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Technology Weak Signal(s) Detection Systems

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Abstract

Purpose: The purpose of this research is to study the systematic dimensions of "weak signals (WS)". Accordingly, in the theoretical framework of socio-technical systems (STS) and by combining the soft systems methodology (SSM) and Viable systems model (VSM), the conceptual design of a system for weak signals detection in the field of technology in one of Iranian governmental organizations is explored.

Method: This research is qualitative research in terms of methodology, and according to the case of study in this research, it is an applied-developmental research. In this research, based on Mingers approach, SSM-VSM as combined and preferable methodology was used to design the aimed socio-technical system. Library and expert methods, in-depth interviews and expert panels were used to collect qualitative data, as well as the charrette approach as an evolutionary approach in data analysis and design.

Findings: The importance and strategic position of "weak signals" are neglected in Iranian organizations, and Iranian managers rely less on identifying weak signals and analyzing their consequences in making strategic decisions. In order to detect weak signals, Iranian organizations need to develop and strengthen socio-technical infrastructures, and for this, the structural, functional and procedural conceptual design of the system is presented in this research.

Conclusion: Identifying and exploring weak signals of change over machine approaches, including Artificial Intelligence (AI) and Deep learning, fundamentally depends on the development and use of an expert networks including official and virtual networks in Iranian organizations. Technology Watching abilities needs the development and strengthening of systematic infrastructures, especially socio-technical systems.

KeyWords: System Design, Weak Signal, Soft System, Emerging Technology, Reemerging Technology

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Introduction

After the 3rd industrial revolution, the emergence of new technologies has been accompanied by an unprecedented acceleration and during the last few decades, it has had transformative effects and consequences in the world. Technology has been the field of disruptive surprises, and today's organizations need surveillance capabilities to be aware of the surrounding changes more than in the past they did. This is an issue for Iranian organizations considering the severity of the influence of changes and the strategic impact of technology in different social, economic, political, cultural and other dimensions. It is more important to use the transformative capacities of new, emerging and re-emerging sciences and technologies.

Due to the lack of effective mechanisms of organizational foresight and as a result of inattention to the initial signals of these changes, many organizations have been defeated in the scene of encountering surprises and they are no longer alive in their industry. The destruction of large companies producing audio recorders and CDs with the emergence of Apple's basic products and the iPod product is well known (Halaweh, 2013).

The global surprise of the Covid-19 pandemic in 2020 revealed the weakness of decision makers in identifying on time signals of disruptive phenomena (van Veen & Ortt, 2021).

Large companies such as IBM, Xerox, or the removal of famous car manufacturers such as General Motors, Chrysler and Ford in the period of 2006 to 2016 from the list of the top 10 car manufacturers in the world are also such cases (Carins & Wright, 2018: 2-5).

Meanwhile, crises, surprises, and disruptive events have never formed and spread all of a sudden. In other words, the beginning of the formation of these events is always accompanied by the production and release of elementary warning signals. Therefore, identifying and investigating what and how these signals are formed and the process of spreading them and monitoring the process of strengthening or weakening them, in addition to preventing the occurrence of strategic surprises, can be a platform for creating opportunities. Based on this, the timely identification of "weak signals" of change can be considered as an important capability in predicting future events and organizing to help promote and improve strategic decisions in organizations.

Elementary interview among Iranian organizations with technology experts and CEOs show that despite paying attention to environmental events, organizations still face strategic surprises. The results of the initial interview with experts also show that main reason for the inactivity of these

organizations, despite identifying the signals of coming changes and alarming timely warnings about future events by experts, is due to the lack of an Effective and efficient or timely warning scocio-technical system.
In this research, based on the foundations and principles of "system theory", the theoretical framework of "socio-technical systems" and use of combined methodological approach of John Mengers on a case, Iranian governmental system, designing conceptual model of a Technology weak signals Detection System is followed.

Methodology

Today, the socio-technical theory has become an increasingly important approach with the significant growth of applied softwares, e-commerce, social networks, Ubiquitous Computing and smart factories (Herrmann, et al., 2021). On the other hand, the comparison of the framework presented by (Wahbeh et al., 2020) with the framework presented by (Oosthuizen & Pretorius, 2015) shows that the basic human, technical, structural and functional factors as four components, are the critical pillars of the design of Socio-Technical systems.
Accordingly In this research, the position of Iranian Governmental System is studied as a case with a focus on identifying weak signals and preventing strategic surprises. In fact, we intend to design a system for detection of technology weak signals based on the Soft System Methodology (SSM) and through the study of a problematic situation in the real world as a case.
Soft systems methodology is a seven-step process. Some of the steps of this process are in the real world layer and others are in the conceptual layer. (Sensuse & Ramadhan, 2012).
The Viable system Model (VSM) is based on the Organic view of the systems and the concept of organizational cybernetics. According to the VSM, each system consists of five subsystems and a network of communication channels (Beer, 1984) (Espejo & Reyes, 2011, pp. V-VI).
The SSM process consists of 7 basic steps. The first two steps of this method include entering the problem situation and explaining the problem situation. The common product of these two steps is a clear image (or rich picture) of the space and the problem situation.
In the third step, the requirements for the production of the conceptual system necessary for the fourth step should be known.
In the fourth step, the conceptual model of VSM is used and the conceptual design of the system is done.
In each of the steps of SSM-VSM, the data and information obtained from the interview, according to the visual approach of SSM, were drawn directly on the A3 size paper during the expert sessions with the evolutionary approach of

the chart. After the initial form and shape of the design was formed, the initial design was entered into the computer and designed in E-Draw Max software. As Merriam and Tisdell in their book " Qualitative Research: A Guide to Design and Implementation" acknowledge that the outputs from interviews with experts are themes, models or images. Therefore, in the SSM approach, as Checkland explains in his famous book, he uses the visualization approach instead of analyzing the themes. Because basically in this methodology we are looking for the design of a system and not the production of a model from a set of variables and factors.

