NEST: A Model for Detecting Weak Signals of Emerging Trends Using Global Monitoring Expert Network

Seonho Kim, Young il Kwon, Yong il Jeong, Sung-Bae Choi, Jong-Kyu Park, Sung-Wha Hong

Technology Information Analysis Lab.
Department of Information Analysis
Korea Institute of Science and Technology Information
66, Hoegi-ro, Dongdaemun-gu, Seoul 130-741, Korea
{haebang, ylkwn, yijeong, sbchoi, jkpark, shong}@kisti.re.kr

ABSTRACT
The importance of analyzing R&D environment changes and forecasting future technologies for supporting policy decision and efficient resource distribution has been increasingly recognized. Many futurists are forecasting future technology based on Delphi study, brainstorming, expert survey, trend analysis, data mining, etc. However, these processes still need to be formalized. In this paper, we introduce the NEST (New & Emerging Signals of Trends) model, which is a systematic collective intelligence model for collecting information from expert network worldwide and detecting weak signals of emerging technologies, developed by KISTI. The most outstanding feature of NEST model is that it is based on both quantitative and qualitative methods. In the stages of quantitative methods, NEST performs clustering, pattern recognition, scientometrics, and cross impact analysis. In the stages of qualitative methods, NEST conducts environmental scanning, brainstorming, and Delphi study. For illustration purpose, a result of experiment for detecting weak signals of emerging technologies is presented.

Categories and Subject Descriptors
H.5.3 [**Collaborative Computing**]: Collaborative Method for detecting Emerging Trends.

Keywords
Mass Knowledge, Weak Signal, Emerging Trend Detection, Collaborative Computing.

1. INTRODUCTION
This paper introduces a collaborative environmental analysis model, NEST, for forecasting future trends useful to support groups' or nations' decision making and R&D strategy establishment. This model is designed to find weak signals of future trends. Weak signals are events, accidents, or strange issues that are thought to be the beginning of future changes [2]. While the concept of weak signals begun to be discussed in strategic management literature already a quarter century ago, and the importance of it has been widely perceived, the actual research for modeling the analyzing and detecting processes has not received any significant attention [5].

NEST model utilizes knowledge of a group of experts from various fields over the world and uses interactive feature of web 2.0 to communicate and deduce new refined knowledge from the shared knowledge.

In the next section, the result of literature review on related research is presented. In Section 3, a detailed description of KISTI [4]'s NEST model and its components is presented. In Section 4, an experiment study performed to detect weak signals and upward trends using the NEST model is provided. Then, we conclude.

2. Related Work

2.1 Weak Signal and Environment Scanning
'Weak signal' is a small sign in present which has potential of significant changes in the future. Environmental scanning is a process of collecting and analyzing the environment information of an organization or nation to support its decision making. Our NEST model performs environmental scanning using the GTB, Global Trends Briefing [1, 3].

2.2 Trend Detection and Summarization
Hot topics, or trends, are detected by grouping documents into concepts, based on a co-word or co-citation analysis.

3. NEST: New and Emerging Sign of Trend

3.1 Global Monitoring and NEST-Clipping
The NEST consists of both quantitative analysis stages and qualitative analysis stages. The Global Monitoring, an environmental scanning, in Step 1 is the first filtering of NEST process. This process is conducted in the manner of qualitative analysis. In Step 2, the second filtering is performed on the collected information, both in qualitative and quantitative manner, by information analysts in KISTI based on its significance. In Step 3, various quantitative data analysis

techniques, such as clustering, pattern recognition, regression, anomaly detection, etc. are used, to detect weak signals of trends, patterns and structures in the information. In Step 4, also a quantitative analysis step, experts detect upward trends using the weak signal tracking board, which is based on cross impact analysis model developed by KISTI.

NEST-Clipping is second filtering procedure on the monitored information performed by information analysts based on its significance.

