Cloud Model-Based Comprehensive Evaluation Method for Entrepreneurs’ Uncertainty Tolerance

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Abstract: The evaluation of entrepreneurs’ uncertainty tolerance (UT) is more meaningful, e.g., predicting their behaviors, making psychological counseling strategies for them, etc. In fact, it is an uncertain problem that simultaneously contains randomness and fuzziness in evaluating entrepreneurs’ UT. Hence, it is difficult to solve it by traditional evaluation methods. This paper presents a cloud model-based comprehensive evaluation method for entrepreneurs’ UT which overcomes the inability of other methods to take into account randomness and fuzziness simultaneously. First, five UT levels are divided. Then, an evaluation index system which contains 14 secondary level indexes and four primary level indexes is constructed, and an analytic hierarchy process (AHP) method is used to obtain the weights for the secondary level indexes. Subsequently, the backward cloud generator (BCG) and virtual cloud model (CM) are used to obtain the CM of evaluation indexes, and cloud chart of evaluation results are generated by forward cloud generator (FCG). Finally, five core start-up founders of a high-tech company in China are chosen for a case study to illustrate our method. Compared with other traditional evaluation methods, our method has been verified to be a more competitive method. Its results are more visualized and low information lost.

Keywords: uncertainty tolerance; comprehensive evaluation method; entrepreneurs; cloud model

1. Introduction

Uncertainty tolerance is a psychological term, it can be defined as a cognitive bias that affects how a person perceives, interprets, and responds to uncertain situations on a cognitive, emotional, and behavioral level [1]. Individuals who are intolerant of uncertainty feel stressful and upset in uncertain situations, believe uncertainty is negative and should be avoided, and have difficulty functioning in uncertain situations [2]. Entrepreneurs, especially those in a high-tech field, face a highly uncertain decision-making situation, and uncertainty has more heavy influence on their mood, cognition, and behavior than in others. Entrepreneurs with a low uncertainty tolerance level have the following characteristics: (1) showing higher depression tendency emotionally; (2) more likely to overestimate the negative consequences of uncertainty; (3) more likely to take evasion and procrastination to avoid uncertainty [3]. Empirical researches show the negative impact of uncertainty tolerance on entrepreneurs too. For example, some institutions have investigated 242 entrepreneurs and found that depression accounts for 30% [4].

Know that entrepreneurs’ uncertainty tolerance level is the basis for many decisions related to start a business due to it having a profound impact on entrepreneurial behavior. For example, venture capitalists can choose venture projects based on entrepreneurs’ uncertainty tolerance. Furthermore, counseling agency can predict entrepreneurs’ behavior based on their uncertainty tolerance level, in order to take measures to alleviate the negative impact of uncertainty on entrepreneurs. The assessment of entrepreneurs’ uncertainty tolerance is an uncertain problem, and it has the following
features: (1) caused by multi-level and multi-index (e.g., educational, experience, financial situation, etc.); (2) using qualitative (linguistic language) assessment grades; (3) has strong fuzziness and randomness. However, there are few methods for evaluating entrepreneurs’ uncertainty tolerance level so far due to the fact that uncertainty tolerance is still a new research topic in the entrepreneurial field. Several mathematical methods (e.g., fuzzy comprehension evaluation method, rough set theory) have been used in evaluation problems, but they cannot meet the requirement of the evaluation of entrepreneurs’ uncertainty tolerance.

In this paper, we presented a novel evaluation method based on the cloud model (CM) [5]. The CM provides many practical tools which can realize the uncertainty transformation between the qualitative concept and its corresponding quantitative representation, and this method took into account the randomness and fuzziness simultaneously. In this method, we established a set of uncertainty tolerance evaluation index systems for entrepreneurs. The index system includes 14 secondary level indexes and 4 primary level indexes; they fully reflect all aspects of indexes that affecting entrepreneurs’ uncertainty tolerance. Backward cloud generator (BCG) is used to transform the quantitative value to qualitative concept characterized with three digital characteristics. Virtual cloud model is used to obtain the digital characteristics of high-level indexes from low-level indexes. Forward cloud generator (FCG) is used to generate two-dimensional graph of comprehensive evaluation results. The innovations of the method presented in this paper compared with other evaluation methods are as follows: (1) the randomness and fuzziness are considered simultaneously in the evaluation process, while other methods usually only consider the fuzziness; (2) the evaluation result can be converted between qualitative and quantitative expressions; (3) the evaluation result can be displayed in the form of a cloud chart, which contains more complete evaluation results information than traditional evaluation method.

