

# Designing a Tool to Collect Worker Feedback on Novel Solutions in Industrial Work Context

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## ABSTRACT

Digitalisation and automation bring a growing number of new technological solutions to the industrial work context. To keep the work fluent, safe and ergonomic, and to make the new work tools an integral and likeable way of working, it is crucial to design them in a human-centric way and collect worker feedback already to the early versions of the tools. This paper presents the design process and resulting design of a WorkerFeedback tool for collecting worker feedback on novel solutions in an industrial work context. The tool is intended to be quick to use but still support holistic design by including assessment of different design perspectives that have been identified as important in the industrial work context. The design process of the tool is based on UX goals that have been defined from the perspectives of the two user groups of the tool: solution developers collecting feedback as well as industrial workers providing their feedback. The WorkerFeedback tool responds to a lack of a simple feedback tool that would be easy to use for designers and developers without strong expertise in user experience and questionnaire design. The contribution of this paper lies in presenting the tool as well as its design process including UX goals and ethical considerations.

## CCS CONCEPTS

• Human-centered computing; • Human-computer interaction (HCI); • HCI design and evaluation methods;

## KEYWORDS

Worker feedback, Human factors, User experience, UX goals, Industrial work

### ACM Reference Format:

Päivi Heikkilä, Susanna Aromaa, and Hanna Lammi. 2024. Designing a Tool to Collect Worker Feedback on Novel Solutions in Industrial Work Context. In *European Conference on Cognitive Ergonomics (ECCE 2024)*, October 08–11, 2024, Paris, France. ACM, New York, NY, USA, 7 pages. <https://doi.org/10.1145/3673805.3673821>

## 1 INTRODUCTION

The automation and digitalization of industrial work bring a growing number of new technologies and work tools to the factory floor

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ECCE 2024, October 08–11, 2024, Paris, France  
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ACM ISBN 979-8-4007-1824-3/24/10  
<https://doi.org/10.1145/3673805.3673821>

[1, 2]. Even though many of the tools are primarily designed to enhance productivity of manufacturing, the importance of human-centric design and user experience (UX) have been increasingly acknowledged [3, 4]. When industrial workers are using more digital technologies as part of their work, the role of human-centric design and UX become more significant, as they hold the potential to make working more fluent, safe and ergonomic.

For solution developers, it is crucial to develop the UX of the work solutions by collecting feedback from the end-users who have used the solutions in real usage contexts. However, it may be difficult to find suitable tools to collect worker feedback, especially if designers are not used to conducting user studies or if there are scarce resources reserved for that. Novel, easy-to-use assessment tools are also needed for getting an overview of the UX of a technology before conducting more thorough user studies. Easy-to-use methods help in comparing different versions of a solution and encourage participation of also those who would not like to take part in extensive, time-consuming studies. Creating new, effortless ways to participate in the design of novel solutions supports social sustainability and inclusion, by giving workers an opportunity to have an impact on their work tools.

In this paper, we present the design process and the resulting tool for collecting worker feedback (WorkerFeedback tool) in an industrial work context. The tool is intended to be quick to use but still to support holistic design by including the assessment of different design perspectives that have been identified as important in the industrial work context [5, 6]. The design process of the tool is based on UX goals [7] that have been defined from the perspectives of the two user groups of the tool: solution developers collecting feedback as well as industrial workers providing their feedback.

First, we present a brief overview of collecting worker feedback on new technology solutions in industrial work context. Then, we describe the design process and the resulting WorkerFeedback tool, with examples of implementing the UX goals and illustrative images of the user interface. In the discussion, we highlight the role of UX goals and ethical considerations during the design process.

