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# Engaging Stakeholders to Design an Intelligent Decision Support Tool in the Occupational Health Context

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## **Abstract**

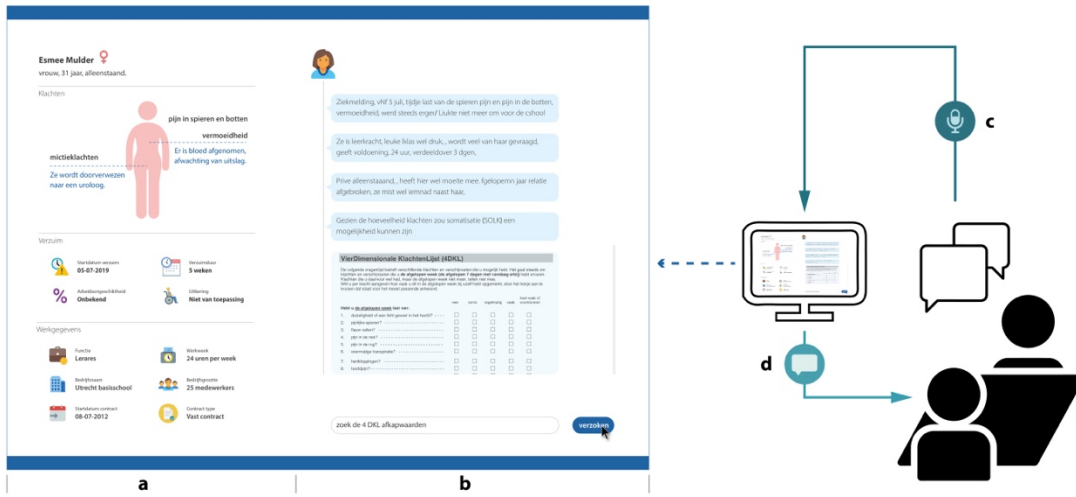
This paper presents a preliminary study for the hands-on creation of an intelligent decision support tool (IDST) for occupational health (OH) physicians. We addressed this challenge through an iterative design process consisting of three phases with different levels of stakeholder involvement, spanning from understanding the context to developing the concept and consolidating the design. We identified a set of design considerations that focused on enriching data collection, improving the accessibility of information, and blending the decision support into the workflow. To demonstrate these insights, we developed the concept of an AI-based OH consultation, called ConsultAI. ConsultAI is a conversational assistant that can provide real-time decision support to OH physicians during clinical interviews. Based on this case study, we discussed stakeholder engagement in the design of IDSTs for OH physicians.

## **Author Keywords**

Intelligent decision support tool; artificial intelligence; stakeholder engagement; occupational healthcare.

## **CSS Concepts**

• **Human-centered computing** ~ **Human computer interaction (HCI)** ~ **Empirical studies in HCI**;



**Figure 1:** The ConsultAI system: left shows its user interface and right shows its information flow during a clinical interview.

## Introduction

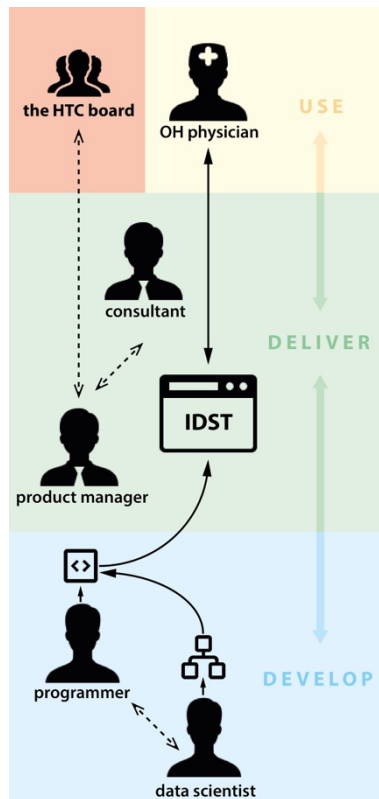
In many industrial regions, workplace development has switched from productivity-oriented to sustainability-focused, where very much attention has been paid to improve health and promote safety and health-oriented culture in the workplace [1]. As a result, a number of digital technologies have been investigated to enhance the effectiveness of occupational health (OH) services. For example, human-computer interaction (HCI) systems such as activity trackers and exergames are increasingly utilized to blend healthful behaviors into the workaday context for preventing work-related suboptimal health status (e.g., [11–13]). In addition to preventive healthcare, OH services also provide medical care for employees. In this context, OH physicians play a crucial role in diagnosing and treating occupational diseases, work-related illnesses and injuries, and