The rest of this paper is formulated as follows. Section 2 provides a brief literature reviewed of entrepreneur trait theory and evaluation method. In Section 3, the basic knowledge of CM theory is introduced. In Section 4, an assessment model based on CM is presented. In Section 5, a practical example is presented, and evaluation results are compared with other methods. Section 6 presents some conclusions and some proposals for future research.

2. Literature Review

2.1. Entrepreneurial Traits

Entrepreneurship research emerged in 1980s as a theoretical research. As an independent discipline, Entrepreneurship has been criticized by the academia due to the lack of solid theoretical basis. Therefore, researchers strive to build the theoretical basis of entrepreneurship by sociology, management, economics, mathematics, psychology and theories of other disciplines [6]. Simon, winner of the Nobel Prize in economics, pointed out that entrepreneurship research is an artificial science, and the core object of entrepreneurship research is entrepreneurs [7]. The entrepreneur’s psychology constitutes the internal environment, while the external indexes constitute the external environment. The internal environment focuses on the entrepreneur’s psychology and behavior, while the external environment focuses on social and macroeconomic issues [8,9]. Research on entrepreneurial traits belongs to the multi-discipline research of psychology and entrepreneurship, which mainly studies the entrepreneur’s psychology and behavior.

The entrepreneurial traits refer to the persistent qualities or characteristics of individuals in the context of entrepreneurship, which make their behaviors consistent in the context of entrepreneurship [10]. Early studies on the entrepreneurial traits mainly focus on the differences between entrepreneurs and non-entrepreneurs, that is, what are the characteristics of entrepreneurs compared with non-entrepreneurs. Knight first pointed out that entrepreneurs have a higher risk-taking tendency than non-entrepreneurs, but this assumption is lack of scientific proof [11]. McClelland pointed out that entrepreneurs tend to have higher achievement needs than non-entrepreneurs [12]. Research by Pandey and Tewary shows that entrepreneurs have a higher control complex and are
more eager to control their own destiny [13]. However, Shane et al. and Murphy et al. through a large number of empirical studies, show that there is no obvious difference between entrepreneurs and non-entrepreneurs, and those characteristics displayed in entrepreneurs will also appear in non-entrepreneurs [14,15].

Facing the conflicting conclusions about the differences between entrepreneurs and non-entrepreneurs, the academia has reflected on how to conduct entrepreneurship research and what should be studied in entrepreneurship research. Some researchers began to study the differences between successful entrepreneurs and unsuccessful entrepreneurs. Chandler and Hanks and other researchers introduced the concept of competency into the field of entrepreneurship, and studied the influencing indexes of entrepreneurial competency, the evaluation of entrepreneurial competency, and the relationship between entrepreneurial competency and entrepreneurial performance [16]. Sarasvathy conducted a series of interviews and experiments with 27 successful entrepreneurs who have won the national entrepreneurship award of the year. The results showed that some behaviors and logics of successful entrepreneurs were contrary to the standard model in textbooks [17]. Sarasvathy refers to the decision logic of successful entrepreneurs as the Effectuation, in order to distinguish it from the traditional causal logic [9].

From the above analysis, we can see that there are few studies on the behavior and psychological characteristics of entrepreneurs in uncertain situations. With the development of entrepreneurship theory and practice, people will pay more and more attention to the psychology and behavior of entrepreneurs in the entrepreneurial process. It is urgent to establish or introduce new theories to study these problems.

2.2. Uncertainty Tolerance

With the deepening of entrepreneurship theory and practice, researchers pay more and more attention to the phenomena related to the differences of cognition, emotion, and behavior of entrepreneurs [18]. For example, some organizations have investigated 242 entrepreneurs and found that 49% of them have one or more mental health problems, of which depression accounts for 30% [19]. However, these studies are still in the stage of descriptive statistical analysis and lack of more in-depth theoretical explanation. Therefore, new theories should be introduced to explain and expand the research on the above phenomena.

Freeston et al. put forward the concept of uncertainty tolerance to explain the formation and maintenance of worry and anxiety, which immediately aroused widespread concern in academia [20]. A large number of theoretical and empirical studies have been carried out around the measurement of uncertainty tolerance, neural mechanism, and emotional, cognitive, and behavioral characteristics [21–23]. Some researchers have introduced the concept of uncertainty tolerance into the field of entrepreneurship research, and defined it as the cognitive bias of individual perception, interpretation, and response to uncertainty in the context of entrepreneurship, which affects the cognition, emotion, and behavior of entrepreneurs [24].