## 2 COLLECTING WORKER FEEDBACK ON NEW TECHNOLOGY SOLUTIONS IN INDUSTRIAL WORK CONTEXT

In human-centred design, it is important to focus on technology users, their needs and requirements and apply human centric methods and techniques [8]. Even though the participation of users (and other stakeholders) in the design process has been long acknowledged, for example in the participatory design approach [9, 10], new practical methods to improve users' participation are still needed, especially in the industry work context. According to Neumann

et al. [11] research on Industry 4.0 technologies and their implementation has not considered humans thoroughly. They think that systematic consideration of human factors in the implementation of novel technologies could avoid negative consequences for employees, organisations and for society as a whole.

According to Kaasinen et al. [12], industry workers would like to be more involved in the design of their workplace and processes. Involving and informing workers early in the design or implementation process of upcoming technologies has brought benefits, such as better motivation to learn using the new solutions and less frustration or reluctance to work with the new tools [13]. One way to involve workers is to provide a possibility for them to give feedback of the tools that are designed to be used as part of their work. User feedback may be a key factor in contributing to the major challenge of how to integrate various new systems into the work processes [14], especially as the industrial work processes, work roles and ways of working are expected to be in a phase of substantial transformation [15].

Traditional methods, such as questionnaires and interviews, have been utilised to collect data on using novel tools in the industry work context (e.g. [16, 17]). In addition, the use of non-invasive wearable devices to measure physiological parameters has been proposed to complement traditional user study approaches [18]. However, ways to evaluate user experience in a work context are still immature and scattered and could be improved by focusing on the actual user experience rather than business-related and problem-solving issues [19].

Questionnaires to evaluate human-technology interaction typically focus on one certain topic, such as usability or user acceptance [20]. They provide useful information on one phenomenon but are lacking a holistic overview to several design perspectives. In the industry work context, the methods to collect worker feedback should be quick and effortless to encourage workers to participate and thus, filling in multiple questionnaires to cover different topics is not feasible. Interpreting the results of various questionnaires is also more challenging for the solution developer.

In addition to ready-made questionnaires, several survey software tools are available for creating tailored questionnaires (e.g., Questback [21] and SurveyMonkey [22]). These tools support easy data collection and analysis, but require the expertise of defining suitable questions, formulating them and interpreting the collected answers. As all solution developers do not have this expertise, a quick and simple feedback tool to provide an overall view to relevant human-centred design perspectives would be beneficial.

### 3 DESIGN PROCESS OF WORKER FEEDBACK TOOL

The design process of the WorkerFeedback tool comprised of creating UX goals for the tool, selecting the questions for collecting worker feedback, designing the user interface (UI) and reviewing usability, functionality and visual aspects as well as ethics of the design. The iterative design process also included continuous testing of the new features and functions by the design team, which consisted of three UX experts, having all over 20 years' experience of human-centered design. The tool was designed as part of a European research and development programme aiming at creating

solutions to support industrial work, both by supporting the design of new solutions as well as by providing new solutions for industrial use.

#### 3.1 Defining the UX goals

The design process of the WorkerFeedback tool started from the concept idea of providing a simple and quick-to-use questionnaire tool to support solution developers in collecting worker feedback of their solution in the industrial work context. The UX goals were defined for the tool to agree on and commit to the main goals for the design, both from the solution developer's and the workers' perspectives. The UX goals were defined by the design team based on the related work and on the design team's prior experience of working with solution developers and workers.

For solution developers' user interface, goals targeting usefulness, easiness of use and trust were emphasized, to ensure that the tool would be easily adopted and provide useful information. The following UX goals were defined:

- **Feeling guided:** The technology designer finds the tool easy to use, even though the designer would not be familiar with making questionnaires or collecting user feedback.
- **Feeling informed:** After collecting the feedback, the technology designer feels informed. The feedback gives an overview of the different aspects of the design, which guides the designer further in developing the solution.
- **Feeling confident:** As the questionnaire is ready-made, the technology designer feels confident that the tool is ethically sound, appropriate for its use and includes relevant aspects of UX.

From workers' perspective, an experience of involvement, in an effortless way, was pursued. The following UX goals were defined:

- **Feeling guided:** The worker finds the questionnaire easy and effortless to fill in.
- **Feeling involved:** The worker feels having an opportunity to contribute to the development of the work tools.
- **Feeling relaxed:** The worker feels it is possible to give honest feedback.

