Advances in Computer Science Research, volume 89
2019 International Conference on Wireless Communication, Network and Multimedia Engineering (WCNME 2019)

Gene Bank Construction of Start-ups' Growth Risk Based on Immune System

Bo Yang and Chang Liu*
School of Information Management, Jiangxi University of Finance and Economics, China
*Corresponding author

***Abstract*—Under the background of dual innovation, start-ups are faced with huge, complex and diverse growth risks with sudden, dominant and dynamic characteristics during the growth process, which has caused many start-ups to fail. There is a lack of research results from a multi-level systematic exploration of the characteristics of the start-ups' growth risk identification structure. Moreover, there are no mature products on ontology applications in the field of growth risk identification of start-ups at home and abroad available yet. Based on the theory of biological immune system, this paper combined the ontology with the start-ups' growth risk, and used the modeling tool protégé and the inference engine JESS to build a start-up growth risk gene pool, in order to identify various risks in the growth process of start-up. The result shows that the ontology model supports the risk identification based on semantic reasoning and can improve the accuracy of the growth risk identification of start-ups.**

Keywords—start-up; growth risk identification; immune system; ontology; SWRL

I. INTRODUCTION

The Chinese government has launched a series of policies to support and encourage entrepreneurs to start their own businesses. But the survival rate of start-ups is relatively low because of the various risks in the growth of start-ups. The start-ups' growth risk refers to the possibility of the loss or failure of the start-up in the process of the growth of the start-up. The success of the start-up is closely related to the effective identification and prevention of the growth risk [1].

In recent years, scholars at home and abroad have conducted a large number of studies on the problem of enterprise risk identification. The traditional risk identification model is mainly based on the historical experience of random theory [2], it is unable to fully consider the risk evolution or transfer caused by time and uncertain emergencies. For the research of dynamic risk recognition model support methods, some scholars use Bayesian theory to estimate the possible risks of the system by estimating the prior probability [3], or use the existing state of the organization system and state transition to predict the future state of the system [4] , but such support methods are more suitable for solving dynamic risk identification problems with relatively simple indicators, uncomplicated situations and relatively stable probabilities, not adapt to a sudden, dynamic and evolution characteristics of start-ups grow risk identification and control. Most of the existing studies on the identification of the start-ups' growth risk focus on the risk identification from a single perspective, lacking the research results of the characteristic structure system of the start-ups' growth risk from the multi-level and systematic perspective.

In view of the shortcomings of the existing research, drawing on the information recognition mechanism of the biological immune system, this papers build an ontology-based start-ups' growth risk gene bank model. It provides new research methods and paths for exploring the identification of start-ups' risk. And it enriches the risk management theory of start-ups and provides practical basis and guidance for entrepreneurs. It is the future trend of enterprise's risk management research to adopt the method of multidisciplinary cross integration. This paper combines management science with life science and other disciplines to solve the problem of growth risk identification of start-ups, and makes a beneficial attempt.

II. BIOLOGICAL IMMUNE SYSTEM MECHANISM

In biology, to protect the host organism, BIS (Biological Immunity System) relies on immune cells to fight and eliminate these pathogens and antigens. Immune cells have surface receptors that distinguish between what is foreign ("non-self") and what is physical ("self"). The "self" corresponds to a set of features that are on the surface of the body cells and characterizes the subjection between each cell and the body cells. The "non-self" corresponds to asset of features that are different from the self and exist on the surface of the pathogen, that is, antigen [5].

When a pathogen invades the body, it releases antigens, which can damage cells and/or change their normal behavior. According to the danger theory, a damaged body cell sends out danger signals, which establish a danger zone around the damaged cells and stimulate circulating immune cells to recruit them to the site of infection (cf. Fig. 1). The danger theory inspired the design and development of risk detection algorithm.

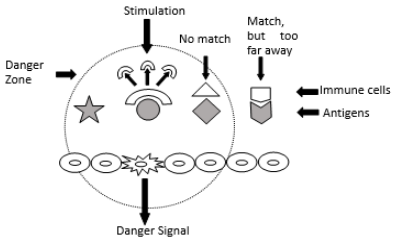

FIGURE I. DANGER THEORY

Immune cells (B cells and NK cells) can be stimulated,

recruited, and involved in the immune response to eliminate antigens and pathogens. When stimulated by a danger signal, B cells proliferate and release antibodies. An antibody attaches to an antigen on the surface of a pathogen to block it and promote its elimination, thereby facilitating its elimination (reaction to disease causing elements, cf. Fig. 2.).