Dugas et al. showed that entrepreneurs with a lower level of uncertainty tolerance often overestimate the negative results of uncertain events in cognitive aspect. In addition, it needs more deterministic information and takes more time to make decisions before making decisions [25]. Greco and Roger studied the effect of uncertainty tolerance on individual emotions and found that entrepreneurs with a lower level of uncertainty tolerance had higher levels of worry, anxiety, and depression than those with a higher level of uncertainty tolerance [26]. Koerner and Dugas studied the impact of uncertainty tolerance on entrepreneur behavior, and the results show that entrepreneurs with a lower level of uncertainty tolerance tend to choose approach strategies or avoidance strategies when facing uncertainty, and often require more effort, resulting in more worries and anxieties [27].

The research on uncertainty tolerance is still a new topic in the entrepreneurship research field. The existing research is mainly qualitative research, and the main research method is an
empirical research method or case study, lacking of quantitative research, especially the evaluation of entrepreneurs’ uncertainty tolerance.

2.3. Assessment Method

It is difficult to make a rational decision for individuals under uncertainty situations if they do not know the level of uncertainty that they can tolerate [28]. In reality, the level of uncertainty that an individual can tolerate is usually described by natural language, it leads to fuzziness in the assessment of uncertainty tolerance. On the other hand, some characteristics of the evaluated object are not stable, and the evaluation process is only carried out at a specific stage, which makes the evaluation results have randomness. Therefore, with the traditional mathematical model it is difficult to evaluate the uncertainty tolerance level of entrepreneurs accurately and effectively.

The commonly used evaluation models are the weighted average method, fuzzy comprehension evaluation method, and comprehensive evaluation of rough. The weighted average method comprehensively considers the indexes of the evaluation object and uses the weight coefficient of each index to calculate the final evaluation score [29]. Its advantages are simple and easy to operate, but the disadvantage is that the evaluation results are too simple, and many evaluation details are lost. The fuzzy comprehension evaluation method is a comprehensive evaluation method based on fuzzy mathematics theory [30]. It uses membership degree to transform qualitative evaluation into quantitative evaluation, which solves the fuzzy and difficult to quantify problems, and is suitable for the evaluation in the uncertain situation. The comprehensive evaluation of rough set is a comprehensive evaluation method based on rough set theory. This method is based on the mining of objective data when determining the index weight, which overcomes the problem of expert subjectivity in other evaluation methods [31].

Most of the above assessment methods consider the fuzziness of uncertainty. However, there are few assessment methods to consider the randomness of uncertainty. Randomness is the uncertainty that the condition cannot determine the result. It reflects the lack of causality. The concept of uncertainty has the characteristics of fuzziness, randomness, and incompleteness of information. Among them, fuzziness and randomness are the most basic characteristics. In order to improve the shortcomings of existing methods in considering randomness, we introduce the CM theory in this paper. The CM has plenty of tools in uncertain transforming between qualitative concepts and their quantitative expressions. It has the capability of expressing fuzziness and randomness existing in human knowledge inference.

3. Preliminaries

In this section, some basic concepts and theories related to CM are introduced briefly as follows.

3.1. Cloud Model

The CM is a transformation model between qualitative concept (et. linguistic language) and quantitative value, and it is constructed based on probability theory and fuzzy mathematics, which can be used to express the fuzziness and randomness of a qualitative concept [32].

Definition 1 ([32]). Supposing \( U \) is the quantitative domain expressed by accurate value, \( C \) is a qualitative concept in \( U \). There exists a corresponding certainty degree \( \mu(x) \) to \( C \) for arbitrary \( x \in U \). As shown in Equation (1), \( x \) is a random realization of the quality concept \( C \). \( \mu(x) \) is a random number with stable tendency which called a cloud drop.

\[
\mu : U \rightarrow [0, 1], \quad \forall x \in U, \quad x \rightarrow \mu(x) \tag{1}
\]

The distribution of \( x \) on quantitative domain \( U \) is called cloud, and each \( x \) is called a cloud drop. The CM has the following characteristics:
(1) Certainty degree is a random number not a fixed number and it has stable tendency on quantitative domain $U$ to $[0, 1]$ for arbitrary $x \in U$; 

(2) Cloud drop generate from CM is unordered. One cloud drop is a quantitative random implementation of the qualitative concept, which can more express the qualitative concept accurate with more cloud drop; 

(3) The certainty degree can be interpreted as the extent to which the cloud drop represents this qualitative concept. The greater the probability of the cloud drop appearing, the greater the certainty degree of cloud drop. 