Therefore, both in the steps leading to the production of illustrative pictures and in the steps of VSM, which is the fourth phase of SSM, the mentioned software is used to directly implement the opinions and comments of the experts in the conceptual model.

The conceptual design of the system is completed after each interview meeting with the experts, and the completed design is approved by the experts. The plan completed by the i-th expert or the i-th person is presented to the i+1 expert. Based on this, according to Charette's method, the plan of each meeting should be more and more complete. This process continues until the expert cannot add or subtract anything from the design. As it is acknowledged in the process of conducting interviews, so-called theoretical saturation is achieved. This is the point of ending the expert process and the beginning of the finalization of the conceptual design of the system.

Result and Conclusion

The initial Rich Picture was revised through 8 revisions based on individual opinions and finally, after the consensus of experts' opinions, the final plan was finalized and approved as an Rich Picture of the key players (Picture 1) of "Technology Weak Signals Detection System".

The illustrative image is arranged from the outermost layer towards the center. The outer layer is actually the outer environment or the distant environment, whose changes and technological events are significant in terms of identifying weak signs.

This layer consists of active elements and factors whose technological outputs and behavior have been mentioned by experts as hot spots and potential signs of future changes. According to experts, the field of technological changes is infinite and limitless. Therefore, in order to take smart and effective action in monitoring the future technological changes based on identifying weak signs, the vital and possibly threatening centers of technology should be considered as hot and high-priority centers and developed Surveillance coverage of the

system through the development of a specialized surveillance network as well as the development of software capabilities based on artificial intelligence, to recognize the weak signs of technological changes.

In the fourth step, the system is completely designed. In this step, based on the basic model of VSM, The components of the system were drawn and modified during the experts interviews. This process continued until the final approval of the experts. According to the STS framework, the system is presented in two structural-functional and process formats (pictures 2 and 3).

Based on the Rich Picture and the outer layer, The world of technology weak signals, experts were asked about how to search and discover these signas. Based on the professional experiences of these participants in technology watching and forecasting, operational units of subsystem 1 were identified. According to experts, these units should include scientific databases (articles and inventions), centers (organizations, main institutes and key technology institutions), event scanning (exhibitions, conferences and congresses and any events related to technology), social research (indicative people of technology such as managers of technology giants in the world, managers of emerging companies with new ideas, researchers and researchers of technology, future-researchers of technology, etc.), financial research unit (Government organizations and institutions, special organizations affiliated to governments, driving and policy-making organizational units in the field of technology). In the process and functional design model (Figure 2) based on the flow of monitoring information and the discovery of weak signals, this model was finalized with the final approval comments of experts.

conclusion

Based on the theoretical framework of the research, the conceptual design of the weak signals detection system (WSDS) was focused on 4 structural, process, functional and human pillars. The way of communication and connection and placement of system components was also explained based on the VSM as described in 3 environmental spaces, operational space and managerial space.

Two functional and procedural conceptual models, which included activities and processes, were integrated into an one as shown in the Picture 2. Based on defined 14 criterias of the "Seifi Kalestan Box of Weak Signals" by virtual network activists and the organization's official monitoring network from the space of the emergence and possible occurrence of weak signals that in the Rich Picture in this research The space was identified and mapped, identified

and recorded and reported in the detection system of weak signals of technology. The review and judgment process as stated in the model is reviewed by specialized units based on the criteria of the probability of environmental impact and if confirmed as weak signals of a possible technological change, it is referred to the brain of the system or to the system management based on VSM. to be System management in subsystem 4 or the intelligent management system validates the report at a specialized and strategic level with independent environmental monitoring of the brain of the system, and then reports to the highest level of the system, i.e. subsystem 5, for policy making and strategic action plan design by subsystem 3. It is referred. Subsystem 3 is responsible for managing and controlling and maintaining the continuity of the activities of the operational units of the entire system, as well as legislation and auditing of the entire system.

In the structural and human concept plan, these system components were identified and established based on the opinions of experts, taking into account the organizational (structural) roles. These two separate models are basically a single model that includes the conceptual design of the system based on STS dimensions in two separate views.

Managers of Iranian organizations are not generally familiar with the concept of weak signals and its functions, or due to disturbing reasons, such as the uncertainties surrounding the probability of occurrence and the power of impact, and of course the risk of human and material investment resulting from the action. Based on these weak signals, they pay less attention to this category. More well-known methods, especially strategic management, are more attractive for Iranian organizations. Meanwhile, Iran is at the center of uncertainties in various economic, social, cultural, technological, security and defense dimensions.

Based on this, the necessity and importance of retraining and improving the insight of employees and managers of organizations regarding the concepts, foundations and methodology of the field of "weak signals" in decision-making and planning is felt.

Technology Watching activities focusing on WSD requires both expert and machine approaches. These two approaches act as complements and the establishment of a system for WSD based on one does not necessarily make the organization unnecessary from the complementary approach.

Technology Watching focusing on weak signals detection in organizations is fundamentally dependent on the expansion of expert watching networks in two forms, official and virtual. Despite all this, considering the expansion of capabilities in the field of artificial intelligence (AI), one should not ignore

these possibilities, and studies and technical measures regarding the development of methodologies and software tools based on AI and deep learning are of strategic importance in this field has a special importance in this way.

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