conducting fitness-for-work physical examinations and reintegration to work plans [1].

Digital health technologies designed to support medical care practices have also been investigated extensively. Even six decades ago, Ledley and Lusted [8] envisaged computing systems as intelligent decision support tools (IDSTs) to assist with difficult decisions in clinical settings. Over recent years, the adoption of electronic health records (EHRs) and the rapid advance of artificial intelligence (AI) facilitate applications of IDSTs to medical decisions. Subsequently, many IDSTs have been introduced to provide insights on, e.g., patient diagnosis, probability of prognosis, and treatment options [15]. However, their usage rarely generates desired results. Previous studies have shown that IDSTs failed in delivering the desired results, due to a lack of consideration in adapting technical advantages to characteristics of the healthcare context [9,16,21].

Designing IDSTs for OH physicians is challenging. Company doctors usually need to make decisions and recommendations based on guidelines related to both health and work, as well as the information received from different resources (e.g., the triage intake and the OH consultation) [14]. Therefore, the decision-making process in the OH context is complex and trivial. One potential solution to address complex needs in such a multidisciplinary healthcare context is understanding opinions from different stakeholders [5]. Linking this to the HCI aspect, we set out a case study to investigate engaging stakeholders in designing an IDST that can be easily adopted and beneficial to OH physicians' work.

To this end, we carried out this study with a variety of stakeholders from an OH service company. We applied three levels of stakeholder engagement [2] into



**Figure 2:** A visualization of existing experiences and relationships between stakeholders in HTC.

different design phases, to understand the context, develop the concept, and consolidate the design. This study resulted in a set of design considerations and a novel IDST design (namely: ConsultAI). As shown in Figure 1, ConsultAI features a dashboard with a chatbot assistant that can be used during the OH consult. It leverages HCI and AI to enrich data collection, improve the accessibility of relevant information, and blend intelligent decision support into physicians' workflow.

## Methods

### Background and Stakeholders

This study was conducted at Human Total Care (HTC), an occupational health and safety service provider from the Netherlands. HTC uses EHRs systems and decision support tools for facilitating OH physicians' daily work. OH physicians are specialized in managing work-related conditions, illness prevention, pre-employment medical assessment, rehabilitation strategies, as well as helping employers identifying risks for the health and safety of their workers [1]. Recently, HTC has investigated AI-based medical decision support. From HTC's view, this study meant to research the next generation of IDSTs, which could be easily adopted by OH physicians. To recruit the participants of this study, we mainly spread the information on an internal Slack channel of HTC. We aimed at finding participants with diverse working content at HTC. As shown in Figure 2, five parties were finally involved in this project as stakeholders.

- **Occupational health physician:** Both senior and junior OH physicians were involved in the research. All of them used electronic health records in their daily work, and few had experiences with using newly developed IDSTs.
- **Research and development (R&D) consultant:** One R&D consultant supported our design. The role