A CM can be characterized with three digital characteristics: $Ex$ (expected value), $En$ (entropy), $He$ (hyper entropy). $Ex$ represents the typical point which best characterizes the quality concept, $En$ is the uncertainty distribution of the concept representing the range of values that could be accepted in the domain, and $He$ is a measure of the uncertainty of the $En$, which represents the randomness of all points of the concept.

3.2. The Normal Cloud Model

The normal cloud model is a special kind of CM, which is based on normal distribution and Gauss membership function. This kind of CM plays a prominent role in application due to its universality and stability. A normal CM also has the above three digital characteristics, and is described as follows:

**Definition 2 ([33]).** Let $U$ be the universe of discourse and $A$ be a qualitative concept in $U$. If $x \in U$ is random instantiation of concept $A$ which statistics $x \sim N(Ex, En^2)$, $En' \sim N(En, He^2)$, the certainty degree of $x$ belonging to the concept $A$ statistics Equation (2). Then the distribution of $x$ in the universe $U$ is considered as a normal cloud.

$$
\mu(x) = \exp \left( \frac{-(x - Ex)^2}{2En^2} \right). \tag{2}
$$

Owing to the normal distribution is the most essential and wide application model in probability distributions. The normal distribution is determined by two parameters: expectation and variance. Normal membership function is the most commonly used membership function in fuzzy theory. The normal cloud model is generated by the normal distribution and the normal membership function. So, in this paper, we assume the distribution of cloud drop is satisfied to the normal cloud model.

4. The Proposed Evaluation Method Based on CM

Evaluating entrepreneurs’ uncertainty tolerance is an uncertain problem that contains fuzziness and randomness simultaneously. It is also an uncertain problem of multi-level and multi-index. It is difficult to evaluate entrepreneurs’ uncertainty tolerance accurately by traditional evaluation methods. In this paper, we presented a novel method for entrepreneurs’ uncertainty tolerance assessment based on CM.

Generally, assuming that an entrepreneurs’ uncertainty tolerance assessment team composed of $m$ experts in the fields of business, education, psychology, etc., the evaluation index system of entrepreneurs’ uncertainty tolerance contains $n$ secondary level indexes, and these $n$ secondary level indexes constitute $q$ primary level indexes and form a comprehensive evaluation index finally.

Based on the assumptions and notations above, we developed an entrepreneurs’ uncertainty tolerance assessment model. A flowchart of the proposed model is shown in Figure 1.
Figure 1. Flowchart of the proposed assessment method.

The key steps of the proposed method are shown as follows:

**Step 1.** Uncertainty tolerance level gradation.

The level of entrepreneurs’ uncertainty tolerance can be divided into five levels “very high, high, normal, low, very low”. The higher the level, the higher the uncertainty that an entrepreneur can tolerate. Table 1 presents the linguistic terms and value interval.

| Uncertainty Tolerance Level | Abbreviation | Value Interval |
|-----------------------------|--------------|---------------|
| Very high                   | VH           | [8.10)        |
| High                        | H            | (6.8)         |
| Normal                      | N            | (4.6)         |
| Low                         | L            | (2.4)         |
| Very low                    | VL           | (0.2)         |

**Step 2.** Evaluation index system and weight setting.

Selecting a reasonable evaluation index system is the basis for accurate evaluation of entrepreneurs’ uncertainty tolerance. The level of uncertainty tolerance of entrepreneurs is affected by many internal and external indexes; internal indexes mainly refer to the psychological and behavioral indexes of entrepreneurs, while external indexes refer to external resources and macro environment indexes. Based on theoretical and practices analysis, four types of evaluation indexes are shown in Table 2.

(1) Physical and mental condition: psychological and physiological differences will affect the level of individual tolerance to uncertainty. These indexes include health condition \(c_1\), risk preference \(c_2\), and entrepreneurial motivation \(c_3\).
(2) Entrepreneurial ability: entrepreneurial competency theory shows that the stronger the entrepreneurial ability, the higher the tolerance to uncertainty. Entrepreneurial ability is mainly composed of management ability ($c_4$), professional ability ($c_5$), social skills ($c_6$), and executive capacity ($c_7$).

(3) Entrepreneurial resources: if entrepreneurs can obtain the support of external resources, their ability to deal with uncertainty will be greatly improved. Several core external resources include entrepreneurial mentor ($c_8$), financing channel ($c_9$), and team support ($c_{10}$).

