IIAI Open Conference Publication Series
IIAI Letters on Informatics and Interdisciplinary Research
Vol. 003, LIIR071
DOI: https://doi.org/10.52731/liir.v003.071

Validation of a Foresight Support System to Imagine an Uncertain Future - Effectiveness Testing through Scenario Planning Workshops -

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Abstract

This paper shows the validation process of the effectiveness of Foresight Support System to help people detect signs of future uncertainties through scenario planning workshops. By enabling us to efficiently collect and output weak signals, the system has been developed to support Foresight activities that generate future-oriented ideas as a response to uncertainties involved in the global economy and society. Although gathering weak signals generally requires considerable amount of time and labor, such signals are essential to forcibly drive the creativity of people who attended Foresight workshops. To validate the efficiency of the system, scenario planning workshops were held using Scanning Materials collected both by the system and manually as a comparison. . The outcome of the validation process suggested that weak signals gathered by Foresight Support System developed by authors can fast retrieve information in wider scopes. Moreover, the system enables us to collect and output information that includes semantically diversified words. During the workshops, it was also confirmed that the Scanning Materials collected by the system were employed as sprouts of ideas more often than manually collected materials. As a result, the effectiveness of the system in supporting people to detect signs of uncertainties in mid- and long-term was successfully validated.

Keywords: Foresight, KJ method, Creativity, Natural language processing

1 Introduction

Due to the intensified competition in the global economy as well as the advancement of digitalization seen in the recent years, firms have faced unprecedented social and economic uncertainties which involves various issues. Thus, building up flexibilities in management strategy planning by detecting signs of drastic changes in society and economy is ever more vital for the long-term success of business [1]. To enhance the resilience of management strategies, Foresight, a combination of Horizon Scanning [2] and Scenario Planning [3], has been attracting attentions from various industries. In this paper, the effectiveness of Foresight Support System, which has been

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developed to support processes that generate future-oriented ideas as a response to such uncertainties observed in the global society, is verified to improve efficiency in various activities to overcome issues seen in the rapidly-changing society.

2 Literature Review

2.1 Foresight Practice

Foresight practice examined in this paper is supported by the forecasting technique developed by Stanford Research Institute in 1960s based on PEST analysis [4]. It started to gain world-wide attention once it was reported that the management of Royal Dutch/ Shell were prepared for the eventuality of the 1973 oil crisis thanks to Scenario Planning technique [3]. In Japan, *Foresight Methodology* (Saritas,2013) has been mainly applied for various Foresight practice. It is structured the consecutive six basic phases as shown in Figure. 1 [5].

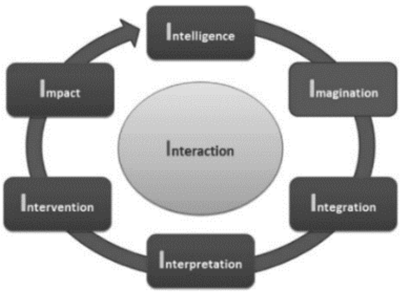

Figure 1: Phases of the Foresight Methodology (Saritas,2013)

Among them, Intelligence and Imagination are mainly focused in this research. During the Intelligence phase, Horizon scanning is conducted to search large amount of input for the Foresight practice. In this paper, Horizon scanning is defined as the activities to identify opportunities and restrictions from various information. This allows us to accumulate related data and knowledge to forecast future issues and, therefore, enhance the quality of decision making [6].

During the Imagination phase, the participants of Foresight practice construct various possible scenarios by synthesizing the input gained from the Intelligence phase. Inherently, they are shaped by the subjective perception of the participants [5]. In here, it is noteworthy that those scenarios are not forecasts. They are rather for enhancing planning skills by broadening participants' perspectives through scenario creation [7]. It is also important to generate diverse scenarios for various future possibilities with emergent interaction within the organization. This allows scenarios to be socialized by sharing recognition and then, circulating it for knowledge creation [8].