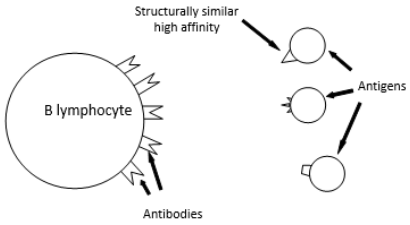

FIGURE II. ANTIBODY-ANTIGEN IDENTIFICATION MECHANISM

Based on biological immunity concepts, the framework of Bayar N, etc. showed that biologic immunization could provide methodological guidance and computer assistance to multidisciplinary teams working on risk management projects [6]. This paper expands these efforts to show how to use ontologies to detect risk events, identify growth risks, and select pre-control schemes in the identification system of the start-ups' growth risk.

III. Characteristics And Architecture Of Start-Ups' Growth Risk

The basis of establishing the active identification model and method for the start-ups' growth risk is to construct the growth risk characteristics and structural system of start-ups, deeply analyze the formation process and evolution mechanism of the risk, and determine the risk source and characteristic architecture.

A. Formation and Evolution Mechanism of Start-ups' Growth Risk

On the basis of existing research, this paper recognizes the various uncertainties faced by the start-ups from the dynamic perspective, and explores the formation process and evolution mechanism of the start-ups' growth risk.

Based on the theory of enterprise growth, the start-ups' growth risk can be defined as the possibility of deviation from the expected target caused by the uncertainty of internal and external environmental conditions in the process of enterprise growth. The uncertainty of the internal and external environment of the enterprise constitutes various risk factors. The risk factors are accumulated and affected by the environment, finance, social network and other environmental impacts, and the risk events cause risk loss. The start-ups' growth risk is caused by the risk of loss of business deviations beyond the range of deviations that can be accommodated [7]. Fig. 3 shows the formation process of start-ups' growth risks.

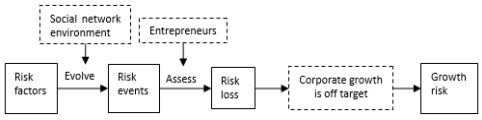

FIGURE III. THE FORMATION PROCESS OF START-UPS' GROWTH RISKS

Meanwhile, dynamic risk events can be analyzed from three dimensions of individuals, organizations and social network environment to explore the risk events of start-up of the bidirectional conversion [8], as shown in Fig. 4.

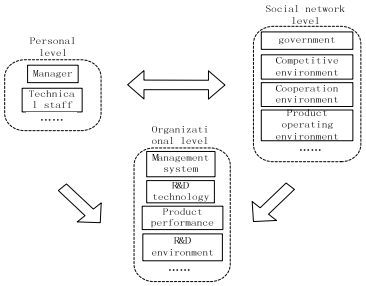

FIGURE IV. MUTUAL INFLUENCE OF RISK EVENTS IN START-UPS

B. The Growth Risk sources and Risk Characteristic Structure System of the Start-ups

The identification process of start-ups' growth risk consists of the determination of risk sources, the construction of risk characteristic structure system and the identification of important risk indicators. Its function is to determine the types of risk factors and risk sources, so as to prepare for other steps of risk management [7].

According to the preliminary results of the project and the basis of the existing research, this project construct a characteristic structure system of start-ups' growth risk based on the principles of pertinence, comprehensiveness and authoritativeness, as shown in Fig. 5.

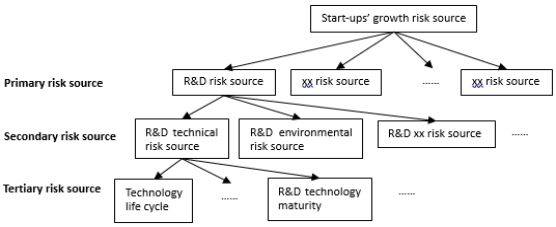

FIGURE V. CLASSIFICATION STRUCTURE OF START-UPS' GROWTH RISK OF

IV. Design Of Gene Bank Of Start-Ups' Growth Risk

According to the previous analysis of the biological immune mechanism and the characteristics and architecture of the start-ups' growth risk, a list of the correspondence between the biological immune system and the start-ups' risk system of the start-up is listed in Table 1.