(4) Macro environment: the impact of macro environment on any business activities is universal, and the entrepreneurship policy ($c_{11}$), laws and regulations ($c_{12}$), market environment ($c_{13}$), and economic environment ($c_{14}$) also has an impact on entrepreneurs’ uncertainty tolerance.

| Table 2. Uncertainty tolerance level of the evaluation indexes of entrepreneurs. |
|-----------------------------------------------|
| Primary Level Indexes | Abbreviation | Secondary Level Indexes |
|-----------------------|--------------|------------------------|
| Physical and mental condition | c_1 | Health condition |
| | c_2 | Risk preference |
| | c_3 | Entrepreneurial motivation |
| Entrepreneurial ability | c_4 | Management ability |
| | c_5 | Professional ability |
| | c_6 | Social skills |
| | c_7 | Executive capacity |
| Entrepreneurial resources | c_8 | Entrepreneurial mentor |
| | c_9 | Financing channel |
| | c_{10} | Team support |
| Macro environment | c_{11} | Entrepreneurship Policy |
| | c_{12} | Laws and regulations |
| | c_{13} | Market environment |
| | c_{14} | Economic environment |

The evaluation indexes of uncertainty tolerance are all subjective indexes, and experts are required to assess the importance of each index. The evaluation indexes are all subjective indexes in this paper, and while the AHP method is a subjective weighting method with the superiority of simplicity and practicality compared with other methods, it can sufficiently reflect the subjective differences of knowledge, preference, and experience of experts. In addition, the emphasis and innovation of this paper is not the method of weighting the evaluation indexes, so we obtain the weights of each secondary level index by the AHP [34] method. All weight values of secondary level indexes constitute the weight vector $W$ as follows:

$$W = \left[ w_{21}, w_{22}, \cdots, w_{2j}, \cdots, w_{2n} \right]^T,$$

The weight of the $t$th primary level index can be calculated as follows:

$$w_{1t} = \sum_{j \in L_t} w_{2j},$$

where $w_{1t}$ denotes the weight of the $t$th primary level index, and $L_t$ denotes all the numbers of secondary level indexes that contained to the $t$th primary level index.

**Step 3.** Develop the CM of evaluation indexes.

Entrepreneur uncertainty tolerance assessment is a multi-level evaluation problem, and we should assess start at the lowest level, then to a higher level. Experts give specific evaluation values for each evaluation index, and we need to translate specific values into qualitative concepts. The CM
provides a powerful tool for us to translate specific value into qualitative concepts and integrate the evaluation results.

Supposing that \( m \) experts score the \( n \) indexes of the evaluated objects, the \( i \)th expert considers that \( x_{ij} \) is the suitable value for the \( j \)th indexes. The evaluation matrix is as follows:

\[
X = \begin{bmatrix}
  x_{11} & x_{12} & \cdots & x_{1n} \\
  x_{21} & x_{22} & \cdots & x_{2n} \\
  \vdots & \vdots & \ddots & \vdots \\
  x_{m1} & x_{m2} & \cdots & x_{mn}
\end{bmatrix},
\]

(5)

**Step 3.1. CM of secondary level indexes.**

We use BCG to obtain three digital characteristics of the CM of secondary level indexes. The BCG is an algorithm that converts a certain amount of accurate data into a qualitative concept represented by three digital characteristics, i.e., \( Ex, En, He \). Take the \( j \)th secondary level index as an example, its three digital characteristics can be calculated by the following formulas:

\[
Ex_{2j} = \frac{\sum_{i=1}^{m} x_{ij}}{m}, \quad (j = 1, 2, \cdots, n),
\]

(6)

\[
En_{2j} = \sqrt{\frac{1}{2m} \sum_{i=1}^{m} (x_{ij} - Ex_{2j})^2}, \quad (j = 1, 2, \cdots, n),
\]

(7)

\[
He_{2j} = \sqrt{\frac{1}{m-1} \sum_{i=1}^{m} (x_{ij} - Ex_{2j})^2 - En_{2j}^2}, \quad (j = 1, 2, \cdots, n),
\]

(8)

where \( Ex_{2j} \) denotes the expected value of the \( j \)th secondary level index, \( En_{2j} \) denotes the entropy value of the \( j \)th secondary level index, \( He_{2j} \) denotes the hyper entropy value of the \( j \)th secondary level index, \( m \) denotes the number of experts, and \( n \) denotes the number of secondary level indexes.