#### 3.2 Selection of the questions for collecting worker feedback

The questions for collecting worker feedback were originally defined based on the Design and Evaluation Framework for Operator 4.0 solutions [5], that includes five design and evaluation perspectives: user experience, user acceptance, usability, safety and ethics. The first version of the questionnaire has been used in two studies [17, 23], and after that, the framework has been complemented with two design and evaluation perspectives: usefulness and ergonomics [6]. These perspectives were added as they were identified as critical for the value of the developed system and the workers' physical and mental wellbeing. The 14 questions have been formulated to cover each of the seven perspectives of the questionnaire, which provides a holistic, yet concise overview of relevant worker-centric design and evaluation aspects. Although the questionnaire is not validated, it was selected due to its context-relevance and the holistic scope that was considered potential to provide design insights.

In addition to adopting the questions related to the seven design and evaluation perspectives, background questions of respondents' demographics were defined.

### 3.3 User interface design

The user interface of the tool was iteratively designed in design workshops that proceeded from designing the key design elements and overall structure to detailed UI design. In addition to the three UX experts, one software developer participated in relevant design sessions and implemented the tool. The concept and the overall structure of the user interface are presented in section 4.

### 3.4 Design reviews

The first design version of the tool was reviewed by the design team from the perspectives of usability, functionality and ethics. Based on each review, modifications to the UI were implemented. The reviews covered both the solution developer's view and the workers' view of the tool.

The purpose of the usability review was to ensure that basic usability is not overlooked while focusing on the more general UX goals. The review was conducted based on the usability heuristics created by Nielsen [24]. Each view of the tool interface was reviewed from the perspective of the ten heuristics.

The review of functionality and visual aspects was conducted in co-operation with two human factors experts of a project partner responsible for supporting the UI design of the tools developed in the project, from the perspective of industrial and functional requirements. The areas of analysis included navigation, visual aspects, feedback messages, user input and interaction, as well as profiling of the tool. The appropriateness of functionality and visual aspects was evaluated with altogether 26 statements and the severity of potential problems or missing functions was assessed on a scale 0-3.

In addition to usability and functionality, the first version of the design was reviewed from the perspective of ethics, which has been considered important to be embedded in project work and design activities [25]. The review was conducted based on 12 ethical guidelines, created to support the design of digital solutions in industrial work [26]. The design decisions were reviewed from the perspective of each of the 12 guidelines related to the ethical themes of privacy, autonomy, dignity, reliability, inclusion and benefit to society [27]. The ethics review was conducted to support the UX goals related to ethics and on a more general level, to follow the ethics by design approach [28], aiming at proactive consideration of ethics in an early phase of the design process. In addition, a data protection expert was consulted to understand the impact of General Data Protection Regulation (GDPR) [29] on the design of the tool.

## 4 WORKER FEEDBACK TOOL

This section presents the design of the WorkerFeedback tool, first from the solution developer's perspective and then from the industrial workers' perspective. The design is presented with a brief description of the key features and functionalities with illustrations of the main views. The results also describe how the UX goals are realised in design.

### 4.1 Solution developer's perspective

The WorkerFeedback tool was designed to be a web-based tool that enables a developer of a solution to collect feedback on the use of the solution when it is piloted or tried out by test users. The tool includes a possibility to use the questionnaire for different test cases, check the status of the responses and view the results of each case. The ready-made questions for collecting worker feedback include four background questions (gender, age, work role and experience in using the solution in question) and fourteen statements linked to seven design perspectives: user experience, usability, user acceptance, usefulness, ergonomics, safety and ethics (see the statements in [6]). Each perspective is addressed by two statements. All statements also include a possibility to share open feedback related to them.