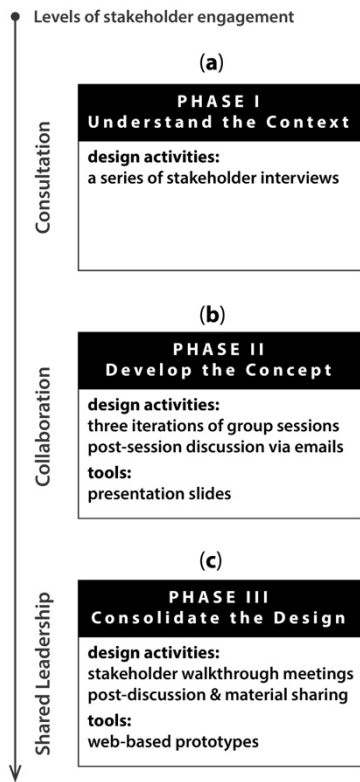
of R&D consultants is helping health professionals solve problems of using the software and advising developing teams to improve the software.

- **Product manager:** Two product managers were involved in the design process. At HTC, product managers supervise the software development from a higher level than R&D consultants. They regularly report software R&D plans to the board of directors.
- **Software programmer:** One software programmer attended our research activities. The programmer worked on the maintenance of the software and also investigated the possibility of adding new features to the software-based services of HTC.
- **Data scientist:** Two data scientists were actively involved in this study. As part of the R&D of HTC, data scientists work on creating algorithms to support OH professionals' decision-making tasks.

### Design Process

We drew on literature that describes multiple levels of stakeholder involvement to help us develop this case study. According to Arnstein [2], the continuum of engagement can be described at three levels, including *consultation*, *collaborative partnership*, and *shared leadership*. This paradigm has been widely utilized to support stakeholder engagement in many different types of activities, such as participation of governance [3], health interventions [17], environmental management [10], etc. In this project, we wanted to involve stakeholders for supporting the design process of IDSTs for OH physicians. As shown in Figure 3, we mapped the three levels of stakeholder engagement with different phases of our design process.

**Phase I: consult stakeholders to understand the context.** To identify design challenges from such a



**Figure 3:** The design process of this case study.

complex background, we carried out a series of stakeholder interviews. First, we conducted in-depth interviews with two product managers. They showed the current software systems and elaborated on the technology roadmap of HTC. Second, we consulted a software developer and two data scientists, who provided technical views into the design context. This helped us in learning the constraints and opportunities of an IDST in occupational medicine. Third, we followed our inquiry with an R&D consultant. Based on her feedback, we formulated questions for OH physicians. Fourth, we conducted four interviews with physicians, to get a better understanding of their experiences with HDRs and IDSTs. All these insights were synthesized as an OH physician workflow map (Figure 4).

**Phase II: collaborate with stakeholders to develop the concept.** We conducted three iterations of group sessions with stakeholders to ideate possible designs. The setups of all three group sessions were similar. To start, we presented the slides to stakeholders, which contained the analysis of OH physician workflow, the recap of the previous session, and several design proposals. The presentation aimed to facilitate collaborations on ideating design concepts. Each group session took 1-1.5 hours. Afterward, a meeting summary was sent to all participants via email. As such, we could also gather stakeholder feedback between the sessions to modify our design proposals.

**Phase III: share the leadership with stakeholders to consolidate the design.** Based on earlier activities, we confirmed a design concept called ConsultAI. It was implemented as a web-based prototype. We conducted stakeholder walkthrough meetings [6] to demonstrate the concept and stimulate discussions on how to enhance the applicability of the prototype. We proposed

to share the leadership in consolidating the design with stakeholders. This encouraged them to provide us suggestions with various useful materials (e.g., newsletters, scientific articles, commercial cases).

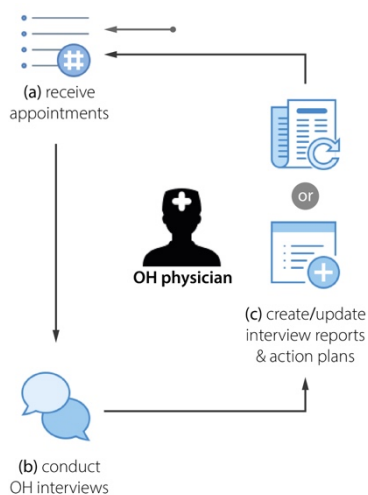
## Results

### *Design considerations*

All Stakeholder interviews (in Phase I) were tape-recorded, transcribed, reviewed, and summarized into transcripts for thematic analysis [4]. We followed the inductive approach [18] to generate qualitative insights that can be classified into three aspects.

