Web Intelligence Meets Extenics: New Frontiers of Innovation for Small & Middle Business

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Abstract

Innovation is important but many of them rely on skilled persons which are scarce in most small & middle business (SMB). Obtaining enough information and knowledge then processing them effectively is two key factors for innovation. Web Intelligence (WI) can provide enough knowledge; meanwhile Extenics provides a novel methodology to process knowledge to support innovation process. So we present a WI and Extenics combined knowledge management model to aid innovation process and obtained satisfactory results. By briefly demonstrating the potentials of WI-Extenics-based Innovation research, we believe that integrating WI with Extenics will be a novel research issues for innovation in SMB.

1. Introduction

Small & middle business (SMB) acts an increasingly important role in economics in which innovation is the critical success factors. But most innovation relies on skilled persons while there are no enough skilled persons in most SMB, which restricts their innovation activities. There are several innovation researches such as information based innovative service [1], gene-engineering-based design method [2] and TRIZ [3] et al. but only a little SMB can use them effectively. With the rapid development of the web, there exists large information for innovation (The information is so huge that we are facing with information overload [4]). Web Intelligence (WI) combining with Brain Informatics (BI) form a new interdisciplinary field that studies the mechanisms of human information processing by integrating experimental cognitive neuroscience with advanced information technology [5]. Knowledge management is sustaining and enhancing innovation in organizations. But most of the SMB focus on descriptive knowledge, such as product data, marketing information and new technology, while neglect methodology knowledge, such as how to utilize knowledge and information to benefit innovation activities. Extenics [6] proposes series methods to aid people collect and process information and is becoming a new methodology potentially for innovation.

In most small & middle businesses there are no enough skilled persons to share their innovation experience; however, they can obtain knowledge for the web. The purpose of this paper is to propose a WI and Extenics integrated knowledge management platform for SMB as a new method to accumulate knowledge and improve the efficiency of the innovation process.

The rest of the paper is organized as follows: Section 2 analysis how WI benefits the innovation process. Section 3 describes how WI and Extenics integrate; Section 4 gives a new innovation model based on WI and Extenics. Section 5 concludes the paper with future research directions.

2. How WI Benefits the Innovation Process

Innovation is essentially a knowledge creation, transmitting and usage process. Therefore the study of
innovation is related to knowledge management and organizational learning [7]. Industrial innovation is also involved in R&D, prototype development, manufacturing, marketing, and other factors of the parallel process. The current innovation process model presented that its process is an information-based process. It often utilizes expert system to assist in development work, using Computer Simulation to test prototype. Through information networks the suppliers and users can design the new products together, and emphasis on the external cooperation to fulfill the innovation. Innovation is a gradual and cumulative process which needs knowledge and information. In general, innovation process is a systematic process, which is made up of different actors and institutions or departments [8].

From the above analysis we can see that knowledge acquisition and utilization are the two key factors for the innovation quality. However, in the most SMBs, there is no enough knowledge to serve innovation process; their innovation has to rely on few able-persons. That means the innovation will be out of control if several able persons are quit.

In order to improve the stability of innovation in SMBs, some basic methods or tools should be applied to implement innovation process efficiently. Nowadays, the rapid developments of internet and information systems make a great chance for human beings to acquire knowledge. From the perspective of enterprise innovation, knowledge can be divided into two categories: descriptive knowledge and methodology knowledge, descriptive knowledge is knowledge of the facts, the principle of knowledge and human knowledge [9]. It reflects the objective laws of the fact and the cognitive description. Methodology knowledge is built on the experience of practice that our predecessors summed up gradually. It can guide the practice with certain methods, skills, tools or ideas. There is plenty of descriptive knowledge on the Internet, on which methodology knowledge is needed to run and then find most possible innovation ideas.

3. When WI Meets Extenics

3.1. Web Intelligence and Brain Informatics

The Internet has become an innovation source of information and knowledge. Billions of pages are publicly available, and it is still growing dramatically. Web Mining and text mining can discover a lot of knowledge from huge amounts of web pages or local text files et al [10]. A lot of novel knowledge has been mined for practical use [14].

Information and knowledge on the web is so large that Web Intelligence (WI) has been recognized as a new direction for scientific research and development to explore the fundamental roles. It impacts both Artificial Intelligence (AI) (for example, knowledge representation, planning, knowledge discovery and data mining, intelligent agents, and social network intelligence) and advanced information technology such as wireless networks, ubiquitous devices, social networks, wisdom Web, and data/knowledge grids. It is one of the most important research fields in the era of Web and agent intelligence [11].

From the viewpoint of Brain Informatics (BI), it’s a new interdisciplinary field that studies the mechanisms of human information processing from both the macro and micro viewpoint by combining experimental cognitive neuroscience with advanced information technology [5]. It’s a long way to achieve WI, which needs support of methodology knowledge and so on.

3.2 Extension theory (Extenics)

Extenics is a new kind of methodology knowledge based on the concepts of matter-element and extension set. Innovation is to solve contradictory problems essentially. To solve contradictory problems, we must consider the matter, the characteristic and their measure together or even their relation and their change. Extenics solves contradictory problems with formalization methods in which we can find methodology knowledge for innovation, such as divergent tree, correlative net, conjugate pair and six transformation methods [6].

One kind of innovation is to make certain transformation which turns one thing that doesn't have property P into another thing that has the property P. extension set [6] can describe this kind of transformation quantitatively and guide users to think systematically.