One of the purposes of this research is to support the creative process in the Imagination phase by developing Foresight Support System (FSS) that complements the collection and accumulation of data in the Intelligence phase.

2.2 The Importance of Weak Signals in the Intelligence Phase

For Horizon scanning, detecting weak signals holds great significance. Ansoff (1957) defined weak signals as signals of change located outside of well-framed information and consideration of such signals allow us to prepare for strategic surprises with necessary flexibilities in the strategy [9]. According to Figure.2., weak signals are information locating outside of array of status quo. Thus, it is important to gather such information to consider and examine various future scenarios that might happen in the future [10].

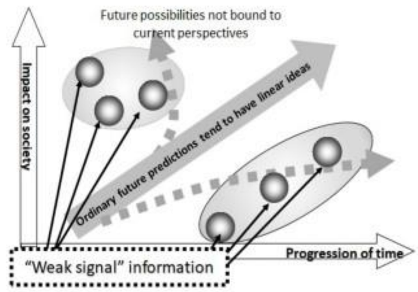

Figure 2: How horizon scanning collects "Weak signal" information
(Washida, Y. and Yahata, A. 2021)

2.3 The Importance of Synthesis in the Imagination Phase

During the Imagination phase, participants synthesize the information gathered through the Intelligence phase to create future scenarios. For scenario design process, information needs not to be analyzed but synthesized using creativity. The characteristics of design process composed of analysis and synthesis are shown in Table 1[11].

Table 1: Analysis or Synthesis (created by the author based on Taura T. and Nagai Y.2017)

Category	*Purpose*	*Outcome*
Analysis	To understand the nature of something that already exists by breaking it down into several parts or constituent characteristics	Quantitative innovation
Synthesis	To combine various things that already exist into something that does not exists	Qualitative innovation

While analytical design creation is based on the assumption of pre-assigned goals and focuses on the past events or problems, synthetic design creation is driven by an intuition or gut feeling towards future innovation [12]. Thus, the goals of scenarios created in the Imagination phase are not to analyze the provided information including weak signals but to combine such elements to imagine uncertain future to enable innovation.

Foresight practice falls into the scope of this research encourages to use the KJ method that applies creative thinking to synthesize information. Although it is often mistaken as an analytic sorting method, the fundamental nature of the KJ method is to integrate unstructured information through creating problem-solving process with divergent and convergent thinking steps [13].

In this research, we encourage participants to diversify stocked knowledge both quantitively and qualitatively by providing FSS to assist data collection and accumulation in the Intelligence phase. We also support activities to generate scenarios to imagine creative future by encouraging them to synthesize such information with creativity by applying the KJ method.

3 Foresight Support System

3.1 Scanning Materials for Foresight Practice

For successful Horizon scanning, gathering weak signals requires considerable amount of time and resources in the existing method. The data collection has been handled implicitly by experts, practitioners and students with professional trainings. On the other hand, Foresight practice conducted in this study automatically outputs each of the collected weak signals in a predefined format. Such documents consist of 5 elements as Title, Comment, Keyword, Summary and Source. They are named as *Scanning Materials*, stemming from the roles they play during the Horizon scanning.

Foresight practice conducted in this research uses a large set of cross-sectional *Scanning Materials* for imagination. Such process is important from the perspective of creativity research. Carson (2011) suggests that high-functioning people with high scores on measures of creativity possess cognitive ability to quickly acquire various information and, then, to utilize them [14] . Ohlsoon (2018) emphasized the possibility of creative insight by consciously incorporating previously unheeded information into consideration [15]. Thus, the Foresight practice discussed in this paper simultaneously provides an enormous amount of diversified information to enable inspiration by forcibly driving one's creativity as the large set of *Scanning Materials* stimulates our creatively to consequently impact design process to generate future scenarios.