TABLE I. CORRESPONDENCE BETWEEN THE BIOLOGICAL IMMUNE SYSTEM AND THE START-UPS' RISK SYSTEM

Biological immune system	**Start-ups' risk system**
Pathogen	Risk events in start-ups
Cell	Start-ups with index and relevant threshold
Antigen	Start-ups' risk
Antibody	Pre-control plan of start-ups' growth risk
Antigen gene	indicator feature database of start-ups' growth risk

The gene bank of start-ups' growth risk includes two

libraries: ontology and rules. Firstly, use the ontology knowledge to formally express the relationship between concepts and concepts in the field of the start-ups' growth risk. Secondly, use the inference mechanism to reason according to the concepts and relationship knowledge in the ontology library, then complete the construction of the rule base [9].

A. Ontology Construction of Gene Bank

This paper uses Protégé for ontology creation. When using Protégé to create ontology, the definition of concepts in the domain should be clearly defined, and the basic information and classification included in the domain should be clear. The most basic concepts in the field of the start-ups' growth risk should correspond to the root of each classification hierarchy tree in the knowledge base of growth risk. To define the root classes of the start-ups' growth risk domain, simply declare them as a named class. All individuals in OWL are members of the class OWL: Thing, so the customized growth risk domain class implies a subclass of OWL: Thing [10].

Using the top-down method and the protégé tool to build a concept based on the immune system growth risk and its related classification system, This paper respectively set up "Pathogens ", "Antigen ", "AntigenGene", "Cell", "Antibody " five classes in an ontology database of start-ups' growth risk based on immune system. And it defines two types of attributes based on the immune system growth risk ontology: numerical attributes and object attribute. Finally, instances of classes in the immune system-based growth risk ontology are defined, which will be stored in the immune system-based growth risk ontology library to support the next reasoning work. Based on the above work, the framework of ontology model of start-ups' growth risk gene bank based on immune system is established, as shown in Fig. 6.

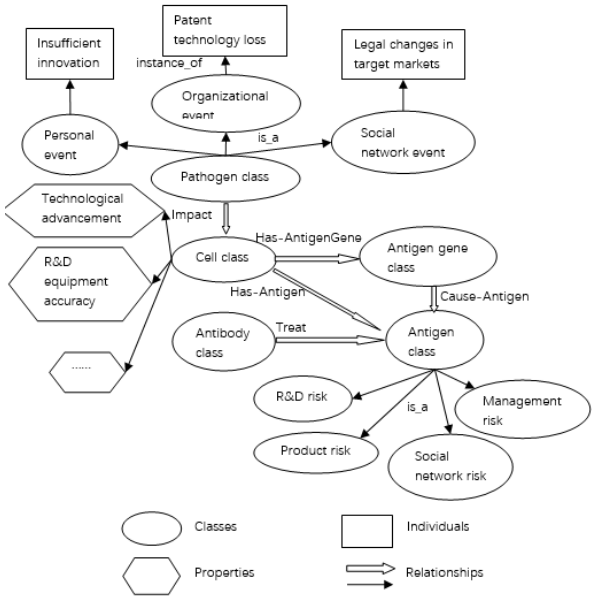

FIGURE VI. ONTOLOGY MODEL OF START-UPS' GROWTH RISK BASED ON IMMUNE SYSTEM

1) Construction of concept layer

a) Pathogen class

Pathogens represent risk events. A risk event is an accident or an emergency. According to the above knowledge, risk events are divided into three subcategories: personal events, organizational events and social network events. The classification of pathogens is shown in Fig. 7.

FIGURE VII. CLASSIFICATION OF PATHOGENS

In the process of the development of start-ups, the risk events of different dimensions interact with each other and transform into derivatives. For example, due to the negligence of recruitment examination, the experience of the R&D staff is reduced. When the index is lower than the pre-set value, it is considered that antigen genes (i.e., risk characteristics) will be generated -- the poor experience of the R&D s staff may lead to a series of other risk events at the same time, which will lead to risk characteristics at other levels.

b) Cell class

• The cell class corresponds to the start-up and represents the state of the enterprise. The numerical attributes related to cells are risk indicators involved in various risks of the start-ups' growth system, including key risk indicators, default range of risk indicators, actual value of the risk indicators. These correspond to the antigen genes, as shown in Fig. 8.

FIGURE VIII. NUMERICAL PROPERTIES OF THE CELL CLASS

c) Antigen gene class

The antigen gene class corresponds to the characteristic of risk. For example, the technology advanced degree is too low, it will show an antigen gene class with low advanced technology. The antigenic gene class are designed to capture knowledge about risk signals. The classification of the antigen gene class is shown in Fig. 9.