**Enrich data collection for predictive modeling.** As described by the data scientists: *"We only have one-off data from triage intake, which limits possibilities and accuracy of the data models."* The physicians also stated that they could not rely on the intelligence-generated diagnosis and prognosis, as the data based on was not sufficient so far. Therefore, they usually ignored the predicted information from IDSTs. E.g., *"The triage data only reveals one part of the fact, so it isn't enough for any predictions. Plus, as a company doctor, I need to learn more, such as how the patient works with co-workers and the employer."* Both data scientists and OH physicians acknowledged that feeding more data into algorithms, models, and systems would be beneficial to the context. E.g., health data collected by tracking devices, monthly survey data on work satisfaction, etc. However, such data collections should be consented by employees and not violate any data privacy and ethical regulations for work and healthcare.

**Improve accessibility to field knowledge and guidelines.** We found that OH service is a complicated context influenced by multiple factors. Especially for OH physicians, it is crucial to follow the guidelines and field



**Figure 4:** A visualization of the workflow of OH physicians in HTC.

knowledge in decision-making process. The guidelines and field knowledge can refer to, i.e., the occupational health and safety legislation, the classification of complaints and causes (CAS code) [20], the OH service contract with the employer, and relevant findings from medical research. Also, our stakeholders stated that such information would be updated frequently. With the current systems, nevertheless, it is challenging to find all these different types of information practically. As one senior doctor said: *"When I meet my patient, I need to open different windows on my computer to look up many things. It is time-consuming and not easy to follow the update."* The R&D consultant also suggested us to develop an IDST that could present the latest guidelines and knowledge on one integrated interface.

***Blend the decision support into physicians' workflow.***

We learned that there was a strong reason for introducing IDSTs into OH. That is to improve work efficiency to compensate for the labor shortage of OH specialists. As the project manager mentioned: *"We can hardly find a qualified company doctor."* On technicians' side, they developed new functionalities, aiming to improve doctors' efficiency. As the developer said: *"We created a dashboard to present patients' info with AI-based advice. We hoped doctors could use them."* However, this new feature was not perceived positively by OH physicians: *"Appointments [with patients] occupy my agenda, so I can hardly find time to look at the info in advance", "It's difficult to remember all the detail before seeing the patient".*

***Design concept: ConsultAI***

Based on interviews and group sessions (Phase I & II), we decided to explore the OH practice setting of an occupational health interview (Figure 4(b)). This is an intensive task where the doctor needs to collect

information about the patient and analyze it into a diagnostic report with a treatment plan [14]. We wanted to leverage HCI and AI to improve this working context. Stakeholder involvement resulted in a new IDST concept called ConsultAI (Figure 1). ConsultAI is realized as a dashboard interface that can be used during the clinical interview.

ConsultAI consists of two digital elements: 1) On the left side it presents a summary of the patient (Figure 1(a)), including self-reported complaints, absence history, and employment information; 2) On the right side it integrates a chatbot (Figure 1(b)) that provides real-time information, such as AI-generated prognosis and diagnosis, medical field knowledge, OH work guidelines, based on the progress of the consult. Explicitly, we elaborate on following HCI features of ConsultAI that map with our design considerations.

***OH Interview as an opportunity to enrich the OH database.***

We envision ConsultAI as an unobtrusive data collector. Figure 1(c) shows that the system leverages speech recognition to collect meaningful information automatically from the consult. The data is saved confidentially in the medical database for enriching short-term and long-term analyses.