Extenics makes it possible to develop the formalized description for activities of creative thinking, such as management innovation. A series of particular extension methods have been developed, such as matter-element extension method, matter-element transformation method and superiority evaluation method [6]. The combination of extension methods with other engineering fields generates the respective extension engineering methods with the formalization tools to solve contradictory problems.

For example, Innovation target and conditions can be expressed as an ordered triad

\[ R = (N, c, v) \]

Which is called matter-element, where \( N \) represents the matter; \( c \), the characteristics; \( v \) is the \( N \)'s measure.
about the characteristics \( c \); the expression \( v = c(N) \) describes the relation between quality and quantity.

The concept of characteristic-element \( M(c,v) \) is composed of the characteristic \( c \) and respective measure \( v \). A matter has many characteristic-elements, which can be described by \( n \)-dimensional matter-elements which show the start of innovation and guide the directions of innovation.

\[
M = \begin{bmatrix}
N_{m1}, & c_{m1}, & v_{m1} \\
\vdots & \vdots & \vdots \\
N_{mn}, & c_{mn}, & v_{mn}
\end{bmatrix} = (N, C, V) \quad (1)
\]

### 3.3 WI and Extenics Benefit Each Other

In this information overload age, it’s very important how to collect the useful knowledge for innovation. Extenics promotes the development of WI in three directions:

Firstly, by integrating web search technology and Extenics, an Information & Knowledge Collection method has been proposed for collecting systemic data, information and knowledge from the web according to an information list cube [12].

Secondly, Extenics can guide users to process the information by Extension transformation and get a lot of innovation ideas from almost all possible directions.

Finally, Extenics can improve web search technology from information search to Actionable Strategy search. By mining information on the web, we obtain the novel solutions to solve the problem.

Meanwhile, WI can improve the efficiency of base-element building process, mostly we collect attributes of elements by human experience, with WI technology such as agent and ontology, we can gradually collect and store attributes with their possible values automatically in the element base, by data mining technology we get much knowledge, through knowledge cultivating [15] method we will finally achieves intelligent knowledge management [4] for innovation.

### 4. WI-Extenics-Based Innovation Methods

Many organizations have rich knowledge, but their innovation is poor, for they can’t effectively apply knowledge to the practice of innovation. Based on the integration of WI and Extenics, we designed a framework of WI-Extenics based formulization innovation process model as shows in figure 1.

The WI and Extenics-based innovation process has four main steps as following:

**Step 1, Collect information and knowledge related to the innovation goal.**

Innovation can be described as the solving process of the problem \( P= G \ast L \), when the condition \( L \) can’t enable the goal \( G \) to come true, then \( P \) is called the innovation problem.

The condition \( L \) and the goal \( G \) both can be described as matter-elements, affair-elements or relation-elements which have their objects, attributes and values.

**Step 2, Choose innovation path**

There are three ways to solve the problem [13]: (1) the goal doesn’t be changed, the problem can be solved through changing its conditions; (2) the conditions don’t be changed, the problem can be solved through changing its goal; (3) the problem can be solved through changing both its goal and conditions at the same time.

To solve an innovation problem through changing its conditions, we can transform the base elements, the fields or the evaluation rules.

**Step 4, Transformation**

The transform objects can be the area (range) of the innovation, the elements or the evaluation rules. Each kind of objects can be transformed by many methods, including basic transformation method (including replacement, Enlargement/reduction, add/minus, Combination/decomposition, and replication), combination transformation method and transforming bridge method.

**Step 4, Solution Integration and Evaluation**

Innovation Evaluation model is a summary and extension of innovation process. Evaluate the innovation solutions by superiority evaluation method which can get a more practical result.
Traditional innovation process mostly relies on skilled persons, and most of its process is implicitly. The WI and Extenics-based innovation model divides the whole innovation process into four steps, every step can be implemented by ordinary people and most possible solutions can be found out by formalized method. Table 1 shows their difference:

**Table 1. differences between traditional innovation process and Extenics-based innovation process**

<table>
<thead>
<tr>
<th>Contents</th>
<th>Traditional process</th>
<th>Our new process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human resource</td>
<td>Skilled innovative person</td>
<td>Common people</td>
</tr>
<tr>
<td>Number of results</td>
<td>No more than 5</td>
<td>Often more than 10</td>
</tr>
<tr>
<td>Quantity of solutions</td>
<td>few</td>
<td>many</td>
</tr>
<tr>
<td>Cover range</td>
<td>Certain range</td>
<td>Almost cover all possible ranges</td>
</tr>
<tr>
<td>Risk of investment</td>
<td>high</td>
<td>low</td>
</tr>
</tbody>
</table>

This model has been used in brand marketing planning, attractions planning and new product designing in several SMBs in Ningbo, Zhejiang province, China, and got satisfied results.

5. Conclusions

By analyzing the problems faced in innovation process in SMB and integrating WI and Extenics, we present a systemic innovation model in which the Matter-element and transformation methods gives a practical way to find various innovation directions by knowledge based formalization method. It can aid SMB to innovate by ordinary employees and reduce the dependence on special high-paid experts, therefore improve the innovation efficiencies.

The synergy between WI and Extenics will advance our understanding knowledge, utilization of information, and creativity. As a result, Web intelligence and Extenics based innovation for SMB will become a novel topic that will change the thinking on innovation by information technology, and improve the innovation efficiency in SMB. How to combine the experience of employees with Web information effectively so as to make a continuing innovation mechanism in SMBs will be the future study.

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7. References