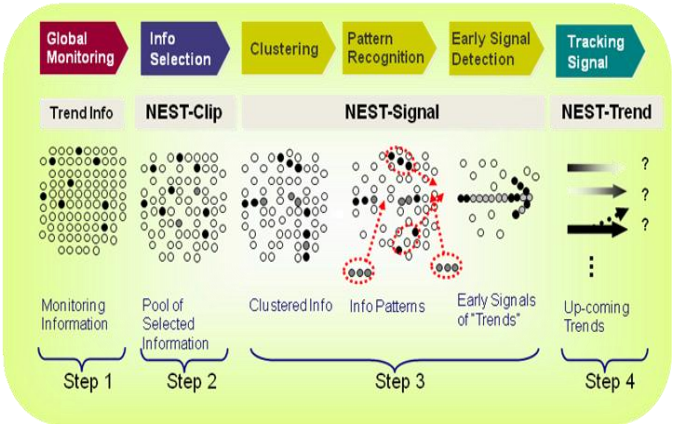

Figure 1: Four steps of NEST model

3.2 NEST-Signal Detection

In this step, information analysts analyze GTB and NEST-Clip to find the candidates of weak signal. An evaluation index for measuring the strength of impact is defined by the information analysts. Table 1 shows several examples of the index.

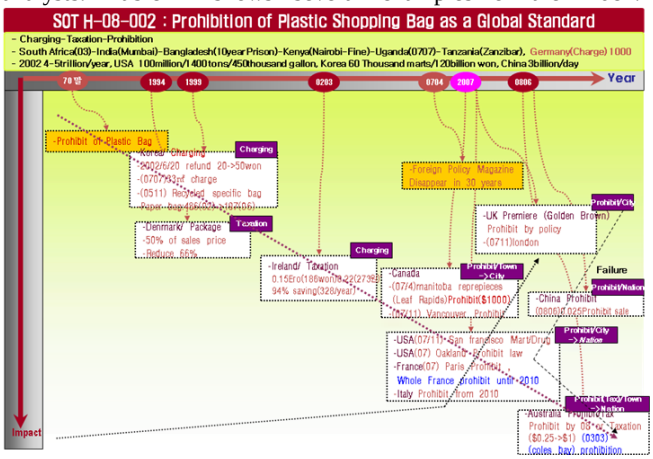

Figure 2: An example of Weak Signal Tracking Board

Table 1: Example of impact strength index

- Range of influence: local → national → International
- Growth of industry: primary → secondary → tertiary
- Degree of Convergence: stage 1 → stage 2 → stage 3
- Stage of R&D life cycle: Planning → Science → Development (6 sub-stages) → Industrialization
- Extension of social system: case → regulation → treaty → rule → law
- Increase of occurrence frequency: very weak → weak → neutral

Figure 2 shows an actual instance of the usage of weak signal tracking board, obtained during the experiment study.

3.3 Upward Trend Detection

NEST's upward trend detection process is an application of auto-regression based extrapolation model. A regular monitoring framework "Study-Watch board", shown in Figure 3, is devised to detect trends and issues.

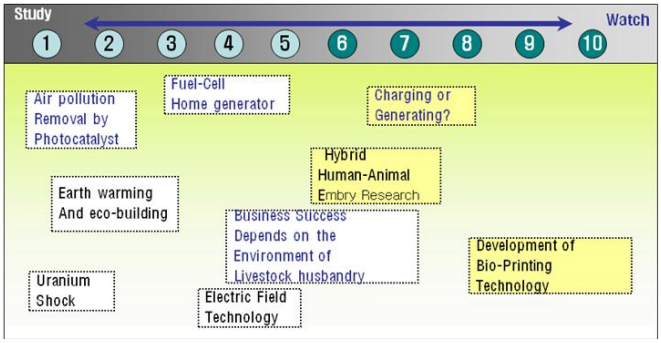

Figure 3: An example of Study-Watch board

4. Experiment and Conclusions

138 thousands of environmental scanning data collected by Global Monitoring Network, which has been operated for 10 years and archived in GTB website, is used as the source data. 57 weak signal candidates were selected after NEST-Signal detection process, the step 3 in Figure 1, and prepared for online Delphi study. Table 2 presents the summary of the 57 weak signal candidates.

Table 3: Number of prospective candidates for each field

Field	Candidates	Prospectiveness	Field	Candidate	Prospectiveness
Machine	8	3.35 0.78 0.70	Chemistry	1	3.31
Energy	2	3.06 0.50 0.65	Environ.	4	3.24 0.70 0.79
Material	4	3.35 0.80 0.70	Bio Tech	17	3.92 0.68 4.01
Policy	4	3.84 0.50 0.70	IT	17	3.85 0.78 0.70

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