3.2 *Scanning Materials* output by FSS

Authors have been working on the development of FSS with automated functions to output *Scanning Materials* [16]. Such functions enable document retrieval and comment generations. The former is designed to digitally retrieve newspaper articles contains weak signals based on the machine learning of 2,266 *Scanning Materials* manually inputted by experts and 33 students with understandings of Horizon scanning over a 17-year period from 2003 to 2020. Figure.3. demonstrates the procedure to output the relevant information in the predefined format.

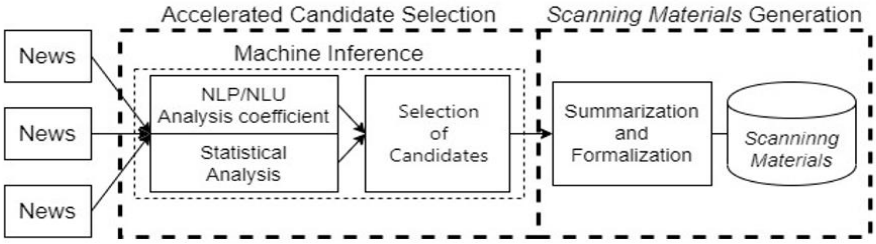

Figure 3: Schematic Drawing of Foresight Support System (created by the author)

Document retrieval based on the supervised learning using neural network has attracted scholarly attentions in recent years. The research focusing on the text generations about future possibilities is rarely seen and, thus, the usability of such dataset is considered to be high. The existing research point out the peculiarities of articles retrieved by FSS compared to the general news articles. This suggests the possibility of FSS to successfully detect weak signals contained in them. On the other hand, we recognize the technical challenges for comment generation function to describe the reasons why readers think certain articles imply future. We continue to tackle with the issues through, for instance, the expansion of comment generation models.

In this study, the effectiveness of FSS will be evaluated thorough scenario planning workshops using *Scanning Materials* generated by FSS.

4 Purpose

This study is conducted to verify the effectiveness of FSS, which is developed to automatically generate *Scanning Materials* for Horizon scanning for Intelligence phase of Foresight practice, through Foresight workshop. The main purpose of such efforts is to enable more effective Foresight practice beyond one's scope of cognition through providing wider varieties of information retrieved by the system. It is also expected to optimize the time and resources required for Foresight practice. Eventually, FSS can provide more opportunities for people to experience Foresight practice not only to prepare for uncertainties in drastic changes in society but also to generate scenarios for creative future.

5 Methodology

In this paper, *Scanning Materials* were generated both manually and automatically to pin down semantic characteristics of each category for comparison. Then scenario planning workshops were held using the materials to compare their adoption and contribution rate to validate the effectiveness of materials automatically generated by FSS. The followings demonstrate each step of process validation.

5.1 Preparation for the Intelligence Phase

The digital data inputted to FSS for the validation is consist of newspaper articles published on *The Asahi Shimbun*, one of the major newspapers circulated in Japan, in FY 2020. 76,000 articles fell into the scope of the validation process and FSS retrieved articles that contains weak signals among them. Then, finally, the articles appeared on the top of research results were generated as *Scanning Materials* in the predefined format. As FSS holds technical issues for comment generation functions to rightly describe the reasons why readers consider the articles imply future, such comments were added manually by authors. This group of *Scanning Materials* are categorized as Group A.

Meanwhile, 16 graduate students who learned how to generate *Scanning Materials* manually retrieved them. Each students use the web search engines to retrieve articles that fall into the concept of the article explained in 2.2 and, then, manually fill in the predefined formats. This group of *Scanning Materials* are categorized as Group B.

Then, words contained in those two groups of *Scanning Materials* were analyzed with the statistical software.

5.2 Preparation for the Imagination Phase

We collected total of 150 sheets of dataset, 75 from each group of *Scanning Materials,* from a variety of fields and topics. Then we held the future scenario planning workshops with 16 MBA students using the sets of 150 sheets as an information source. Categories of each piece of information were unknown to the participants. The followings are the procedure to create scenarios.