**Step 3.2. CM of primary level indexes.**

We use an algorithm from virtual cloud theory to synthesize the digital characteristics of secondary level indexes into the digital characteristics of primary level indexes. Take the \( t \)th primary level index as an example; its three digital characteristics can be calculated by the following formulas:

\[
Ex_{1t} = \frac{\sum_{j \in L_t} w_{2j} \times Ex_{2j}}{\sum_{k \in L_t} w_{2k}},
\]

(9)

\[
En_{1t} = \frac{\sum_{j \in L_t} w_{2j}^2 \times En_{2j}}{\sum_{k \in L_t} w_{2k}^2},
\]

(10)

\[
He_{1t} = \frac{\sum_{j \in L_t} w_{2j}^2 \times He_{2j}}{\sum_{k \in L_t} w_{2k}^2},
\]

(11)

where \( Ex_{1t} \) denotes the expected value of the \( t \)th primary level index, \( En_{1t} \) denotes the entropy value of the \( t \)th primary level index, and \( He_{1t} \) denotes the hyper entropy value of the \( t \)th primary level index. \( L_t \) denotes all the numbers of secondary level indexes that contained the \( t \)th primary level index.

**Step 3.3. CM of comprehensive indexes.**

We can also use the virtual CM to calculate the digital characteristics of comprehensive evaluation indexes; its three digital characteristics can be calculated by the following formulas:

\[
Ex = \frac{\sum_{i \in L_d} w_{1i} \times Ex_{1t}}{\sum_{q \in L_d} w_{1q}},
\]

(12)

\[
En = \frac{\sum_{i \in L_d} w_{1i}^2 \times En_{1t}}{\sum_{q \in L_d} w_{1q}^2},
\]

(13)
\[ He = \sum_{t \in L_s} \frac{w_{1t}^2 \times He_{1t}}{\sum_{q \in L_s} w_{1q}^2}, \quad (14) \]

where \( w_{1t} \) denotes the weight of the \( t \)-th primary level index, and \( L_s \) denotes all the numbers of primary level indexes that contained to the comprehensive index.

**Step 4.** Draw a cloud chart.

We can get the evaluation result and its distribution by FCG. FCG is an algorithm which can generate quantitative values \((x, \mu(x))\) from the digital characteristics \( C = (Ex, En, He) \) of clouds. First, generate a normal random number \( y_i = R_N(En, He) \) where \( En \) is the expected value and \( He^2 \) is the variance; next, generate a normal random number \( x_i = R_N(Ex, y_i) \) where \( E_x \) is the expected value and \( y_i^2 \) is the variance; then, to calculate \( \mu(x_i) = \exp\left(\frac{(x_i - E_x)^2}{2y_i^2}\right) \); finally, the above process is repeated until the required \( n \) cloud drops are produced. With \( x_i \) as the horizontal axis and \( \mu(x_i) \) as the vertical axis, the distribution of cloud drops can be depicted on the graph.

5. Case Study

Entrepreneurial activities in high-tech fields have been booming in China since 2014. High-tech entrepreneurship is characterized by high failure rate, and founders of high-tech start-up companies are under tremendous pressure. Especially in recent years, news about suicides of high-tech entrepreneurs due to depression are appearing in news reports frequently, and the problem of entrepreneurs’ psychological health attracts more and more concern. It is very important and significant to predict the behavior and emotion of high-tech entrepreneurs through evaluating their UT.

A high-tech logistics company is selected in order to conduct our research. The company is located in Chengdu City, Sichuan Province, China. It is founded by five core founders in 2017, the basic information of these founders is shown in Table 3. The main business of the company is improving the level of informatization and automation of the traditional logistic parks by internet of things technology. For example, improve the efficiency of vehicles entering and leaving by electronic identification technology. By 2019, the company has operated six logistic parks in the Xindu logistic center which is located in the northeast of Chengdu. We found some founders were more anxious during the process of new venture creation than others. We try to illustrate this phenomenon by evaluating the UT of these entrepreneurs.

| Table 3. Basic Information of Entrepreneurs. |
|---------------------------------------------|
| Entrepreneur | Age | Gender | Education |
|---------------|-----|--------|-----------|
| 1#            | 51  | male   | bachelor  |
| 2#            | 36  | female | doctor    |
| 3#            | 36  | male   | bachelor  |
| 4#            | 27  | male   | master    |
| 5#            | 27  | male   | bachelor  |

5.1. Weight Setting

In total, 12 experts are invited to estimate the relative importance for the evaluation index. These experts come from colleges, a venture capital institution, a counseling agency, and a successful high-tech start-up company, and they have a deep understanding of high-tech entrepreneurship. Firstly, experts are asked to make a series of pairwise comparisons among the secondary level indexes according to a ratio scale 1 to 5, where the higher the score, the high the relative importance. Secondly, we use the eigenvalue method to estimate the relative weights of the secondary level indexes. Then, we examine the results above for consistence test by Consistency Ratio (C.R.), in order to eliminate logical errors. If the value of C.R. is less than 0.1, it means that the consistency test is passed, otherwise it means that the consistency test is not passed. Finally, we obtain the weights of each level and an index is shown in Table 4.
Table 4. Indexes weight.