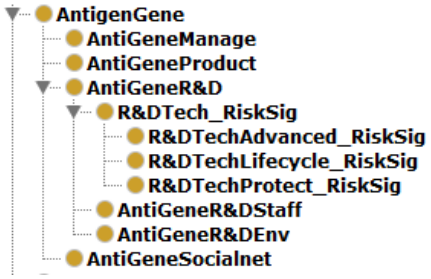

FIGURE IX. CLASSIFICATION OF ANTIGEN GENE

d) Antigen class

The antigen class corresponds to the start-ups' growth risk. According to the above knowledge, growth risk is divided into four first-level subclasses, corresponding to risk source (first-level indicator): R&D risk source, product risk source,

management risk source, and social network risk source. Secondary subclasses correspond to risk factors (secondary indicators). For example, R&D risk sources include R&D technology risk factor, R&D staff risk factor, and R&D environment risk factor. The classification of antigens is shown in Fig. 10.

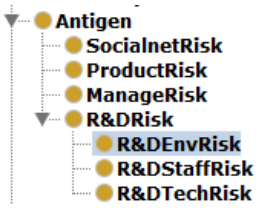

FIGURE X. CLASSIFICATION OF ANTIGENS

e) Antibody class

Antibodies protect cells and are used to process antigens. In the field of the start-ups' growth risk. The antibody class corresponds to the response to the risk and the pre-control plan. It aims to enumerate and classify the options available to control the growth risk of each type of start-ups.

2) Construction of property layer

OWL has two main Property types: Object Property and Data Property. Object properties are typically used to represent relationships between classes, while data properties are typically used to represent data attributes that each class has. On the basis of defining the core concept of the start-ups' growth risk and analyzing the mechanism of biological immune system and the growth risk and system structure of start-ups, the properties of the ontology of the start-ups' growth risk based on the immune system can be obtained.

a) Object property construction, as shown in Fig. 11:

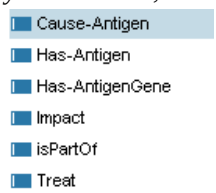

FIGURE XI. PARTIAL OBJECT PROPERTIES

b) Data property construction, as shown in Fig. 12:

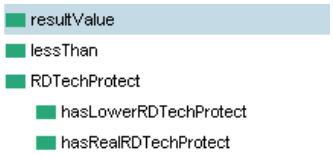

FIGURE XII. PARTIAL DATA PROPERTIES

3) Construction of physical layer

Through a large amount of information collection, on the basis of ontology library concept layer and attribute layer construction, the instance construction is carried out. The purpose of it is to prepare the reasoning for the next step.

B. Construction of Gene Bank Rules

Based on the ontology of the gene bank of the previous section, this study edits the rules of the gene bank of start-ups' growth risk in The SWRL Editor, according to the mechanism of biological immune system and the formation and evolution mechanism and risk characteristic structure of start-ups' growth risk.

A simple example is given to illustrate the establishment of SWRL rules. The description is based on the rule that a cell having an antigen gene produces a corresponding antibody. For example, if an enterprise (cell) has R&D technology risk characteristics (antigen genes), and R&D technology risk characteristics (antigen genes) lead to R&D technology risk sources (antigens), then the enterprise (cell) has R&D technology growth risks (antigens). Using SWRL to translate the above natural language, we can get the SWRL rule: the cell has a R&D technology antigen gene ∧ R&D technology antigen gene leads to the development of technology antigen → cells have R&D technology antigen. The corresponding SWRL inference rules are formatted as follows:

Cell(?p) ∧ Has-AntigenGene(?p,?ag_t) ∧ RDTech_RiskSig(?ag_t) ∧ Cause-Antigen(?ag_t,?a_t) ∧ RDTech_Risk(?a_t) → Has-Antigen(?p, ?a_t)

V. REASONING OF GENE BANK ONTOLOGY

This example uses Jess-based reasoning techniques. In the previous work, a gene bank of start-ups' growth risk based on immune system has been constructed, and the ontology information is stored in protégé and the SWRL rule language describes the logical relationship between ontology knowledge. In order to dig out the implicit new knowledge of the ontology of the start-ups' growth risk domain, the OWL ontology, attributes, instances and SWRL rules in the field of start-ups' growth risk need to be converted into the Jess ontology base and the rule base according to the requirements, and then Jess reasoning engine should be run for reasoning. Finally, the new inferred knowledge is updated and the growth risk OWL ontology knowledge base is expanded [11], as shown in Fig. 13.