1.Read all 150 *Scanning Materials*

2.Organize and Sort all information using the KJ method

3.Create five future scenarios per participant with Title (short text) and Contents (long text) by synthesizing 2 to 9 *Scanning Materials*. All *Scanning Materials* used to generate the scenarios were clarified with adding numbers assigned to each *Scanning Material* to the scenarios.

Then, we evaluate the effectiveness of FSS by comparing and analyzing adoption frequencies and contribution rates of *Scanning Materials* by groups.

6 Results

6.1 Characteristics of Scanning Materials

To evaluate the results, words contained in each group of *Scanning Materials* were generated as text to identify co-occurrence network (A=Figure.4-a, B=Figure.4-b) by categorizing them into cluster groups based on the semantic relevance. The followings are the semantic characteristics of each group.

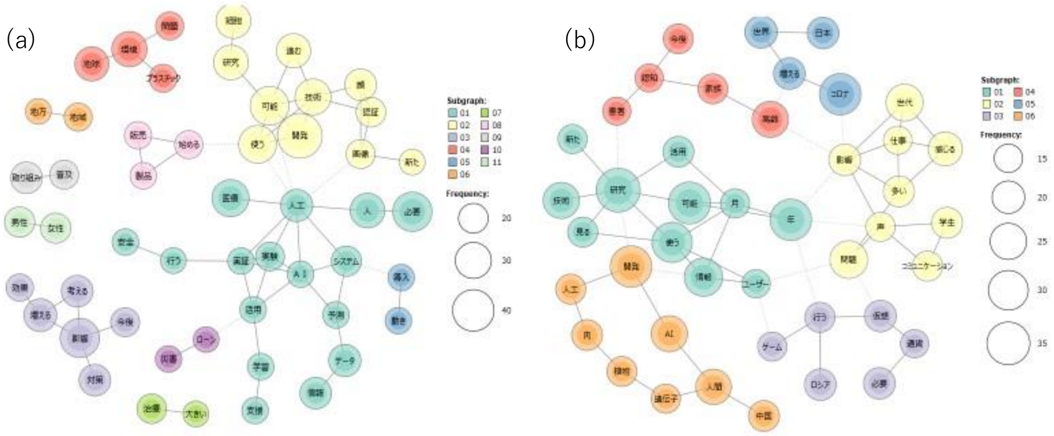

Figure 4: (a) Semantic Characteristics of Group A
(b)Semantic Characteristics of Group B (created by the author)

Words in Group A are categorized into 11 cluster groups. The biggest group is surrounding the “AI” (Figure.4-a_01) including its experiments, evaluations, and contribution to the medical industry. For example, the articles about applying machine intelligence to experiments and evaluations of various fields including welfare consulting, water level prediction for the natural disaster management, vacant houses management, wild animal damage control, and ones implies the expansion of AI application to the field of the regenerative medicine were selected. The next big cluster groups (Figure.4-a_02) contains terms such as “Technologies(技術)”, “Development(開発)”, and “Research(研究)”. These groups include the articles mention the possibility of virtual automobile development or introduce research to use birds for monitoring illegal fishing vessels. It is noteworthy that they are not mere reports on the existing technologies or applications but contain sprouts of future innovation. Those main cluster groups are surrounded by 9 smaller groups. Half of them are not related to the bigger groups, such as “Environment (環境)” group including climate change, plastics, waste problems (Figure.4-a_04) and “Gender (男性、女性)”

groups representing the changes in gender consciousness seen in the emergence of male babysitters or the encouragement for male workers to take parental leaves (Figure. 4-a_11). This shows Group A contains articles about diversified topics.

