

# **NuKey-Bot: Chat-bot System for Supporting Behavioral Scientific Risk Communication and Enhancing Participatory Public Acceptance of a Nuclear Facility**

Yong Hee Lee

*Accident Monitoring and Mitigation Dept., Korea Atomic Energy Research Institute*

*898-111 Daeduk-Daero., Yuseong-Gu, Daejeon,*

*\*Corresponding author: yhlee@kaeri.re.kr*

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## **1. Background**

In the 21st century, the safety issues such as the Fukushima accident have revealed a huge impact beyond technical expectations. It went beyond objective safety to require individuals and societies to feel safe in practice, including risk perception and emotion. In particular, unfamiliarity and technical information about nuclear power is blocking public acceptance and social awareness of nuclear. It has recently been highlighted that the effectiveness of relevant information in terms of correct perception of risks is not only a matter of the accuracy of the information itself but also of the method of communication. This study was conducted as part of the development of an information system for a new level of management in the process of monitoring and delivering radiation information that determines the safety awareness of nuclear facilities. A chat-bot based information service system is proposed for both parties of risk communication among interest groups about a nuclear facility. The engineered UI/UX which is more familiar to the public. is devised to promote interactions that increase awareness beyond the limitations of traditional information disclosure websites.

## **2. Requirements Engineering for Enhancing Public Acceptance and Risk Communication**

### **2.1 Nuclear Acceptance and Risk Communication**

People has respected the dramatic contribution of nuclear power to energy that is dramatically efficient and fundamentally different from carbon-based paradigm of energy. Public had been remained confident to the nuclear in spite of some experiences of nuclear bombs and trial failure in the early stage of the nuclear utilization. Nowadays the belief on the safety becomes doubtful to public especially after Fukushima After the accident and succeeding events. most nuclear facilities in Korea are also suffering from a strong reluctances and various challenges in spite of world level competitiveness and advanced implementation of safety plan including post-Fukushima action items. Public is almost refusing to hear and discuss the reality of nuclear safety. Most of the risk communications on nuclear and nuclear facilities have been broken down with a few minor mistakes in managerial practices without any technical issue.

However new emerging technologies such as AI, chat-bot as well as technical efforts such as behavioral science on safety may provide a new potential to get over the hardship of risk communication and public acceptance in Korea(2018/2020 Lee, 2019 Kim). By virtue of a cat-bot technology a new information service may drastically enhance the communication. It has a purpose to get a rather robust foundation, especially, between KAERI and people living near KAERI, to enhance the fundamental communications and establish the acceptance on safety. It depends on a needs analysis and a careful design of interactions and experience scenarios for a chat-bot based service to the public.

### **2.2 Human Factors Approaches for Support Design**

Traditionally, the safety and efficiency achieved by improving ergonomics on workers' time-and-motion through management, forming the first industrial revolution. However, the development of technology led to a new era that showed a decisive role in transforming human convenience and productivity in the late 20th century by improving machines and the environment to fit humans. Smartphones are the favorite of the new industrial revolution era (2015/2019 Lee) that was achieved by improving interfaces and interactions.

Smartphones are enthusiastic about the innovative effects of interfaces and interactions with touch screens. Though significant systematic design has been achieved, the application of full-scale human factors engineering is limited. It particularly remains in segmented guidelines for specific design reviews, such as screens and devices, or for experimental evaluations for feasibility verifications by respective issues. The suitability of interface has fundamental limitations just by guidelines or post-review and improvement on compatibility issues. A systems approach to derive initial requirements to system and collect possible alternatives to satisfy them has become indispensable.

For apps in smartphones, human engineered design is fundamental. In case of chat-bot with active recent introduction, more dynamic design such as simulations are required because interactions through text or speech are premised. In particular, the development criteria for active usability-oriented development in HCI requires considerable attention. It is necessary to ensure conservative performance on safety-related issues rather than simply increasing average performance.

### 2.3 Design Engineering of a Chat-bot Service

Requirement analysis, which determines requirements in the early stages of system development, is relatively inadequate in ergonomics compared to its importance. In Requirement engineering, ergonomics is crucial, but it is difficult to overcome the reality that must be presented based on language and understanding in certain areas of expertise. It is natural that requirements for professional information systems, such as radiation information for nuclear facilities, are determined by radiologists. Ergonomics plays only an auxiliary role in helping secure the suitability of the interface in the implementation of already determined requirements. Although ergonomics proposes a number of interface guidelines, they are primarily for review, not for design purposes.

This did not change much in the design of a web-based public information homepage, depending on the eye and peripheral knowledge or flow of information system implementers. Ergonomics has failed to show a leading role in the HCI field, which emerged at the end of the 20th century. This is due not only to the prevalence of Ethnography and structural analysis techniques, such as FGI, which are frequent in analyzing user requirements, but also to the lack of close standards and systematic methods for changing rapidly evolving information and communications technologies.

Systematic approach on human factors were applied from the early stages of requirement analysis to overcome the fundamental limitations of radiation monitoring management information systems. The following summarizes the requirement analysis and design techniques applied in this study.