The main page of the tool lists all the test cases for which the solution developer has adopted the questionnaire. It shows the number of responses for each case, a link to the results and options for creating, editing and deleting test cases. When the user wants to create a new test case, a new page is opened for that. The page includes a preview of the questionnaire items and editable fields with pre-filled texts, except the name for the test case and the expiration date that need to be added. The Results view of each test case shows an overview of the responses (Figure 1), background information of the respondents (Figure 2), detailed scales of responses to each questionnaire item (Figure 3) and open feedback (Figure 4).

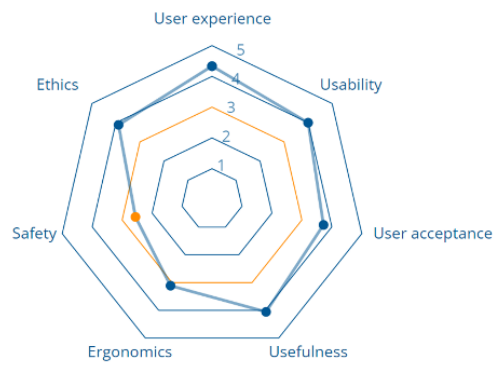
The UX goal *Feeling guided* is followed in design: The use is based on the ready-made questionnaire [6], which ensures that relevant design aspects are considered, and no expertise of user experience design is necessarily needed when collecting feedback. The user is guided by providing indications and information for creating and sending the questionnaire as well as for interpreting the results, which also supports the UX goal *Feeling informed*. To serve different needs of users, results are shown on two levels: as an overview showing the average scores of the feedback in a visual format (Figure 1) and as detailed scales of each question with access to open feedback for deeper understanding (Figure 3). The UX goal *Feeling confident* is supported by providing the ready-made, research-based set of questionnaire statements and by considering ethical aspects of use, especially ensuring that the users can give their feedback anonymously. This is supported by not collecting personal information of the respondents, defining background questions at a general level (e.g., categorising age to three age groups only) and not showing the results before the minimum number of four responses. The latter design decision also supports the UX goal *Feeling informed*, not to misdirect the designer of the results based on the very first responses.

### 4.2 Workers' perspective

For the respondents, such as industrial workers who have been testing or using a new solution, the tool gives a quick and easy method to give feedback of the use of the solution. To give feedback, the respondents receive a web link, which leads to a questionnaire optimised to be completed using a mobile phone. The questionnaire starts with a welcome page for a short informative text and then proceeds through the four background questions and the fourteen questionnaire statements with a possibility to add free feedback

## Overview

N=9



### Results:

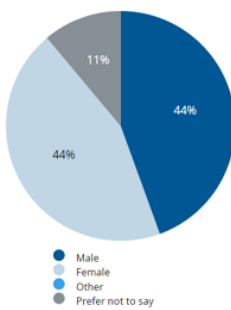
User experience	4.3
Usability	4.0
User acceptance	3.7
Usefulness	4.1
Ergonomics	3.1
Safety	2.6
Ethics	3.9

5 = Excellent; very well designed  
 4 = Good; nice to use  
 3 = Neutral; neither like nor dislike  
 2 = Poor; further investigation suggested, consider changes  
 1 = Very poor; further investigation needed, changes should be implemented

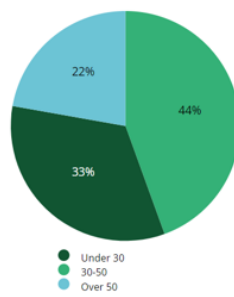
Figure 1: Overview of the worker feedback results.

## Background

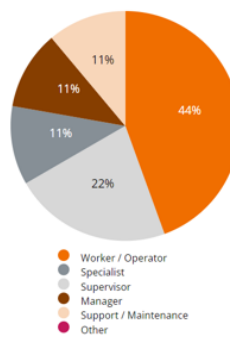
How would you describe your gender?



What is your age?



What is your work role?



Have you used this solution before?