***Easy access to relevant information without influencing the consultation.***

Due to the real-time data analytics, ConsultAI queries related information according to the consult, which is delivered through the chatbot interface at the right moment (Figure 1(d)). Thereafter, the physician can seamlessly incorporate domain knowledge and guidelines into the consultation.

***Intelligent decision support as an integral part of the workflow.***

In clinical settings, AI-generated predictions and suggestions are usually presented as

*Marly is a senior company doctor, who is interviewing her new patient, Esmee. To support the interview, Marly uses ConsultAI. As the first consultation, Marly takes a glance at the dashboard, which presents the summary of Esmee's reported complaints, absence history, and work information. This helps her get an overview of Esmee and find questions to start. During the interview, ConsultAI automatically records the conversation, extracts valuable information, produces suggestions, and presents them on the interface with a chatbot. Marly finds the suggestions fit the interview progress, and some of them are quite useful. They could inspire diagnostic direction, facilitate discussion, help with knowing new OH guidelines. Even when Marly mentions a questionnaire to learn more about Esmee's symptoms, the system automatically shows this questionnaire. ConsultAI pre-fills most contents of the consultation report according to this interview. Marly can then review and revise it, which reduces a lot of administrative work for her. Marly feels ConsultAI is unobtrusive and straightforward, and it improves her work efficiency.*

**Box 1:** The scenario of using ConsultAI for an OH consultation.

pre-acquired references [15], which makes intelligent support disconnected to the actual decision-making. Instead of applying a static, one-time presentation, ConsultAI uses the chatbot to bring the prognosis, diagnosis, and AI-based advice to the workflow of the consultation continuously and task-dependently. Also, the chatbot interface allows OH physicians to discuss the predictions with the system, aiming to increase the system's benefits and credibility to medical decisions.

Based on this consolidated design proposal, we created a scenario (Box 1) to demonstrate the use of the ConsultAI system during the OH consultation.

### **Discussion, Conclusion, Future Work**

This paper has reported a case study that investigated engaging stakeholders in designing an intelligent decision support tool (IDST) for occupational health (OH) physicians. By describing the design process, design considerations, and design concept of 'ConsultAI', we have exemplified how stakeholder engagement can contribute to the IDST design in a specific medical context. We have provided implications and solution space to this design challenge, in terms of enriching the health and work-related database, supporting secure access to relevant information, and blending decision support into the workflow.

There were several lessons learned concerning stakeholder engagement in the design process. Firstly, the variation in the stakeholders helped us gain deep insights into the possibilities and constraints of the OH context. This has been shown from receiving convergent and divergent opinions on IDSTs in our stakeholder interviews. For instance, we learned that both technicians and clinicians were concerned about insufficient data collection for developing intelligent

algorithms. Yet, there was a mismatch between the intended technical feature and needs of work tasks.

Secondly, the continuum of stakeholder engagement enhanced the design process in the target context. Previous work [5] mainly took stakeholder perspectives to analyze the practice setting of medical decision-making. Following [2], this study explored involving stakeholders in the entire design process. In HCI, a large body of research has investigated the benefits of co-designing with users and stakeholders (e.g., [7,19]). Similarly, in this study we found that through experiencing different engagement levels, stakeholders became familiar with design-oriented tasks and confident to share opinions.

Thirdly, applying HCI design techniques supported stakeholders to engage in the design process. For this study, we included several tools (e.g., mockups, prototypes) and methods (e.g., stakeholder walkthrough) in different design phases. We found they were useful to engage stakeholders in thinking along with us throughout the entire design project.

In the future, it would be worthy of exploring how stakeholder engagement could support the evaluation of new IDST designs. For instance, the inclusion of multiple perspectives might contribute to the development of experimental protocols. Stakeholders might also contribute to the data analysis of the design evaluation. For future study, we plan to explore with our stakeholders on the evaluation criteria and experiment plan of ConsultAI. We then plan to conduct experiments, taking ConsultAI as a research probe, to investigate how HCI can inform the AI development that can be well adopted by occupational health specialists for everyday work.

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