On the other hand, words in Group B are categorized into 6 cluster groups. The main characteristics of the group are: all cluster groups have semantic relevance and the difference in their sizes are negligible. “Development(開発)”, and “Research(研究)” groups (Figure. 4-b_1, Figure.4-b _2) contain articles about development of AI that learn languages and social manners as well as its possible applications to funeral services and dementia treatment to meet the growing demand due to the aging population. Other notable trait is that they contains article about food problem such as research and development of artificial meat or genetically modified foods (Figure. 4-b _6). The cluster group focuses mainly on digitization (Figure.4-b_3) includes articles about drug development in Metaverse environment, gamification of learning process, impact of cryptocurrencies on environment as well as financial disparities. The group evolving around the word “Covid-19 (コロナ)” (Figure.4-b _5) includes articles about the effect of the global pandemic such as after effects, racial discrimination, decline in the number of people who lives alone. Additionally, the names of countries appearing on each cluster group (Figure.4-b_3, Figure. 4-b_ 5,Figure.4-b_6) with semantic distance signify that information collectors are interested in the situation or trends in particular countries.

6.2 Adoption Frequencies of *Scanning Materials*

The workshops involve the creation of possible future scenarios using the 150 *Scanning Materials* from both Group A and B. 16 MBA students generate 5 scenarios each by synthesizing 2 to 9 *Scanning Materials* using the KJ method. Then, the adoption frequencies of *Scanning Materials* for 85 scenarios were compared by group as in Figure.5.

Scanning Materials from Group A were adopted to scenarios for 176 times as accumulative total, 2.35 times per sheet. 18 sheets, 24% of them, were adopted 0 times while 57 sheets were used at least once. The most adopted 2 sheets were used for 7 times each.

On the other hand, *Scanning Materials* from Group B were adopted for 232 times as accumulative total, 3.09 times per sheet. 9 sheets, 12% of them, were adopted 0 times while 66 sheets were used at least once. 5 sheets were adopted more than 7 times and one of them were adopted for 9 times.

	0	1	2	3	4	5	6	7	8	9	SUM	AVG
A(FSS)	18	13	12	13	7	2	8	2	0	0	176	2.35
B(HUMAN)	9	13	9	13	10	11	5	4	0	1	232	3.09

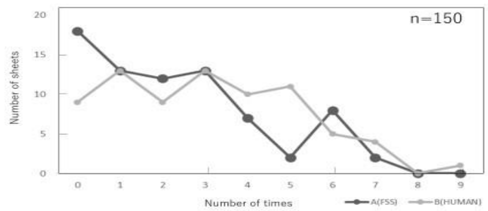

Figure5: Comparison of adopted frequencies of *Scanning Materials* by group

6.3 Contribution Rate of *Scanning Materials* from Group A

Next, all 85 scenarios that were generated by synthesis of 2 to 9 *Scanning Materials* each are to be closely examined. To identify *Scanning Materials* as references, each scenario contains numbers uniquely assigned to each of them. Authors then computed the contribution rate of *Scanning Materials* in Group A based on their number out of the whole *Scanning Materials* that were adopted to create a scenario. (Figure.6)

It turned out that 11 of 85 scenario used only *Scanning Materials* from Group A to be 13% of total numbers of scenarios. 3 out of 85, on the other hand, exclusively used materials from Group B. The other 71 scenarios used information from both Group A and B. Therefore, the average contribution rate of *Scanning Materials* from Group A is 57%. This suggests they are as useful as the materials from the other group.

Group A	0%	=<10%	=<20%	=<30%	=<40%	=<50%	=<60%	=<70%	=<80%	=<90%	90%<	100%
Number of scenario	3	0	1	7	9	9	9	24	10	2	0	11