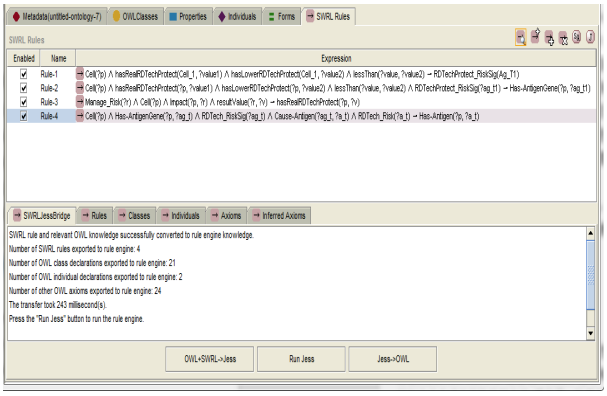

FIGURE XIII. JESS INFERENCE INTERFACE

Through the above methods, we can further explore the implicit semantic relationships between classes in the ontology database of the start-ups' growth risk domain and between classes and instances. And the gene bank of start-ups' growth risk can be gradually improved to make the reasoning results more accurate.

VI. CONCLUSION

With the support of existing research, this paper explores the characteristics structure system of the start-ups' growth risk identification from multiple levels systematically, draws on the identification mechanism of immune system, and combines the combination of immunology theory and computer science. This paper proposes a new approach to identifying and controlling growth risks in start-ups, and provides a detailed design of a gene pool based on the growth risk of emerging systems in the immune system. The main contents of this paper are as follows:

- Use the ontology development tool to establish an ontology library of the stat-ups' growth risk according to the principle of immune response.
- Use SWRL rule language and Jess reasoning engine to transform the ontology of start-ups' growth risk domain and SWRL rules into Jess fact library and rule base. Update the gene bank of the start-ups' based on the immune system.

The research in this paper belongs to the exploratory work. And a lot of research is needed to achieve further improvement. The future research work is to further explore the correlation between the risk events and the start-ups' growth risk and dig into the formation and evolution rules of growth risks based on the update and expansion of the case, then update and expand the knowledge in the gene bank of the start-ups' growth risk based on immune system for growth risk identification to guide the risk control of start-ups.

ACKNOWLEDGMENT

This work was financially supported by Science and Technology Research Project of Jiangxi Education Department (2018ACB29004),Jiangxi Provincial Department of Education Science and Technology Research Key Project (Grant No:GJJ180249), Jiangxi university humanities and social science research project (GL18103), National Natural Science Foundation project (71640022,71561010).

REFERENCES

[1] Wang Qiaoyi. Entrepreneurs' Risk Control Ability, Entrepreneurial Self-efficacy and New Venture Growth [D]. Zhejiang Sci-Tech University, 2014.

[2] Stanganelli, Marialuce. A new pattern of risk management: The Hyogo Framework for Action and Italian practice [J]. Socio-Economic Planning Sciences, 2008, 42(2): 92-111.

[3] Hu Zhijun, Peng Fei, etc. Bayesian Evaluation and Selection Strategies in Venture Project Portfolio Decision Analysis [J]. Chinese Journal of Management Science, 2017, 25(2): 30-39.

[4] YANG Junping, YU Xiaoyu, TAO Xiangming, Li Yajie. Social network, prior experience, and entrepreneurial risk recognition, 2017, 20(5): 35-46.

[5] Shen Lin. The improvement of intrusion detection system and pattern matching algorithm based on artificial immunity [D]. 2013.

[6] Bayar N, Darmoul S, Hajri-Gabouj S, et al. An Immune Based Ontology Implementation of Hazard and Operability Analysis in Production Systems [J]. Applied Mechanics and Materials, 2014, 575:884-894.

[7] Ma Yibo. Research on Growth Risk Early-warning System of Knowledge-intensive New Venture [D]. Harbin Engineering University, 2013.

[8] Yin Miaomiao, Sun He, Ma Yanli. Research on Cross-level Transformation Mechanism of New Enterprise Entrepreneurship Ability——Based on Case Analysis of High-tech Industry [J].Foreign Economics & Management, 2018, 40(10):18-31.

[9] Gong Muge, Wen Youkui. Knowledge Base of Hypertension Diagnosis Based on Ontology [J]. Journal of Intelligence, 2010, 29(s1):169-172.

[10] Zhang Yong, Lu Junbai. An Overview of Ontology Modeling Based on Protégé [J]. Fujian Computer, 2011, 27(1):43-45.

[11] XIA Lixin, DUAN Feifei, ZHAI Shanshan. Empirical Research on JESS Reasoning of Ontology [J]. Information Science, 2017, 35(05):106-110+118.