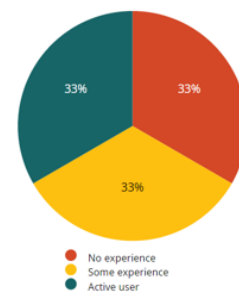
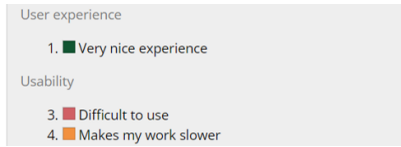


Figure 2: Background information of the respondents.



Figure 3: Detailed scales of worker feedback related to each questionnaire item.



**Figure 4: Compiled open feedback with a connection to the responses indicated with colors.**

related to each statement (Figure 5). At the end of the questionnaire, the respondent is allowed to share any free feedback on the use of the solution.

The UX goal *Feeling guided* is realised by minimalistic UI design with concise introduction texts and a progress bar to make the status of the questionnaire visible to the respondent. The UX goal *Feeling involved* has been the fundamental goal of the tool from the workers' perspective and is aimed to be supported by the easy-to-use user interface and clear formulation of the questions, to encourage filling in the questionnaire without excluding respondents, for example, because of digital skills. The UX goal *Feeling relaxed* has been considered in design decisions related to privacy of the users: no personal information is collected, and the user is briefly informed about privacy as well as the voluntariness of responding to the questionnaire. The tool enables giving open feedback to allow users to share their thoughts, but it is also possible to respond to the statements only.

### 4.3 Modifications based on the design reviews

The usability review of the tool led to several minor UI modifications. Most of the identified usability issues were related to consistency and to aesthetic and minimalist design. Regarding consistency, it is essential to use the same terms and the structure of the user interface throughout the tool to meet the users' expectations [24]. In the reviewed version of the tool, the inconsistencies concerned, for example, the placement of the "Login," "Save" and "Cancel" buttons that inadvertently were not logically placed when navigating in the

tool, as well as the use of uppercase or lowercase letters. As for the aesthetic and minimalist design, it should be ensured that the visual elements of the interface support the user's primary goals [24]. The review resulted in removing unnecessary UI elements; for example, a column "State" to indicate the status of the questionnaire, was considered unnecessary. The usability review proved to be useful, as the design was conducted as a co-creation activity in several phases, which had caused minor inconsistencies and other usability issues.

In the further review of functionality and visual aspects, the UI was assessed to meet the joint UI requirements of the project, and no severe problems were identified. For example, regarding visual aspects, the icons of the tool were evaluated as universal and intuitive, and no changes were considered necessary. However, some development needs were identified for further design, such as developing language variants, which had not been topical in this early stage of the design.

In the ethics review, the guidelines related to privacy of users [26] were identified as most relevant for the design of the tool. To ensure anonymous responding to the questionnaire, the background information was decided to be less detailed than originally designed, and the minimum number of respondents was decided to be four, to protect the privacy of users, but still not to prevent collecting feedback of small samples that are typical in the industrial work context.

## 5 DISCUSSION

This paper described the design process and the resulting design of the WorkerFeedback tool, enabling a straightforward way to collect worker feedback on the use of novel technology solutions in an industrial work context. The aim of the WorkerFeedback tool is to serve both the developers of new solutions to easily collect informative feedback from the (test) users of their solutions and industrial workers to effortlessly provide their feedback, thus enabling an uncomplicated way of participating in the design of new work tools.

**Figure 5: Workers' view on the feedback questionnaire.**

The tool responds to a gap of not thoroughly considering human aspects when designing novel technological solutions in the industry work context [11, 12]. The tool includes ready-made questionnaire items of seven design and evaluation perspectives [6] and thus, it provides a holistic view of workers' experiences when using a novel technology solution. Along with helping also non-UX experts to collect feedback, it guides a feedback collector to understand the results and how to interpret them. Unlike existing survey software tools (e.g. [21, 22]) it does not require knowledge of creating questionnaire items or combining questions from multiple questionnaires [20].

