481, 0.492)$$

Also for computing the final weight of Tables 3 through 5, the same above steps are acted.