| Primary Level Indexes            | Weight | Secondary Level Indexes       | Weight |
|---------------------------------|--------|-------------------------------|--------|
| Physical and mental condition   | 0.18   | Health condition              | 0.07   |
|                                 |        | Risk preference               | 0.03   |
|                                 |        | Entrepreneurial motivation    | 0.08   |
| Entrepreneurial ability         | 0.37   | Management ability            | 0.12   |
|                                 |        | Professional ability          | 0.07   |
|                                 |        | Social skills                 | 0.08   |
|                                 |        | Executive capacity            | 0.10   |
| Entrepreneurial resources       | 0.32   | Entrepreneurial mentor        | 0.12   |
|                                 |        | Financing channel             | 0.09   |
|                                 |        | Team support                  | 0.11   |
| Macro environment               | 0.13   | Entrepreneurship Policy       | 0.04   |
|                                 |        | Laws and regulations          | 0.02   |
|                                 |        | Market environment            | 0.04   |
|                                 |        | Economic environment          | 0.03   |

5.2. The Cloud Model

Experts are invited to rate each index of uncertainty tolerance of entrepreneurs. The BCG is used to process the scoring data of each secondary level index, getting the three digital characteristics of the CM of all secondary level indexes, which are shown in Table 5.

Table 5. The cloud model (CM) of secondary level indexes.

| Secondary Level Indexes | \((E_x, E_n, H_e)\) |
|-------------------------|--------------------|
| Health condition        | \((5.1250, 1.4491, 0.1581)\) |
| Risk preference         | \((5.5000, 1.2533, 0.3771)\) |
| Entrepreneurial motivation | \((6.5000, 1.2533, 0.3788)\) |
| Management ability      | \((5.2500, 1.2533, 0.2684)\) |
| Professional ability    | \((3.8750, 1.1358, 0.5133)\) |
| Social skills           | \((6.2500, 1.3316, 0.3611)\) |
| Executive capacity      | \((5.0000, 0.9400, 0.1626)\) |
| Entrepreneurial mentor  | \((5.1250, 0.8225, 0.1412)\) |
| Financing channel       | \((7.6250, 0.9008, 0.1668)\) |
| Team support            | \((5.5000, 0.6267, 0.3271)\) |
| Entrepreneurship Policy | \((7.2500, 1.0183, 0.1856)\) |
| Laws and regulations    | \((5.8750, 1.1358, 0.5133)\) |
| Market environment      | \((5.2500, 1.0183, 0.1856)\) |
| Economic environment    | \((5.3750, 0.9008, 0.1668)\) |

The virtual cloud algorithm is used to integrate the digital characteristics of the secondary level indexes to get the digital characteristics of the primary level indexes which are shown in Table 6.

Table 6. The CM of primary level indexes.

| Primary Level Indexes               | \((E_x, E_n, H_e)\) |
|-------------------------------------|--------------------|
| Physical and mental condition       | \((5.7986, 1.3320, 0.2900)\) |
| Entrepreneurial ability             | \((5.1385, 1.1635, 0.2890)\) |
| Entrepreneurial resources           | \((6.1007, 0.7832, 0.2110)\) |
| Macro environment                   | \((5.4306, 0.9981, 0.2250)\) |

After the same method, integrating the digital characteristics of the primary level indexes gets the CM of uncertainty tolerance of 1# entrepreneur. The uncertainty tolerance of 1# entrepreneur can be characterized by three digital characteristics as follows:

\[ C = (E_x, E_n, H_e) = (5.6032, 1.0378, 0.2577) \]
5.3. The Cloud Chart of Evaluation Result

The FCG was used to carry out 1000 times random simulation calculations to generate cloud drop \( x \) and membership degree \( \mu(x) \) based on \( Ex, En, He \), taking \( x \) as the horizontal axis and \( \mu(x) \) as the vertical axis, and we can draw a cloud chart of the comprehensive evaluation results as in Figure 2. As can be seen from Figure 2, the expected value of uncertainty tolerance of the 1# entrepreneur is 5.6032, and the cloud drops near this value are the most and densest. We can also see that the cloud drops between the range of 6 and 8 are also relatively dense. Therefore, we can define that the degree of uncertainty tolerance of 1# entrepreneur should be above medium.