During the design process, UX goals were used as a method to focus on the needs and the intended user experiences of both user groups. The UX goals for the solution developer's UI were defined as 1) feeling guided, 2) feeling informed, and 3) feeling confident. These were followed with consistent and minimalistic design (1), several views on results to serve different information needs of solution developers (2) and providing a research-based set of questionnaire statements and aiming at ethically sound design principles (3). The goals aim to ensure easiness of use, obtaining valuable results and building confidence in assessing the design from different perspectives, even though the solution developer would be unexperienced in collecting user feedback. The UX goals for the industrial workers' UI were defined as 1) feeling guided, 2) feeling involved and 3) feeling relaxed. The goal feeling guided aims to ensure that the use of the questionnaire stays quick and simple, not to exclude any respondents due to their time constraints or digital skills. The other two UX goals aim to support workers' feeling of participation in designing their work tools and their willingness to share honest feedback.

UX goals guided the design decisions during the design process. While the goals were found important and unambiguous by the design team, some contradictions occurred. First, to become informed, the solution developer might want to add, remove, or modify questionnaire items of the tool. However, to ensure holistic view on human-centered aspects, the questionnaire was decided to be fixed. The solution developer could also benefit from detailed background information of the respondents, for example concerning their work role and work tasks. To ensure anonymity, however, the background information was decided to be collected at a very general level. The third dilemma concerned the possibility to share open feedback related to the questions. As open feedback is likely to provide insights for the solution developers and it enables respondents to freely share their experiences, it is important to provide this possibility. However, from the perspective of anonymity, it would be good to guide the respondents not to reveal any personal information in their responses, and this, in turn, may discourage sharing open feedback and restrain the feeling of being relaxed.

In general, the aim of ensuring the anonymity of respondents according to GDPR was a challenge during the design process and needs to be considered when utilising the tool or designing similar feedback collection tools. Even though privacy of respondents is protected by not collecting direct personal information of them, not collecting detailed background information, and not showing the results until a minimum number of four responses, still some personal information may be conveyed to the feedback collector as part of the open feedback. The GDPR compliance still needs to

be confirmed by the data controller, whether it is the designer of the feedback collection tool or a solution developer collecting the feedback.

The contribution of this paper lies in presenting a tool to foster collecting worker feedback in an industrial work context as well as giving a concrete example of a design process including UX goals for the two target groups of the tool. This supports the call for human-centered design to create design and innovations instead of only evaluating designs [30] and to focus on the process of UX design and design decisions in practice [31] including also ethical considerations. Currently, the tool is designed to be used with the ready-made questionnaire [6], but it is possible to include other questionnaires and a possibility to create questionnaires to the tool later if considered necessary. The tool is designed to support the development of different types of technological solutions in the industrial context, whether they support perceptive, cognitive or physical activities. However, it may be applied also in other work contexts, especially in hands-on work.

The design of the WorkerFeedback tool has been iterative and it has been reviewed by the design group. To ensure that it fulfills the UX goals and is usable and appropriate to use, it still needs to be studied in real use cases. In the future, testing the tool in real-life industrial use cases will eventually validate the value of the tool.

## 6 CONCLUSIONS

This paper introduced the design process and the resulting tool for collecting worker feedback (WorkerFeedback tool), intended to be used especially in an industrial work context. The tool is designed to be quick to use but still to support holistic design by including assessment of different design perspectives. The design process of the tool is based on UX goals that were defined from the perspectives of the two user groups of the tool: solution developers collecting feedback as well as industrial workers providing their feedback. The UX goals, ethical considerations and design choices presented in this paper can be beneficial for the design and research community as well as for solution developers focusing on solutions that have similar user groups and goals.

## ACKNOWLEDGMENTS

The authors are grateful to Timo Kinnunen who has implemented the tool as well as colleagues and experts who have given feedback of the tool. This research has been funded by the European Union's Horizon 2020 research and innovation program under grant agreement No. 873087 (project SHOP4CF).

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