- *System requirements: items/indication/operation requirements, etc. in the regulations/laws*
- *User requirements: Requirements for stakeholders*
- *Requirements for experts: Requirements for business and operating groups of a service*
- *Operator requirements: Information processing operator requirements*

Apart from the existing interpretation of radiation monitoring legal requirements for nuclear facilities, the applied technique derived the requirements by developing several episodes through FGI and survey/scenario methods based on independent understanding of individual stakeholder groups. This was aggregated into Persona and Scenario, which represented the requirements of the stakeholder group, and based on this, we constructed a rapid prototype of the initial conceptual design. (2020 Lee)

The key to this study's requirements analysis is to reflect stakeholders' subjective perceptions of safety. Beyond the factual accuracy of the radiation information, the recognition requirements required for the transmission process are derived. The implementation of chat-bots and apps is already available with

techniques and available alternatives. The results of the requirement analysis for the initial conceptual design were used as a basis for the implementation of in-process verification. The human factors techniques applied in the development of this design including UI/UX are as follows: (2019 Lee, 2021 Lee & Min)

- Review based on UI/UX checklist (expert/user)
- Independent review based on *Emotional Vocabulary*: independent three-way evaluation
- Usability subjective evaluation and observation measurement: mutual comparison evaluation

### 3. NuKey Bot: A Chat-bot Service System

Public disclosure of information about radiation situations is a legal requirement under regulations relating to nuclear facility management. The statutes and technical guidelines specify in detail the items of information to be disclosed. Radiation information relating to nuclear facilities has already been multiplied by the agency concerned. Public institutions such as *IER Net*, *Yuseong-Gu* are providing redundant information.



Figure 1. Radiation Information Service (ref. *IER Net*)

However, few ordinary people directly explored and utilized this information except for some related NGOs. Already disclosed information alone was viewed as excessive information or complained of inconsistency with necessary information. A systematic scheme shows a service system for the management of public acceptance. A living-lab type infrastructure may be indispensable for the foundation to enhance the risk communication. However, the results of the detailed requirements analysis for the initial conceptual design showed that inadequacy of information and presentation was a fundamental problem.

For example, citizens who are classified as less willing to participate among stakeholders felt stressed by the fact that many encountered professional unit-based numbers such as micro( $\mu$ )-Sv. This was distorted into a suspicion of a neutral willingness to communicate through anxiety about the reality of the data or the immediacy of the provision, depending on external circumstances, such as information on events that cause anxiety. Therefore, detailed specifications of the requirements were derived in a new way of behavioral science. Public demands were information that clearly

helped interpret the following various dimensions beyond the physical figures of the current state:

- Has anyone experienced any problems? Facilities < Ambient environment < Social group < Family < Individual
- Is there any possibility of this happening in the future? Current<Scheduled Activity/Event<Future(Daily)
- Does it affect your activities? Current<Scheduled Activity/Even<Future(Daily)

These requirements mean that a number of integration and interpretation processes for semantic interpretation should be provided or supported beyond the accuracy and immediacy requirements for the present values of radiation levels. Existing public information maximizes the effective number of measurements, increases measurement points, and increases frequency of supply in order to increase accuracy. (See *IER Net*) It also provided professional results in a separate professional report. However, for citizens, this information (display) was so far from the requirements that it could not be positive about the information itself and its providers (facilities and government agencies). Some Examples of citizens' information requirements are as follows.

- The current meaning should be given.
- We should be able to see the changes.
- Future expectations should be possible.

In particular, in order for this information to be satisfied, it must be possible to calibrate or subjectively capture it with information related to me rather than objective absolute values. It also needs to be combined with other relevant information. For example, radiation information valid for citizens requires a variety of integrated and detailed analyses, not current radiation level measurements for the facility.

- Integration and comparison of radiation: natural/residential/medical, etc. around the user
- Integration of links with living activities: food and beverage, travel, etc. around the user
- Detailed inspection of current issues (incidents): related events and activities of the facilities and near

This requires an information system that can meet situational or subjective needs through interaction, indicating the need for a chat-bot-based adaptive information system that can organize and provide dynamic information. In this study, we presented a basic design and step-by-step development plan that provides an interactive voice-based information search method, and produced a starting product containing the results of the conceptual design.



Figure 2. Scope of Information Service with NuKey-Bot

Figure2 and 3 shows a scheme of the risk communication service among interest groups and a data processing infra system as a back-bone. And a business model is planned separately on the service.



Figure 3. Example Screens and Interactions of NuKey-bot

#### 4. Conclusions

This paper proposed a preliminary design of a chat-bot based service system that could facilitate public engagement to improve radiation monitoring management of nuclear facilities. Properly disclosed information systems about the status radiation and related information by virtue of behavioral science are important channels for determining social acceptance for nuclear facilities, and the validity of the relevant interaction schemes can have a decisive impact on the perceptions of the nuclear facility's safety. Therefore, the design proposed in this study should go further to verification of whether to promote the communication and awareness of safety as well as the acceptance of new concepts (2019/2020 Lee) rather than traditional usability assessments. After a trial distributed to people near KAERI, it will be delivered to a public service system for overall radiation monitoring management.

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