![Cloud Chart of Evaluation Result](image)

**Figure 2.** The CM of the comprehensive evaluation of 1# entrepreneur.

The cloud chart of the evaluation results of four primary level indexes are shown in Figure 3. As can be seen from Figure 3, the 1# entrepreneur performs best in terms of entrepreneurial resources, but the worst in entrepreneurial ability. In addition, we can see that the cloud drops of (a) and (b) in Figure 3 are more dispersed than those of (c) and (d), which indicates that experts’ views on evaluation of the entrepreneur’s physical and mental condition and entrepreneurial ability are more different than entrepreneurial resources and the macro environment.
We can see that Figures 2 and 3 are very similar by comparison. As we know, Figure 2 is the cloud chart of the comprehensive evaluation index, and Figure 3 is the cloud chart of primary level indexes, while the comprehensive evaluation index is integrated from the primary level indexes. In other words, Figure 3 shows the decomposition of Figure 1 in four dimensions. The digital characteristics of primary level indexes are relatively close, so the cloud chart of the primary level indexes is also similar to the comprehensive evaluation index.

6. Comparisons and Discussion

In order to further verify the effectiveness of the proposed evaluation method in this paper, three typical evaluation methods, namely the fuzzy comprehension evaluation method (FCEM) [30], fuzzy analytic hierarchy process (FAHP) [35], and osculating value method (OVM) [36], are chosen to conduct the evaluation results related to the case study, respectively. Results as shown in Table 5 are analyzed as follows:

As seen in Table 7, the evaluation results calculated by CM are fairly consistent with the other three traditional evaluation methods, indicating that the proposed method is considerably reliable and efficient. The exceptions are the 3# entrepreneur whose assessment result is N level evaluated by OVM; however, they have H level assessment results by another method. This difference is acceptable in reality. According to our observation in reality, the effectiveness of this evaluation method is also verified. We found that the 5# entrepreneur shows significant depressive tendencies during the entrepreneurial process. We analyze that the reason may be that he is a fresh graduate and lacks relevant working experience.

Table 7. Comparison of evaluation results by four different methods.

| ID | FCEM Level | OVM Level | FAHP Level | CM Level | (Ex, En, He) |
|----|------------|-----------|------------|----------|-------------|
| 1# | N          | N         | N          | N        | (5.6032, 1.0378, 0.2577) |
| 2# | H          | H         | H          | H        | (7.1032, 0.9418, 0.2979) |
| 3# | H          | N         | H          | H        | (6.3523, 1.0961, 0.4483) |
| 4# | N          | N         | N          | N        | (5.5432, 1.0196, 0.3422) |
| 5# | L          | L         | L          | L        | (3.4512, 1.0881, 0.3577) |
Among these evaluation methods, OVM has an inability to deal with the problem of fuzziness in the evaluation process and requires high quality data. In OVM, FCEM, and FAHP methods, it did not consider the randomness problem in the evaluation process. In addition, it needs structure 38 subordinate functions when using the FAHP method due to the fact that each evaluation index does not have a linear relation with its actual value, which makes the evaluation process more complex and difficult compared to the CM method.

Compared with other evaluation methods, the assessment of UT of entrepreneurs based on CM is more concise about evaluation processes and contains more information on evaluation result. It cannot only give the evaluation grade expressed in a natural language, but also can give the digital characteristics of the qualitative concept and shows the results in the form of a cloud chart. The average level of UT of the evaluated object can be obtained through the value of $Ex$, and the consistency of the experts' opinions on the evaluated object can be obtained through the value of $En$, and the psychological differences of experts when making evaluations of the evaluated objects can be obtained through the value of $He$. In short, the assessment method of entrepreneurs' UT based on the CM is accurate and the results are expressed in diversified forms. It can evaluate all aspects of the entrepreneur being evaluated, not just get a conceptional result of good or bad.

7. Conclusions

In this paper, an evaluation index system of multi-level and multi-attribute is established for the UT of entrepreneurs, and a novel method to evaluate the UT of entrepreneurs based on CM is proposed. In this method, the evaluation results of each index are represented by CM, and the two-dimensional graph of the final comprehensive evaluation result is drawn. When applying this method to the evaluation of entrepreneurs’ UT of a Chinese high-tech company, the theoretical results are basically consistent with the actual situation that we observed later.

Compared with other methods, the evaluation results of this method contain more detailed information, more accurately reflect the UT level of the entrepreneurs, and the presentation of the results is more intuitive. Venture investors or venture service organizations can use this method to evaluate the UT of entrepreneurs, so as to predict the behavior of entrepreneurs, and take corresponding behavior guidance and intervention measures. The application of CM to the evaluation of other objects, or the combination of CM and other methods can be considered in the future.

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