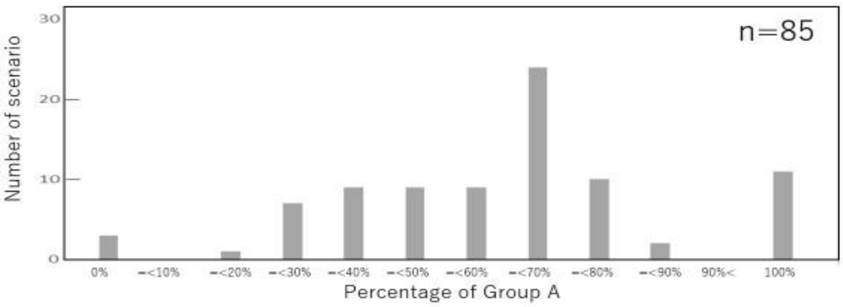

Figure 6: Contribution rate of *Scanning Materials* in Group A (created by the author)

7 Insight

Comparison of semantic characteristics of Group A and B shows Group A has more cluster groups. It also turns out that the group contains terms less related to each other. Such outcome suggests that *Scanning Materials* in Group A are more diversified. It is due to the wider search scope,76,000 articles in total, in addition to the learning accuracy of FSS. On the other hand, the cluster groups in Group B are related to each other. This suggests that manual selection of information can be affected by the social trends, meanings, and opinions of collectors. Thus, abilities of FSS to retrieve information from wider scope beyond human cognition are validated.

We conducted manual collection of information to measure the usability of *Scanning Materials* in Group A. In here, we would like to emphasize that FSS developed by authors is a tool to provide *Scanning Materials* for Foresight practice conducted by the group of diversified stakeholders and, therefore, not to automate generation of future scenarios itself. We firmly believe that it is us as human who creates scenarios and/ or visions to be prepared for uncertain future and such creation can only be done by personal interactions. FSS helps us to expand the scope of our cognition by offering diversified information as necessary stimuli. Based on the very philosophy of the school of Emergent Strategy that the human interaction through Foresight practice to form shared knowledge and recognition by creating future scenarios considering various future possibilities with emergent approaches should be conducted by humans, we conducted workshops, not laboratory experiment, to verify the effectiveness of the system.

Scanning Materials were distributed to the participants for Foresight practice without showing their group categories. Though the adoption frequencies of the materials in Group A were slightly lower than the ones of Group B, the difference was negligible. During the scenario creation, in fact, *Scanning Materials* from both groups were mixed almost evenly. The contribution rate of information in Group A was around 57% in average. As for the contribution to the scenario creation process, it is noteworthy that 11 out of 85 scenarios were generated using only *Scanning Materials* in Group A while only 3 out of 85 were generated based on the information in Group B. This suggests that *Scanning Materials* in Group A successfully complemented Foresight practice by retrieving and providing useful information.

8 Conclusion

This paper shows the validation process of the effectiveness of Foresight Support System (FSS) developed by the authors through Foresight practice. The system has been developed to support Horizon scanning conducted during Intelligence Phase by retrieving and providing necessary information. The search result of FSS' quick and wide information retrieving is much wider and more diversified than information manually collected when it comes to, for example, semantic relevance. In addition, the information output from the FSS was found to be sufficient for use in the scenario planning workshops conducted as user testing. Therefore, this research suggests the information retrieved by FSS is effective in quality to support future scenario creation.

9 Future Works

This study examined the trends in information collected and output and their adoption frequencies and contribution rate for future scenario planning. Although it was both statistically and quantitatively proven that FSS adequately supports Foresight activities, the reasons are still unclear. Thus, authors will evaluate impression to determine what kind of stimuli one gets from the information output by FSS. We would like to continue our efforts to increase the sprout of creativity for uncertain future through practical implementation of FSS as well as the validation process of FSS as Foresight practice.

Acknowledgement

This work was supported by JST SPRING, Grant Number JPMJSP2102.We thank the reviewers for their careful reading and many suggestions. We thank students and experts at Hitotsubashi University who created scanning material used in our experiments. The collection of this dataset was approved by the Ethical Review Committee of JAIST. Computational resource of AI Bridging Cloud Infrastructure (ABCI) provided by National Institute of Advanced Industrial Science and Technology (AIST) was used. Asahi Shimbun corpus was used in our experiments.

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